2015 - 2016

Annual Report

British Beet Research Organisation
BBRO

Introduction

We have produced this new Annual Report to help growers and stakeholders understand more about the work being carried out on behalf of the UK sugar beet industry. A recent survey of attendees at the BBRO's Winter Technical Meetings in February 2016 showed that this new publication had popular support and we hope it will become an important part of BBRO output.

Independent reviews of our research portfolio have been carried out over the last two years and the BBRO is often asked how project funding is agreed. In this report our prioritisation process, carried out by the stakeholder board on your behalf, has been outlined by Alison Lawson, Chair of the Stakeholder Board.

This new Annual Report covers the three 'core pillars' of activity: Crop Progression, Crop Stability and Crop Recovery and has a summary of each project with details of the work being carried out as well as project milestones, outcomes and recommendations.

Finally, I would like to thank the research partners and the BBRO's dedicated research team for work carried out on behalf of the UK sugar beet industry.

Colin MacEwan
Head of BBRO

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BBRO Board

Stakeholder Board

Alison Lawson
BBRO Stakeholder Board Chair
BBRO Office – **01603 672169**
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Stakeholder Board Members

Alison Lawson (Chair)
Agricultural contractor and grower

Susie Emmett
Green Shoots

Mark Fletcher
Grower

Colin MacEwan
BBRO

Nick Morris
British Sugar

Simon Smith
Grower

Paul Simmonds
British Sugar

Dr Debbie Sparkes
University of Nottingham

There have been a number of changes to the BBRO structure over the past few months and some exciting developments on the horizon. It has been a great pleasure, as Chair of the BBRO Stakeholder Board to be part of this development process. We have a small team of eight Board members representing growers, processor and industry; meeting four -five times a year. Our role includes assessing projects against 13 differing criteria to ensure projects are robust, targeted and of high value. The BBRO research programme is funded from the levy payment so it is vitally important to us that we invest in research that has the potential to impact positively on the industry.

The core work of BBRO is of course based in research, however, we are increasing our efforts to ensure the key outcomes of our work reach the growers. The Stakeholder Board has spent a lot of time discussing communications and we are pleased to announce the launch of our new website **www.bbro.co.uk** and the development of an exciting knowledge exchange programme.

We have also strengthened our science team, appointing Dr Simon Bowen to the newly created role of yield progression and knowledge exchange lead. He has excellent knowledge of soil health and will be particularly focussed on crop growth; whilst Dr Mark Stevens concentrates on crop health and the management of weeds, pests and diseases as lead for crop stability and Colin Walters develops the crop recovery pillar. Those of you attending the BBRO Winter Technical Meetings, held in February will be aware that we are also developing new young scientists by supporting a number of PhD students researching areas relating to the sugar beet crop, investing into the future security of the crop. Their presentations were well received and we will be building on this aspect as we move forward.

Despite the strength of knowledge and experience we have on the Stakeholder Board we are sure there are some 'on farm' innovations that we could all still learn from and some best practise to be shared. I strongly encourage growers to pick up the phone, dial our new number and get involved.

Technical Board

Technical Board Members

Dr Debbie Sparkes	*University of Nottingham (Chair)*
Dr Ian Bedford	*John Innes Centre*
Dr Jim Monaghan	*Harper Adams University*
Dr Tim Hess	*Cranfield University*
Dr Jon Knight	*Agriculture and Horticulture Development Board*
Dr Mark Stevens	*BBRO*

It is vital that the BBRO research programme translates into practical on farm delivery. In order to ensure this happens each of our core pillars of activities contain an element of knowledge exchange (KE), led and co-ordinated by Dr Simon Bowen. This targeted KE strategy has five clear objectives:

1	2	3	4	5
Promote the **BBRO brand**	Enable an innovative and dynamic **culture**	Maximise value through **collaborative data** collection	Deliver KE through a robust yet flexible **structure**	Convey **personalised** knowledge with impact
To demonstrate credibility and **consistency**, build allegiance and increase influence among stakeholders	Capable of working collaboratively to adapt to a changing environment	To understand and respond to the changing needs of the growers and processor and measure the effectiveness of our actions	To consistently ensure **widespread** KE and uptake of good practice	To frame and target information to the correct audience for maximal impact

Increasing our engagement is of utmost importance and we have adopted a flexible approach to delivering a tailored service to growers, advisers and influencers. This includes Winter Technical Events, Summer Field Demonstration Days, access to demonstration sites, grower meetings, training and of course the Advisory Bulletin.

As BBRO strengthens so does the number and relevance of key messages we need to get out to industry. We are all too well aware of the time pressures for growers and are therefore creating ways to easily digest information to assist in the day to day management and decision making for the sugar beet crop. This includes the launch of our updated website **www.bbro.co.uk**. The site will allow quick and easy access to our latest reports, pest and disease updates, key messages as the crop develops and special BBRO grower events.

For those of you into social media check out our accounts: **Dr Beet** **@bbro_research** for updates and grower to grower discussions, or follow **@BBRO_Beet** for news items.

Ensuring growers receive the info they need in a timely fashion is one thing, but bringing the information to life in a practical form for all involved is quite another. To help achieve this we are developing a suite of courses aimed at operators. The first pilot events held in February for drill operators proved popular. These will be developed for next year to include more on seed bed preparation and practical drill use. We will also run courses on: weeds, pests and diseases, crop recovery and agronomy for sugar beet growth.

To find out more info please check out the website:

www.bbro.co.uk

call our new phone number:

01603 672169

or email Ches Broom:

francesca.broom@bbro.co.uk

BBRO@bbro.co.uk

BBRO

Research Theme:

4.

Crop Progression

Crop Progression

Project Lead:
Dr Simon Bowen

Agronomy based KE role:
Soils, Water, Nutrition.

Crop Progression is one of the three BBRO pillars. This pillar focuses on soil management and crop establishment. It is well established that there is a direct relationship between radiation interception and sugar yield so the key to producing a high yielding crop is early canopy closure which enables the crop to utilise the high levels of solar radiation received in June and July. Aspects of agronomy such as soil management and cultivation, variety choice, plant population, planting dates and the nutritional and water requirements of our crops are therefore important factors in influencing the progression of our yields.

A recent BBRO review of the agronomy requirements of the beet crop by Dr Debbie Sparkes at the University of Nottingham reminded us of a yield gap in excess of 25t/ha (5t/ha sugar) between commercial yields and those achieved in variety trials. The yield gap between commercial yields and the potential yield, as calculated by a beet crop growth model is somewhat greater.

The Crop Progression research programme is targeted at areas where we believe there is the greatest potential for closing this yield gap. Whilst improved genetics (varieties) continues to close the gap, there is a need to strengthen the programme in other key areas such as soil management, early crop rooting and canopy development and how these are influenced by the nutritional and the water relationships between plants and the soil, leading to an understanding of how we can optimise our management of these.

We are also targeting the use of on farm data to identify how we can further progress yields. It is usually the interaction of a range of agronomy factors on farm that delivers an improvement and the smarter and more precise decisions that drives these improvements comes from having good data on our crops. Using different ways of collecting this data through crop and soil sensors, remotes sensing and using benchmarking and yield models is increasingly recognised as key. This is an area that BBRO is already working in and will be looking to engage with growers going forward.

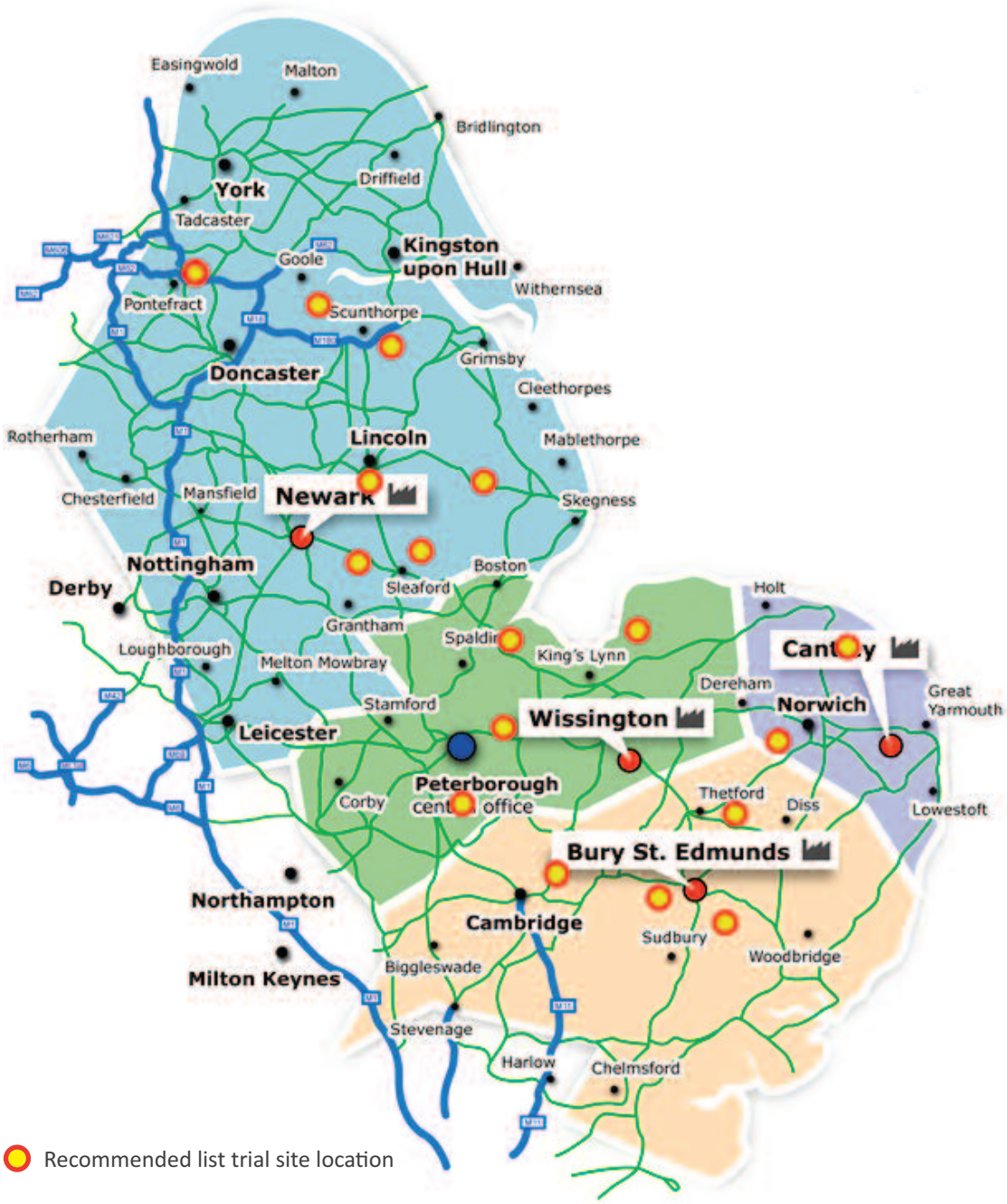
Variety Trials Programme

Project Summary

The research programme, jointly funded by BBRO and the British Society of Plant Breeders (BSPB), provides data for the preparation and selection of a Recommended List (RL) of Sugar Beet Varieties. The research is designed to monitor the development and improvement of sugar beet varieties made by breeding companies. A comprehensive set of field trials assess agronomic performance, disease resistance and bolting levels. Carried out by BBRO, KWS, NIAB and SESVanderHave, the programme provides information for all sectors of the sugar industry for efficient variety selection, utilisation and development. Yield trials are located within commercial crops and receive inputs appropriate to their locations and soil type. Additional trials are early sown to measure levels of bolters. Special plots are grown to assess variety response to inoculated levels of powdery mildew and rust.

Tarehouse at Wissington designed specifically for analysing trials plots

2017 Recommended List Trials Programme Locations



Recommended list trial site location

The Recommended List Trials Programme involves 17 sites of which 13 can be taken to full yield assessments. The programme includes trials for disease assessment and early sown bolting. Our target is to select eight out of 13 of the trials for harvest, with the results going towards the Recommended List. The yield assessment sites involve 120 varieties, with four replications of each. That's a total of 3,840 plots taken from seed to harvest and ultimately processing through the BBRO plot trial processing unit with the sugar analysis being done in the commercial tare house at Wissington.

Research Theme:

Crop Progression

BBRO/BSPB Recommended List 2017

Variety *(ranked in sugar yield order)*	Status [1]		Mean of Relative data an of (C) varieties = 100				Sugar content %	Bolters per ha		Rust	Powdery mildew	Year first listed	Maintainer [7]
			Sugar yield [3]	Adjusted Tonnes [3]	Root yield [3]	Plant population [4]		Early sowing [5]	Normal sowing	1=susceptible 9=resistant [6]			
Mean of controls			**17.3t/ha**	**113.6t/ha**	**95.9t/ha**	**100%**	**18.1**	**8,043**	**40**	**4**	**4**		
Recommended List													
Darnella KWS	PR1		105.0	105.0	105.4	99.7	18.1	18,724 #	62	(3)	(6)	2016	KWS
BTS 260	PR1		104.1	104.1	104.3	95.1	18.1	12,183 #	50	(6)	(5)	2016	BET
Sabatina KWS	PR2		103.9	103.8	104.2	99.0	18.1	8,954	16	(7)	(5)	2015	KWS
Alisha KWS	PR1		103.8	104.0	101.8	98.4	18.5	12,646 #	38	(7)	(5)	2016	KWS
BTS 470	PR2		103.7	103.8	102.8	99.6	18.3	15,788 #	91	(5)	(5)	2015	BET
BTS 860	PR1		103.3	103.6	101.7	99.0	18.4	10,143	9	(6)	(5)	2016	BET
Salamanca KWS	PR2		102.5	102.5	102.2	101.1	18.2	11,359	42	(6)	(5)	2015	KWS
Firefly	PR1		101.9	101.7	102.7	100.1	18.0	3,355	42	(2)	(5)	2016	SV
BTS 340	PR2		101.7	101.5	102.6	98.9	17.9	9,447	74	(1)	(5)	2015	BET
Pasteur	R (C)		100.9	101.0	100.4	100.9	18.2	5,166	7	4	5	2011	STR
Haydn	R		100.9	101.0	100.6	98.8	18.2	3,121	0	5	(4)	2013	STR
Hornet	PR3		100.7	100.8	100.3	99.4	18.2	9,740	50	6	(4)	2014	SV
Springbok	R (C)		100.3	100.5	99.6	98.7	18.3	10,561	69	5	(4)	2013	SV
Cayman	R (C)		100.1	100.1	100.2	101.3	18.1	7,147	40	4	4	2011	SV
Stingray	R		99.9	100.0	99.9	98.7	18.1	6,145	52	6	(4)	2013	SV
SY Muse	R (C)		98.8	98.6	100.0	100.5	17.9	9,471	26	4	5	2012	SYN
Descriptive List		**Specific use [2]**											
Sandra KWS	S	AYPR	98.4	98.4	97.7	100.1	18.3	25,792 #	114	5	5	2013	KWS
Cantona KWS	PS1	BCN	104.1	104.3	103.3	99.1	18.3	7,511	50	(6)	(5)	2016	KWS
Aurora	PS2	BCN	100.3	100.0	102.2	100.6	17.8	9,666	96	(5)	(3)	2015	SV
Leesha KWS	PS2	BCN	100.2	100.6	97.1	100.9	18.7	13,488 #	127	(8)	(5)	2015	KWS
Davy	PS1	BCN	100.0	99.7	101.9	99.0	17.8	12,836 #	54	(5)	(4)	2016	STR
Flixter	PS1	BCN	99.9	99.4	102.8	96.5	17.6	7,110	0	(3)	(4)	2016	SYN
Thor	S	BCN	99.2	99.1	100.0	100.1	18.0	3,305	33	5	2	2012	STR

Definitions and Explanations:

1. All newly listed varieties (PR1/PS1) have results from three years using breeders' seed. Thereafter commercial seed is used and the data from breeders' seed is phased out. R and S varieties have normally been tested with seed from commercial bulks but there are exceptions (visit www.bbro.co.uk).

2. AYPR and BCN varieties are not recommended for general use but only for where the relevant problem exists. All characters reported were determined in trials in the absence of AYPR/BCN.

3. Differences in yields of less than 3% should be treated with reserve. Control varieties are indicated by (C). The control set includes Lipizzan which is no longer listed.

4. Based on pre-gapping population counts. Yields based on average harvest population of 104,000 plants/ha.

5. Varieties marked with a # should not be sown before mid-March, due to their propensity to produce higher levels of bolters in cold conditions. In most seasons, for sowing after mid-March, the ratings from normal sowings are applicable.

6. Bracketed figures (x) denotes limited data.

7. Breeders/maintainers and their UK agents are listed on www.bbro.co.uk

Disclaimer

Understanding plant/soil interactions to improve sugar beet productivity

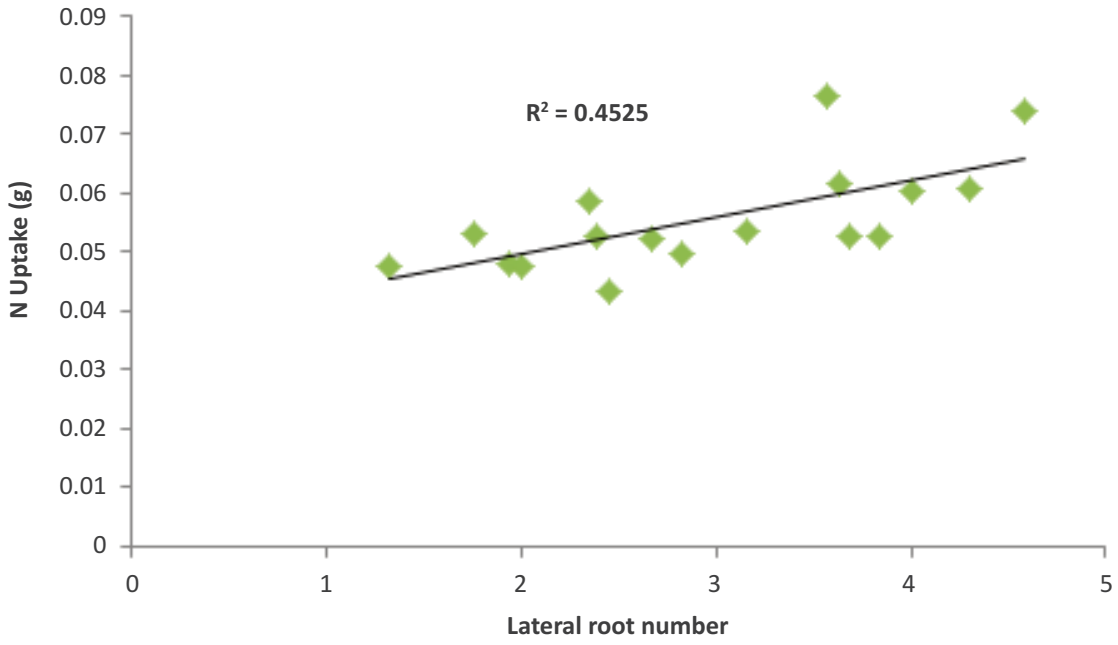
Project Summary

On average, 10% sugar beet yield is lost to drought in the UK. In field surveys are being used to identify constraints to rooting at depth, which limits water uptake. Future work will explore ways to overcome the constraints identified. The importance of early nutrient uptake to enhance rapid canopy expansion is well understood. In this project we aim to identify rooting traits linked to enhanced nutrient uptake, and thereby yield, with the long-term aim of providing a screen for use by breeders. Patchy establishment is a problem in many sugar beet fields; by surveying seedbeds over a number of years we will identify the seedbed properties most important in determining emergence and develop a tool to quantify seedbed quality.

Main Objectives

- Identifying limitations to water uptake for sugar beet in the field; and potential solutions.
- Link rooting traits to nutrient uptake to develop a screen for use by breeders.
- Identify the optimum seedbed conditions for sugar beet establishment.

Sponsor: **BBRO**
Project Leader: **Dr Debbie Sparkes**
Status: (year) 1 **2** 3 4



Outcomes and Achievements

- Survey of beet fields measuring penetration resistance and taking 1 metre soil cores for X-ray CT scanning to look for rooting constraints (see opposite).
- Root phenotyping of commercial varieties shows links between lateral root number and early nitrogen uptake (graph above).
- Using soil properties measured in 16 beet fields drilled in 2015, models were developed that accounted for 60% of the variation in establishment on mineral soils and 44% on peat soils.

Key Messages for Growers and Industry

Compaction constraints at depth have been identified in a number of sugar beet fields surveyed, which may limit root exploration and water uptake. A field experiment in 2016 will follow root growth/water uptake in more detail (linking with PhD student Tamara Fitters' project, see page 50) The relationship identified between early rooting traits and nutrient uptake, identified in commercial varieties, is currently being tested on breeders' lines. The 2015 seedbed survey found a good relationship between soil physical properties and sugar beet establishment; over the next two years, we will test the robustness of this relationship across seasons and soil types.

Sequential root dig

Project Summary

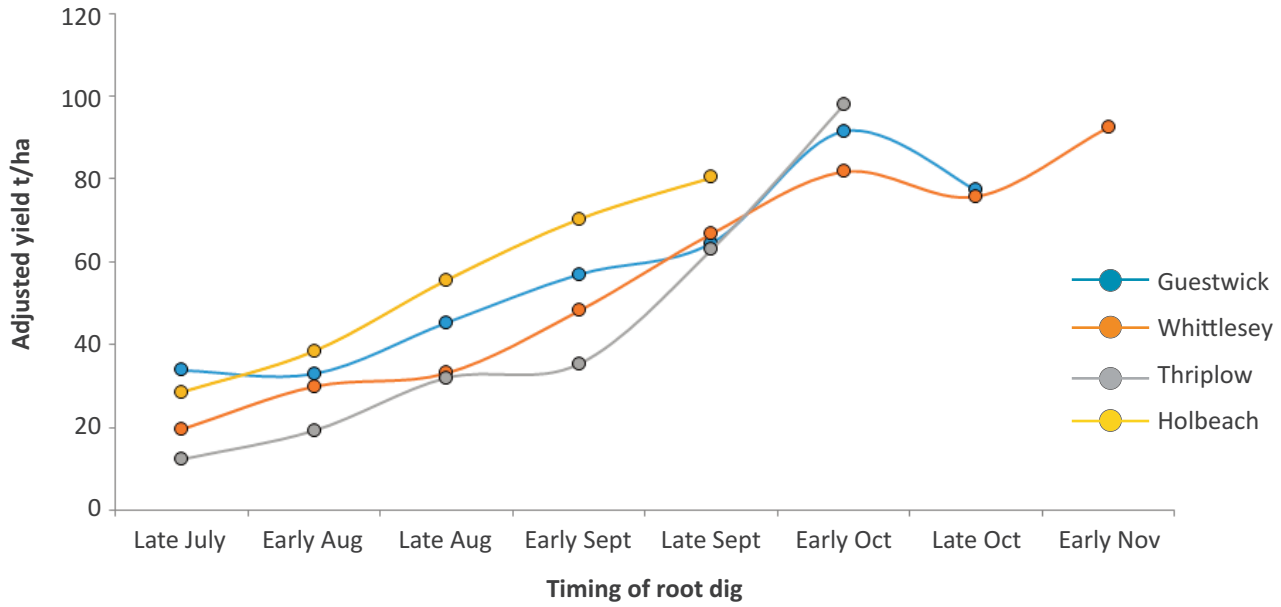
The adjusted yield of clean beet is the product of clean beet yield and their sugar percentage. Clean beet yields are not only governed by how much fresh or dry matter a crop produces, but also by how these are partitioned between tops and beet. Similarly, the yield of sugar is determined by how much of the beet's weight is present as sugar, non-sugar dry matter or water. All of these factors vary on different soil types, between seasons and (it is believed) with plant population. Past work has documented some of these changes in experimental crops, and this work aims to provide corresponding data for modern, high-yielding crops.

Main Objectives

- To establish four sites on a range of soil types each year from which roots are sequentially harvested throughout the season.
- Assess the dry matter production, sugar content and quality by undertaking sequential test digs from June until crops are harvested.

Sponsor: **BBRO**
Project Leader: **Simon Bowen**
Status: (year) **Ongoing**

Sequential Root Yields



Outcomes and Achievements

- At the moment the data base contains around six years of data which is very useful in demonstrating the progression of yield throughout the season. We have increased the length of the root digs programme into the later season
- The 2015 data from the later harvested site at Whittlesey showed an increase in yield of 36% between late September and the middle of November.
- Bearing in mind that the autumn of 2015 was relatively mild, it reinforces the yield potential of crops in the later part of the season, especially when crop canopies remain good and in good soil conditions.

Optimising plant populations and nitrogen (N) rates for modern, high-yielding sugar-beet crops

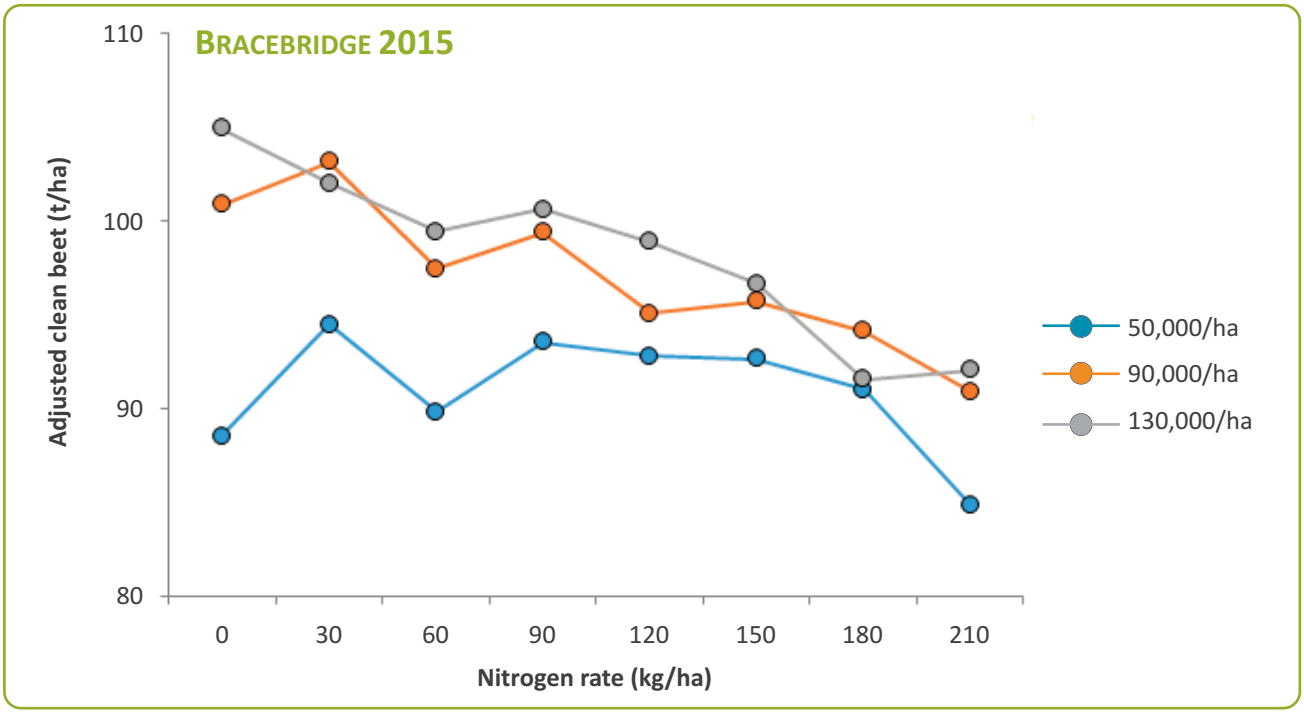
Project Summary

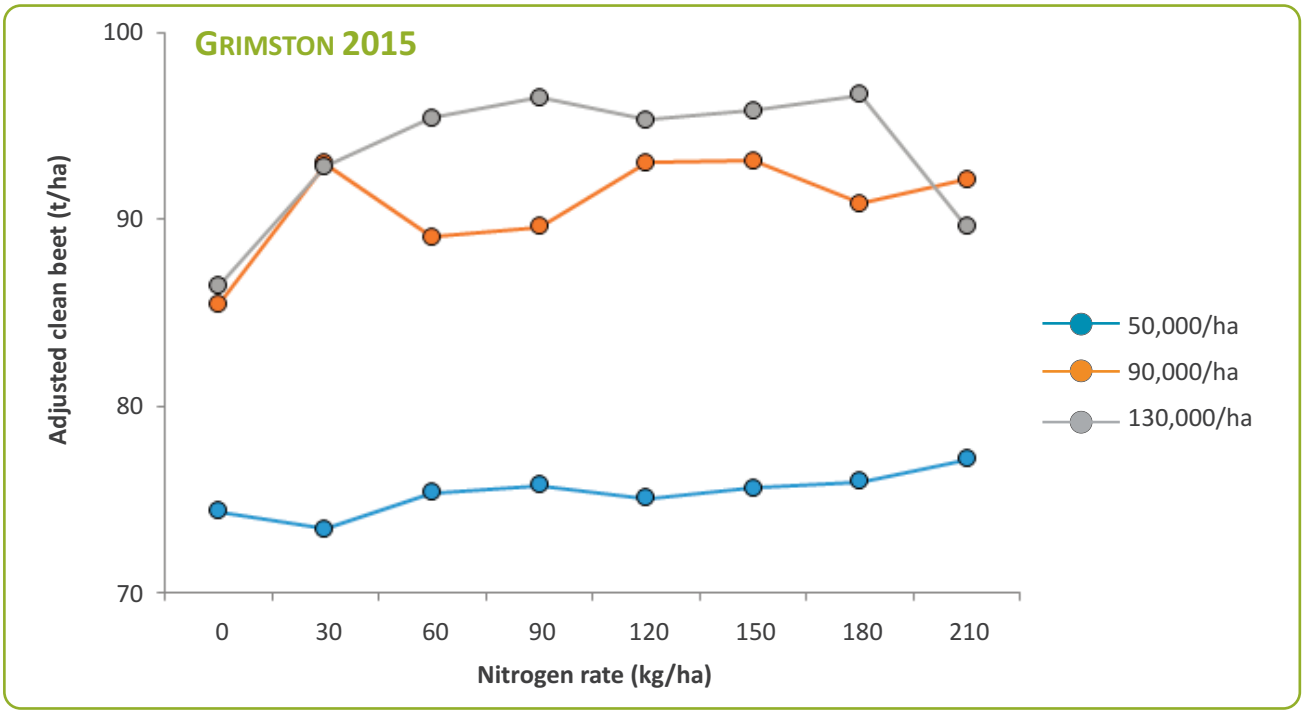
There is circumstantial evidence to suggest that some UK high-yielding sugar-beet crops grown under modern conditions may benefit from higher-than-recommended plant populations and more nitrogen fertiliser. This extensive three-year programme of experiments will examine this by testing factorial combinations of up to seven rates of N (0-200 kg/ha) and six plant population densities (50,000–150,000/ha) on different soil types. **This will allow plant number/N rate yield-response curves to be created to more precisely establish optimal plant numbers and N rates for different soil types**.

Main Objectives

- To assess the interaction of different nitrogen rates and plant populations on crop performance.
- To assess this interaction across different locations (soil types).
- To understand the basis for any interaction in terms of crop partitioning of dry matter.

Sponsor: **BBRO**
Project Leader: **Simon Bowen**
Status: (year) 1 2 **3** 4





OUTCOMES AND ACHIEVEMENTS

- At the Grimston site (sandy loam) there was no response to nitrogen, but a significant effect of population.
- At the Bracebridge site (limestone brash) there was a negative response to nitrogen and plant population, but no interaction between the two factors.
- The lack of nitrogen response in 2015 will, in part, be due to a higher than expected soil mineral nitrogen content.
- Results highlight the lack of responsiveness of the crop at higher nitrogen levels.
- This is part of a series of trials and we need to review all the data across all the sites and seasons before drawing firm conclusions.

Nitrogen (N) prediction response evaluation

Project Summary

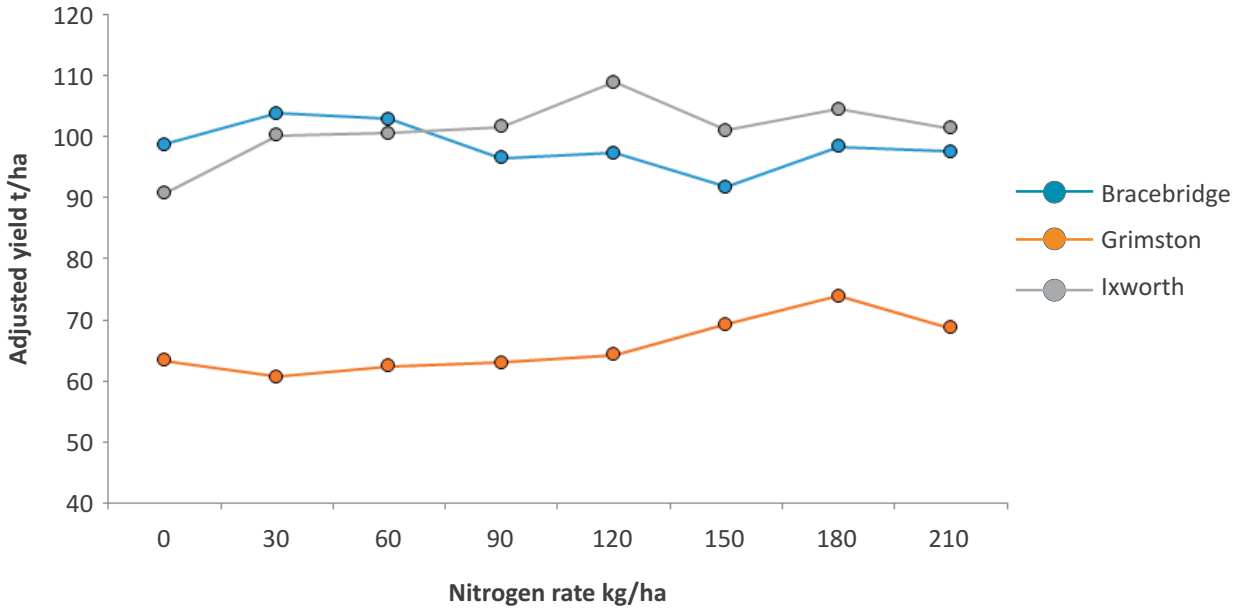
The fertiliser recommendations for sugar beet as laid out by DEFRA in RB209 assume a yield of 60t/ha. While there is no evidence that higher yielding crops require more nitrogen, it remains important in the light of continuing pressure on the use of N fertiliser and the greenhouse gas levels associated with its production and use, that the industry maintains a long-term data set of crop yield response to nitrogen fertiliser to maintain and defend its use in future reviews of publications such as RB209. Of course, such a database will also allow the identification of any changing trends in nitrogen requirements due to factors such as climate change or variety development.

Main Objectives

- To establish three sites on a range of soil types each year with a fully randomised and replicated trial in which a range of nitrogen levels can be assessed for impact on yield.
- Compare field results to recommendations made by RB209.
- To help inform the current review of RB209 of which BBRO is involved.

Sponsor: **BBRO**
Project Leader: **Simon Bowen**
Status: (year) **Ongoing**

Nitrogen Response Trials 2015



Outcomes and Achievements

- There was no response to increasing nitrogen across the three sites. Soil mineral nitrogen levels were high across the sites so the lack of large yield responses to nitrogen would have been expected.
- The data from 2015 is broadly in line with the current RB209 recommendations.
- The 2015 trial results also reinforce the need to take full consideration of soil mineral nitrogen (SMN) as part of the soil nitrogen supply (SNS) to the crop before deciding on the amount of additional nitrogen to apply as the response curve is shallow and the potential for an economic response needs careful evaluation.

Using crop data to understand in-field variations in yield and as a basis for making more precise decisions about crop management

Project Summary

BBRO is currently involved with a number of new areas of technologies around data collection, analysis and processing that may assist with making more precise and timely decisions about crop agronomy. During 2015, remote sensing imagery via an Unmanned Aerial Vehicle (UAV) was undertaken to collect data on some late season crop canopies as a pilot project to understanding how these relate to crop yields.

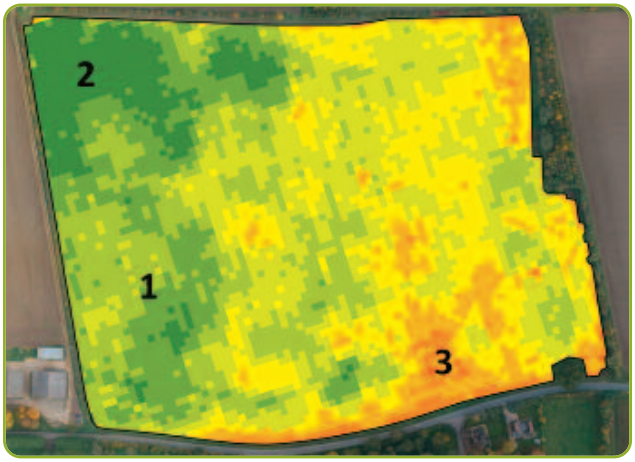
Main Objectives

- To understand how to effectively collect data on crops, convert this data into information and then understand how we can use this in our decision making process:

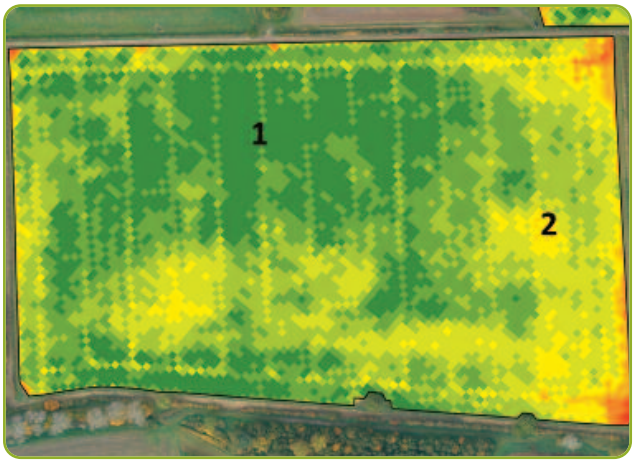
Crop data collection | **Data analysis and processing** | **Agronomic decision making**

- To undertake some preliminary work to assess the correlation between late season canopy cover and crop canopy indexes such as Normalised Difference Vegetation Index (NDVI) and root yield.

Sponsor: **BBRO**
Project Leader: **Simon Bowen**
Status: (year)



Location in field	Length of row dug (m)	Dug area (m2)	Clean root weight (kg)	Clean yield (t/ha)	Sugar %	Adjusted yield (t/ha)
1	2.3	1.15	11.4	99.13	17.4	0.11
2	1.6	0.8	6.5	81.25	17.7	0.09
3	1.9	0.95	9.2	96.84	18.2	0.12



Location in field	Length of row dug (m)	Dug area (m2)	Clean root weight (kg)	Clean yield (t/ha)	Sugar %	Adjusted yield (t/ha)
1	2.55	1.275	11	86.27	17.5	0.10
2	1.9	0.95	7.5	78.95	17.9	0.09

Key Messages for Growers and Industry

- **Images collected of crops in September (above) showed some large variances in crop canopy development. A crop canopy index termed NDVI, was used to help identify the differences.**
- **Yield digs undertaken in different areas of the crop (numbered 1-3) prior to harvest highlighted how variable yields can be within a field and that more data is needed to establish a useful correlation between canopy index and yield.**
- **Investigation of the causes of intra-field variation, which in the case of the crops monitored was considered to mainly be a result of weed and soil structural issues showed it is possible to link imagery to other data sets via Geographic Information System (GIS) to provide a basis for more precise and targeted action.**

Research Theme:

Crop Stability

Crop Stability

Project Lead:
Dr Mark Stevens

Science based KE role:
Weeds, Pests and Diseases.

Crop stability is a key component for a successful and profitable sugar beet crop. Today, growers have a range of tools, technologies and elite varieties, to tackle and limit the ever increasing threats from pests, diseases and weeds. For example, via monitoring and deployment of appropriate varieties, growers are able to protect their crop against the standard or more aggressive strains of rhizomania, and more recently, provide tolerance to beet cyst nematode. In addition, pellet technology provides a platform for fungicides to be placed next to the developing seedling to prevent blackleg and similar early season diseases, whilst the use of insecticide seed treatments has revolutionised pest control ensuring virus-carrying aphids and the soil pest complex are currently less of a threat than they used to be.

However, ongoing challenges such as further reductions in the availability of active ingredients due to changes in regulation, resistance in pests, diseases and weeds or the increasing battle to identify novel products for their control are issues that need to be addressed. This, coupled with changes in climate, that affect existing issues or bring new problems closer to our shores, all ensure that there are a number of areas that BBRO is currently investigating via its research portfolio. Therefore, crop stability is an important part of the BBRO research portfolio to limit the impact of pests, diseases and weeds on the growth and yield of the sugar beet crop. Currently, the BBRO invests in a range of projects in this research pillar and surveillance, monitoring and diagnostic methods are all key components to provide early warning systems. In addition the BBRO works closely with the wider Industry and growers and undertakes pilot projects, where appropriate, that may then develop into larger research projects. In 2015 the BBRO undertook two such studies on violet root rot and downy mildew and will again work with growers and agronomists in 2016 to evaluate the threat and possible control of rhizoctonia and free-living nematodes.

The following section provides a summary of all the current Crop Stability project portfolio and key outputs and findings.

Combating resistance to aphicides in UK aphid pests

Project Summary

Supported by the Chemical Regulation Directorate (CRD), and a consortium of agrochemical companies and other levy boards, this project provides research on aphicide resistance management for the UK farming industries and up-to-date information for agronomic and regulatory procedures. This is heightened by the occurrence of control failures with neonicotinoids against *M. persicae* in southern Europe. The presence of resistant aphids in the UK would have very serious repercussions for neonicotinoid treatments on sugar beet. The project monitors the response of field-collected live samples of *M. persicae* to a range of novel aphicides and also monitors for established forms of resistance. Vigilance is essential to safeguard the contribution of these compounds to aphid pest management in the UK, as resistant aphids that cannot be controlled will cause crop losses.

Main Objectives

The over-riding objective of the project is to retain the availability of effective pesticides by developing appropriate aphid management strategies and provide robust scientific support to the regulatory decision making process. Guidance is available to advisers, growers and the scientific community through the Insecticide Resistance Action Group (IRAG-UK). Other routes of communication for the scientific outcomes include articles in the trade press, presentations to growers and agronomists.

Sponsor: **BBRO in conjunction with CRD/levy boards/agrochemical companies**
Project Leader: **Dr Stephen Foster**
Status: (year) 1 2 **3** 4


Bio-assay for insecticide resistance in aphids

Outcomes and Achievements (2015/16)

- *M. persicae* samples from 26 field and four glasshouse crop sites in England were successfully reared for analysis.
- Screening bioassays applying diagnostic doses to live aphids from these samples continued to show no resistance to neonicotinoids, pymetrozine, flonicamid, spirotetramat or cyantraniliprole.
- MACE resistance (to pirimicarb) continues to be common and widespread in *M. persicae* in the UK.
- There continues to be a very high frequency of *M. persicae* with the new form of super knock-down resistance: this confers strong resistance to some pyrethroids.
- In the field samples, there continued to be an extremely low frequency of *M. persicae* with extreme (R3) esterase resistance to organophosphates (OPs) which is most likely due to the low of use of these compounds in the UK and fitness costs associated with this resistance mechanism.

Key Messages for Growers and Industry

Screening of *M. persicae* samples taken from the field and protected crops in 2015 showed that there continues to be no significant resistance (that may compromise control) to a range of newer compounds belonging to different chemical classes. Furthermore, there have been no significant shifts in response to diagnostic doses of insecticides that are currently effective in the UK.

Mitigating new threats from virus yellows: monitoring aphid populations and insecticide resistance to maintain control

Project Summary

To optimise the use of insecticides on beet by providing forecasts and up-to-date information on the timing and abundance of aphids, their virus content and the precise insecticide resistance mechanisms present. This project builds on previous projects centred on data provided by the Rothamsted Insect Survey's aphid monitoring network of suction traps, with two important developments: 1) testing for two new insecticide resistance mechanisms, to pyrethroids and neonicotinoids and 2) the inclusion of aphids from the network of yellow water pan traps in the resistance testing to add information on local variability. Forecasts of the timing and size of aphid migrations are provided and will aid decisions on aphid control early in the growing season.

Main Objectives

- Trap and identify migrant vectors of sugar beet viruses using suction trap network throughout the 2015 aphid flight season.
- Update equations and provide forecast of size and timing of aphid migration to beet crops in 2015/16.
- Assess insecticide resistance status and virus content of *M. persicae* from five suction traps and from yellow water pan traps throughout 2015 season.

Sponsor: **BBRO**
Project Leader: **Dr James Bell/Prof Lin Field** (Rothamsted Research)
Status: (year) 1 2 3 **4**

Aphid Forecast 2016

Factory Area	Option	Virus yellows (%) on sowing dates			Intended use of insecticide treated seed	Mean Temperature (Jan/Feb)
		15 March	30 March	15 April		
Bury	No Pest Control	23.9	32.1	45.6	—	4.99°C
	+ Pest Control	0.9	1.1	1.3	**99.6%**	
Cantley	No Pest Control	30.2	39.8	75.3	—	5.33°C
	+ Pest Control	1.2	1.3	1.6	**99.3%**	
Wissington	No Pest Control	23.9	32.1	45.6	—	4.99°C
	+ Pest Control	0.9	1.1	1.3	**98.5%**	
Newark	No Pest Control	36.4	48.9	66.6	—	5.03°C
	+ Pest Control	0.9	1.0	1.2	**98.6%**	

Outcomes and Achievements

- 87% of *M. persicae* were positive for MACE (resistant to pirimicarb) and 88% were positive for new super Kdr (M918LUK: resistant to pyrethroids). From the water traps, 153 peach–potato aphids were tested with 90% positive for MACE and new super KDR. No neonicotinoid insecticide resistance was detected.

- 330 *M. persicae* caught in the suction-traps were tested for BMYV but none were found to be carrying the virus.

- Aphid forecasts were produced along with 33 aphid data bulletins and 20 newsletters covering real-time information on aphid phenology, abundance, distribution and insecticide resistance status.

Key Messages for Growers and Industry

Virus yellows remains a key threat to all UK growers but currently this is controlled by the use of insecticide seed treatments. Real-time aphid surveillance is key to understanding future risks particularly if the seed treatments become under threat due to insecticide resistance or EU policy changes.

Beet cyst nematode: control and rotational issues with brassica species

Project Summary

The significance and importance of oilseed rape and other brassica species in sugar beet rotations is increasing. An appreciation of these rotational issues and the implications of other control strategies for different nematode species are needed. For example, certain growers in East Anglia are now growing over a five year period; oilseed rape, cereal, sugar beet, cereal, oilseed rape. In addition, green manures of various brassica species are being deployed on farm in the late summer to improve soil health, or to try and provide alternative strategies to control potato and/or beet cyst nematode (BCN). Therefore, it is critical that the appropriate brassica varieties are adopted on farm in order to prevent an indirect acceleration of the populations of these (or other) nematode species.

Main Objectives

- Evaluate the importance and significance of oilseed rape on BCN populations in the rotation.
- Investigate the role of green manure on BCN build-up.
- Examine the use of nematode resistant radish and mustard species on the impact of BCN and on the yield performance of the following sugar beet crop.

Current BBRO view on cover crops before sugar beet

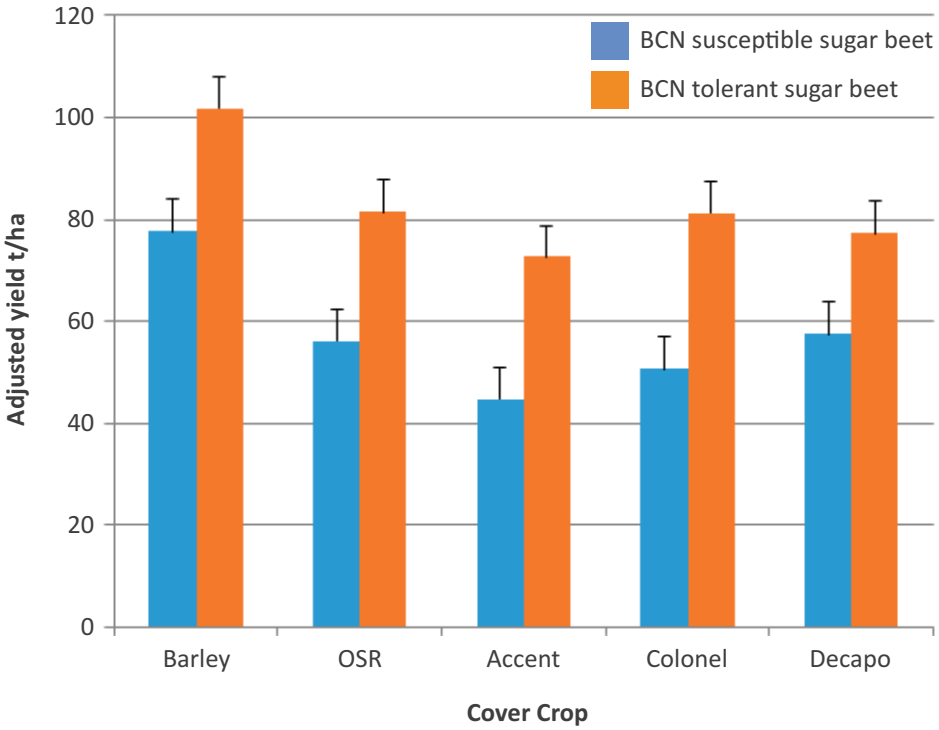
There has been much coverage in the farming press about the benefits of cover crops for the growth and yield of subsequent crops, including sugar beet. The reported benefits of cover crops include weed suppression (especially blackgrass), nematode control (through biofumigation and trap crops), prevention of leaching/retention of nutrients, improved soil structure and reduced establishment costs. Despite all the interest in cover crops, the scientific evidence to support these claims is limited. Specifically for sugar beet, there is a lack of scientifically robust data on the effect of cover crops on the establishment, growth and yield of the crop in UK conditions.

BBRO is currently funding a number of projects on cover crops. These are focussing on two key areas:

1) The impact of specific cover crop varieties on beet cyst nematode populations.

2) The effect of cover crops on soil structure and the growth and yield of the subsequent sugar beet crop. The projects will consider the advantages and disadvantages of cover crops for specific situations alongside an economic evaluation of their use.

Sponsor: **BBRO**
Project Leader: **Dr Mark Stevens**
Status: (year) 1 2 **3** 4



Outcomes and Achievements

- Initial results indicate previous use of brassica cover crops decreased the yield of the following year's sugar beet crop. This may be due to the lack of nitrogen (N) or the slow breakdown of the organic matter.
- Tolerant sugar beet varieties increased the yield by an average of 33% over susceptible varieties.
- BCN testing revealed that following a cover crop the level of BCN decreased in the subsequent sugar beet crop. There was an early indication that radish cover crops performed better than mustard species.

Key Messages for Growers and Industry

- **Ongoing trials will provide an improved understanding of the impact of brassicas in a sugar beet rotation.**
- **Better advice on the appropriate use of mustard/radish green manure crops to protect future yields and a clearer understanding of the control of BCN and other nematodes in the rotation.**
- **Ultimately, recommendations will be made for appropriate selection of cover crops for nematode control in sugar beet.**

Maximising sugar yield via fungicides

Project Summary

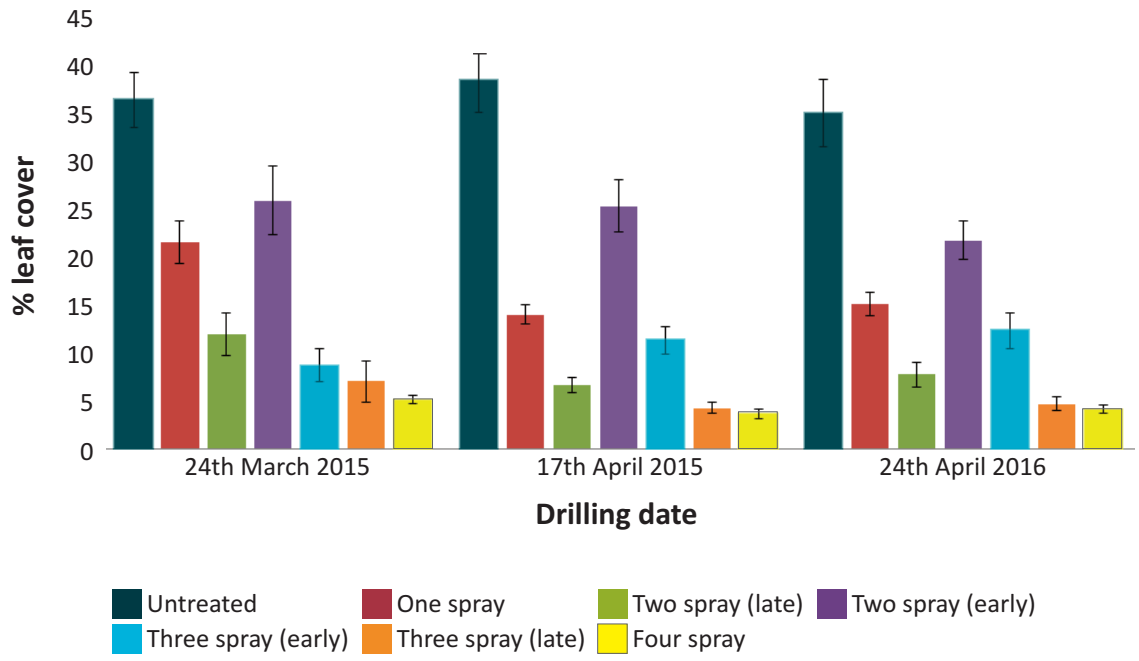
Previous fungicide trials have shown that the application of a single fungicide can give yield benefits of up to 8 adjusted t/ha and, from a two-spray strategy, a potential further 10 adjusted t/ha. The fungicide trials have enabled the industry to optimise disease control, green-leaf cover and, ultimately, yield depending on harvest date. These studies continue to fine-tune advice regarding application timing and lifting date and provide a more robust advisory system for communicating when to apply products to maximise profitability of the crop, linked to the InnovateUK SporeID project.

Main Objectives

- Clarify the impact of drilling date together with crop developmental stage and first application of fungicide.
- Comparison of products to include an assessment of the current triazole/strobilurin fungicides as well as any potential chemistry on current and future sugar beet genetics.
- Assess fungicide timings, the number of applications and impact of harvest date.

Sponsor: **BBRO**
Project Leader: **Dr Mark Stevens**
Status: (year) 1 2 3 **4**

Rust scores 14/10/2015 Hibaldstow



Outcomes and Achievements

- Two trials (based in Norfolk and Lincolnshire) evaluated seven different fungicide programmes over three drill dates and two different harvest dates. In both trials rust was the key disease.
- Later sown crops had lower levels of disease earlier in the season; however they still suffered a yield penalty over earlier sown crops, even when no fungicides were applied.
- Positive yield responses were observed across all fungicide treatments.
- In 2015, when fungicides were applied before disease onset (the two spray early treatment), there was a higher level of rust later in season.

Key Messages for Growers and Industry

Fungicides remain key to protecting the crop from foliar diseases whilst maintaining canopy cover for autumn growth, early frost protection and maximising yield potential. Future trials will be driven by developments and methods developed within the SPOREID project (as outlined on page 39).

Impact and novel control of leaf miner (mangold fly)

Project Summary

The larvae of the leaf miner (*Pegomya hyoscyami*) mine sugar beet leaves extensively, resulting in blisters that reduce photosynthetic area, increase sensitivity to herbicides and increase the likelihood of frost damage. Two or three generations of the pest can occur in the year and while the most vulnerable stage of the crop is currently protected by neonicotinoid seed treatments, later infestations can cause significant damage once seed treatments have worn off. The use of foliar insecticides to control late season leaf miner infestations are currently of limited benefit as they need to be applied to larvae before they enter the leaves. The project is evaluating alternative control strategies and a method to identify adults from water traps to monitor seasonal population changes.

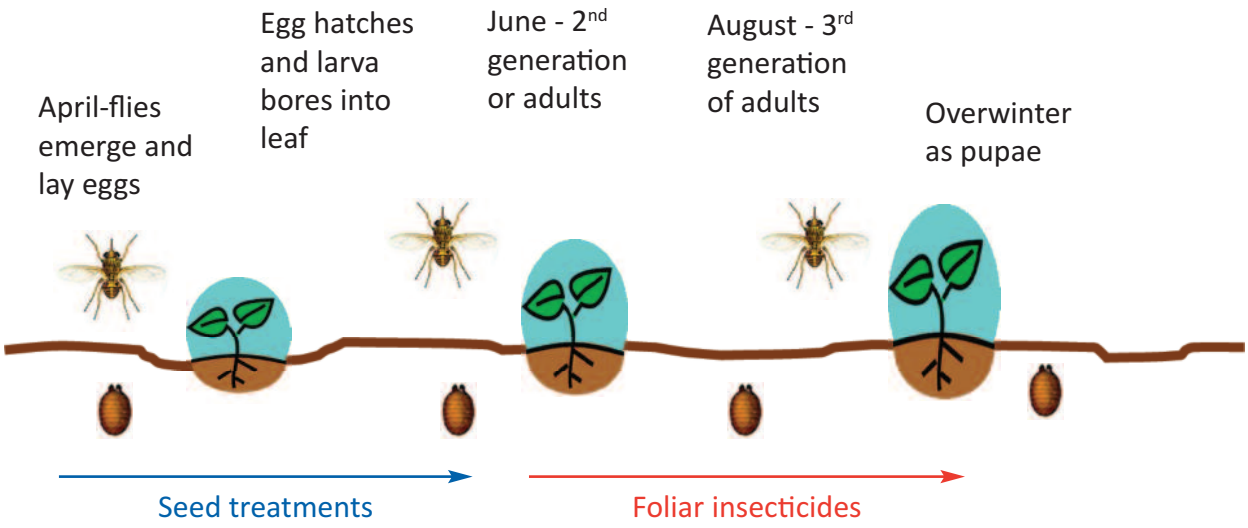
Main Objectives

- Field trial for leaf miner control (assessing a range of treatments applied at different timings).
- Monitoring regional adult activity via the BBRO yellow water trap network.

Sponsor: **BBRO**
Project Leader: **Dr Sacha White (ADAS)**
Status: (year) 1 2

Biology and Control of the Leaf Miner

(Pegomya hyoscyami)



Outcomes and Achievements

- A field trial was conducted in south Lincolnshire in an area identified at above threshold for treatment following first generation leaf miner activity. Eleven treatments were applied either at egg laying, egg hatch or leaf mining against second and third generation activity.
- Chlorpyrifos (Dursban WG; no longer available for use from March 2016 onwards) gave best control of leaf miner infestation and yield benefits. Hallmark Zeon and Danadim Progress provided some control.
- For best control, products needed to be applied at egg hatch.
- A method was developed to identify adult leaf miner (mangold) flies from the yellow water pans. Regional variations were observed and distinct generation patterns were identified.

Key Messages for Growers and Industry

The neonicotinoid seed treatments continue to provide protection against first generation leaf miner damage. The 2015 trial identified existing and novel insecticides that had some control of the pest, but the recent loss of Dursban highlights the need for further active ingredients to control leaf miner.

Discovering the source of sugar beet infection and re-infection by rust and powdery mildew

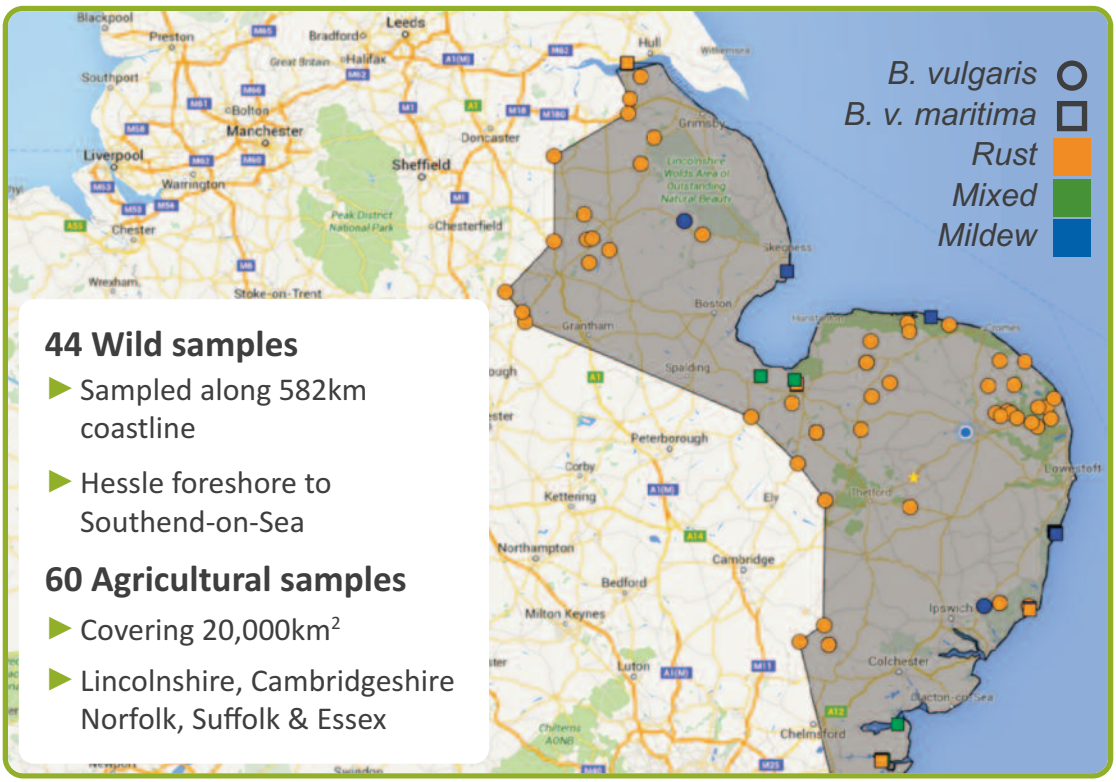
Project Summary

Powdery mildew and rust can cause sugar yield losses of up to 20% and 14% respectively. Little is known about (1) the level of diversity of these fungi, (2) the source of annual infection and (3) the races that re-infect after fungicidal treatment. Wild beet species could act as pathogen reservoirs, causing subsequent infection (and re-infection). In addition, these wild infections could be a source of novel virulence genes that overcome cultivar resistance. Therefore, it is important that a clearer understanding of mildew and rust population diversity is known to identify the causes of infection dynamics and improve future control strategies or resistance management.

Main Objectives

- Quantify the diversity within UK powdery mildew and rust populations.
- Determine the source of infection of the sugar beet crop using agricultural and wild samples.
- Identify the effects of fungicidal application on pathogen genetic diversity.

Sponsor: **BBRO**
Project Leader: **Dr Matthew Clarke (TGAC)**
Status: (year) 1 **2**



Outcomes and Achievements

- Forty four mildew/rust samples have been collected from wild beet populations along the coast from the Humber estuary to Essex.
- Sixty field samples have been collected from commercial sugar beet fields or from BBRO fungicide trials in Lincolnshire and Norfolk where plots had received no, one, two or three applications of fungicides.
- All samples will be analysed at The Genome Analysis Centre at Norwich. These sequence data will be analysed to assess for potential pathogen diversity and any impact of fungicide applications on the selection of mildew and rust populations.

Key Messages for Growers and Industry

Currently, little is known about the diversity of these foliar diseases in sugar beet. This project will provide the first information regarding any changes that occur within these populations both on wild beet or following commercial applications of fungicide.

The findings of this project will be analysed and used to guide future fungicide usage.

Virus yellows: aphid monitoring and alternative control strategies using existing/novel insecticides

Project Summary

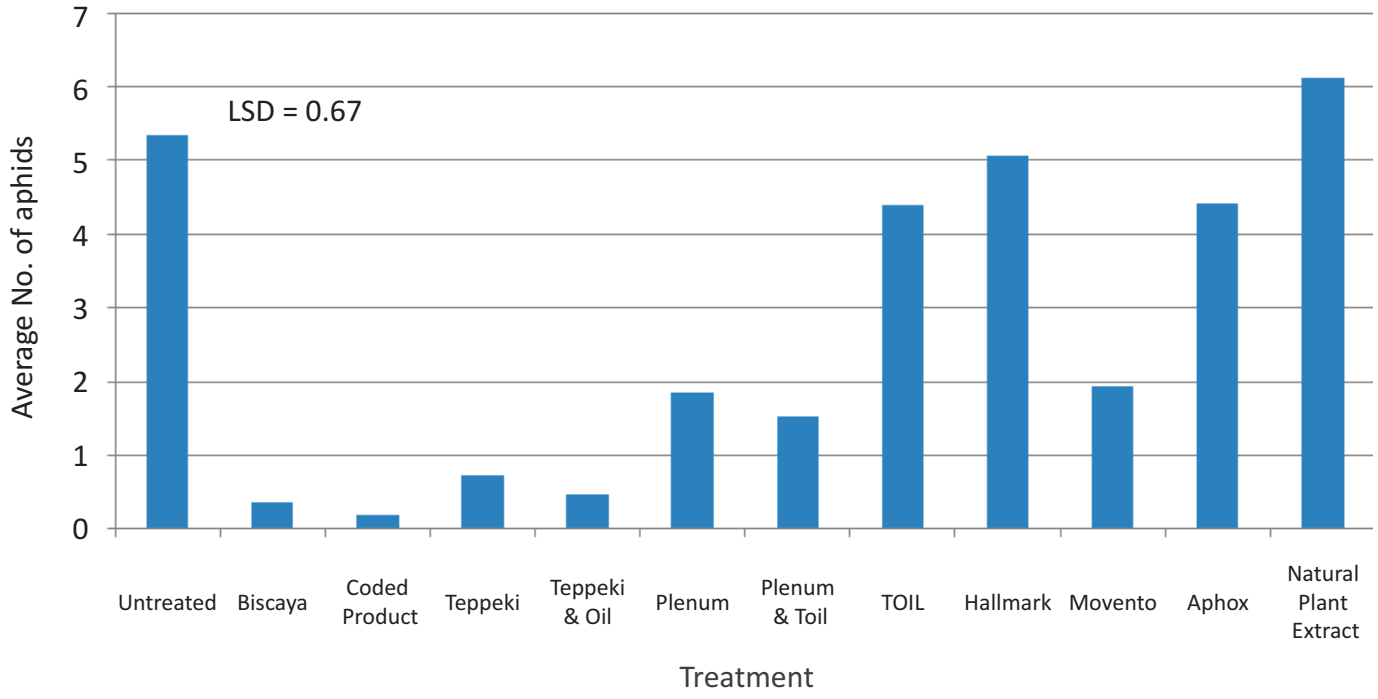
Virus yellows is a greater problem in the UK than anywhere else in Europe due to the influence of our maritime climate. Virus threats are accentuated by the ongoing development of insecticide resistance and climate change. An integrated disease management toolkit is required that utilises resistant varieties and accurate disease forecasts to enable timely and appropriate applications of insecticides. This system will slow the development of insecticide resistance in aphid populations, thus prolonging the life of active ingredients, whilst helping to reduce the amount used. This is crucial with the recent appearance of neonicotinoid resistance within mainland Europe. To achieve durable control of the viruses, aphid populations will be monitored and assessed for resistance and virus content in order to allow us to advise growers of risks to their crops. Existing and/or new insecticides will be assessed providing a potential novel approach for controlling these viruses.

Main Objectives

- Annual aphid surveillance and distribution and impact of yellowing viruses (linked/leveraged against the InnovateUK SPOREID project).
- Efficacy of existing and novel insecticides for the control of *M. persicae*.

Sponsor: **BBRO**
Project Leader: **Dr Mark Stevens**
Status: (year) 1 **2** 3 4

Green Aphids: Grimston 3rd July 2015



Outcomes and Achievements

- A large aphid migration was observed in 2015 (8,189 caught at the thirty sites between May and July). There were significant regional variations in *M. persicae* numbers. This was potentially influenced by the lack of control of aphids in previous autumn sown oilseed rape crops.
- Only two out of 2,000 *M. persicae* tested for virus contained BMYV.
- The aphicide trial at Grimston, Norfolk compared eleven different treatments and identified several alternative products for *M. persicae* control.
- Beneficial insects also played a key role in the control of green and black aphids.

Key Messages for Growers and Industry

Concern remains of the reliance on neonicotinoid seed treatments for the control of pests in sugar beet, particularly virus-carrying aphids.

Encouragingly, several alternative aphicides, particularly flonicamid (Teppeki), gave good control of *M. persicae*. The BBRO will investigate whether this product can be approved for future use in sugar beet.

Monitoring the future risk of rhizomania

Project Summary

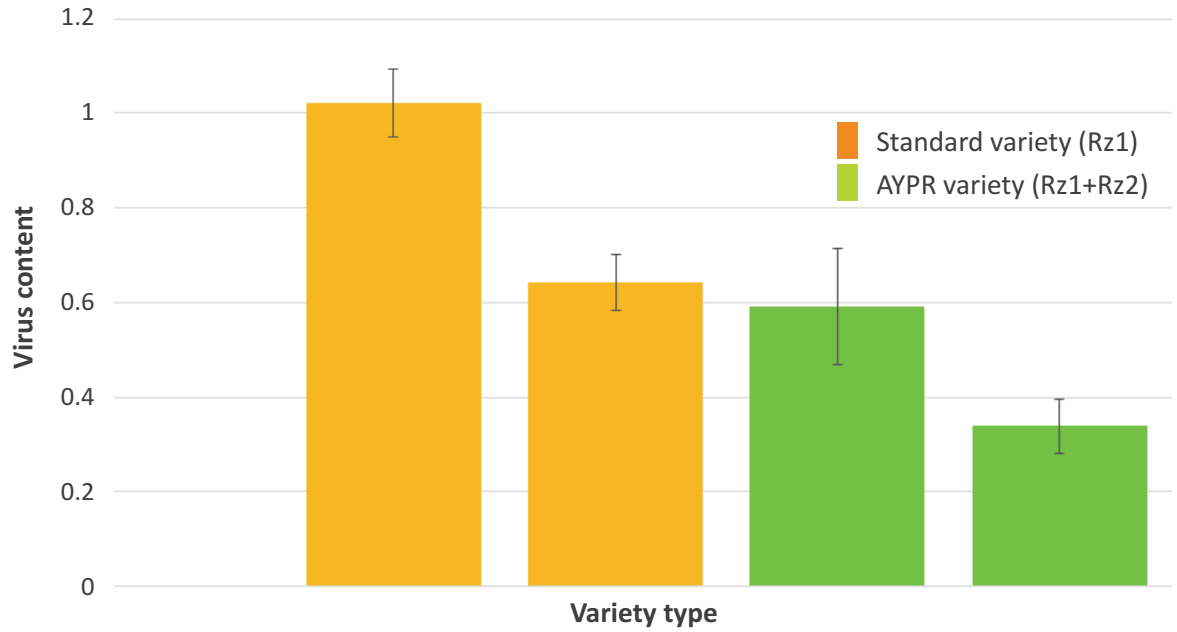
Previously, rhizomania had a major economic impact on the UK industry, potentially decreasing yields by up to 70%. The development of partially-resistant varieties by the breeders have made a major contribution to protect the yield potential of the UK crop. However, new strains of rhizomania, capable of overcoming varietal resistance, were identified in the UK (e.g. P-type [2001] and the AYPR [2007] strain). Such strains pose a serious threat to current 'resistant' varieties, although varieties with an additional resistance gene (Rz1 + Rz2) have been developed and released commercially that yield in the presence of these new strains (e.g. Sandra KWS). If no further sources of novel resistance genes are identified, the likelihood of a future breakdown in rhizomania resistance is high. The project monitors the incidence, distribution and strain variation of the rhizomania virus and assesses any future novel resistance to the virus.

Main Objectives

- Glasshouse evaluation of rhizomania partially resistant varieties for the control of resistance breaking strains in the UK.
- Field evaluation of rhizomania resistance in future varieties.
- Monitoring the incidence, distribution and strain variation of rhizomania.

Sponsor: **BBRO**
Project Leader: **Dr Mark Stevens**
Status: (year) 1 **2** 3 4

Evaluation of rhizomania varieties for resistance to the AYPR strain



Outcomes and Achievements

- Only one new outbreak of the resistance breaking strain of rhizomania was identified in 2015 (Suffolk).
- Field trials evaluating existing and novel partially resistant rhizomania varieties in the presence of the AYPR virus strain near Orford, Suffolk showed that varieties with both Rz1 and Rz2 resistance genes performed well with no classic symptoms of rhizomania visible.
- Glasshouse tests confirmed that varieties with both resistance genes decreased the virus concentration of this aggressive strain in roots.

Key Messages for Growers and Industry

The aggressive AYPR strain of rhizomania does not appear to be spreading from its current locations. Variety Sandra-KWS provides a good control option for growing sugar beet in the presence of this strain.

Innovate UK: Innovative disease monitoring and diagnostics for improved efficiency of crop production (SPOREID)

Project Summary

SPOREID is a new project designed to minimise the impact of disease on yield of the UK sugar beet crop. The yield potential of the UK sugar beet crop is c.130 t/ha compared to an average yield of 70t/ha. One of the factors responsible for this yield gap is foliar diseases which can reduce yield by more than 50% and, whilst current practices prevent yield losses of this magnitude, it is estimated that 10% yield is lost to foliar diseases, representing £24M per year. Climate change may lead to increasing pressure from existing or 'new' emerging diseases, which require increased crop protection. Improved disease management will allow growers to increase the productivity, sustainability and profitability of the crop. This project brings together novel diagnostic tools, crop disease modelling and yield forecasting to underpin grower decision making and investigate the potential impact of emerging diseases on the crop.

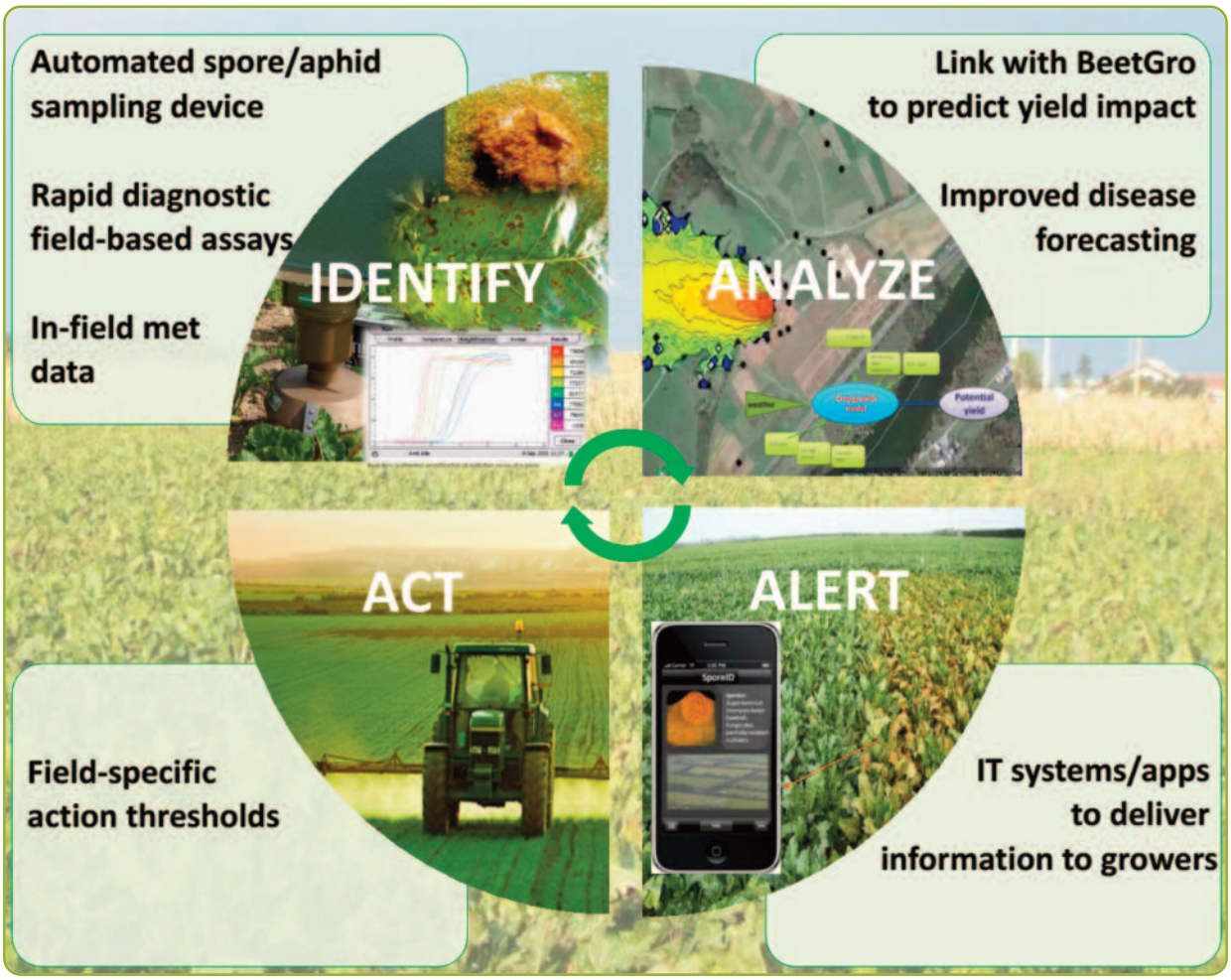
Main Objectives

- To exploit novel diagnostic tools and monitoring systems, crop disease modelling and yield forecasting to improve foliar disease control in sugar beet.
- To provide a new platform that integrates the collection of met data, aphids, mildew and rust spores with rapid DNA-based diagnostics, providing real-time information on disease pressure.

Sponsor: **Innovate UK, BBRO, AB Sugar, British Sugar plc, Burkard Manufacturing Ltd, Crop Performance Ltd, University of Nottingham, Rothamsted Research**

Project Leader: **Dr Mark Stevens**

Status: (year) **1** 2 3 4



Outcomes and Achievements

- To date all commercial fungicides evaluated in glasshouse tests have shown good efficacy against mildew and rust field isolates.
- A method to extract DNA from mildew and rust has been developed involving disruption of spores. Further progress has been made on gene sequencing and primer design for the diagnostic LAMP assay.
- Eight traditional Hirst spore traps were operated between June and September from Essex to Yorkshire and samples collected will be analysed using the new diagnostic methods. This will be repeated in 2016.

Key Messages for Growers and Industry

Ultimately this project will lead to a new user interface for disease monitoring and prediction and for a more robust approach for the application and benefit of fungicides for the UK crop.

Innovate UK: A novel pre-breeding strategy to reduce dependence on insecticides for virus yellows control in sugar beet

Project Summary

Virus yellows is a major economic disease affecting sugar beet; its impact is particularly significant in the UK due to our maritime climate, and will be exacerbated by potential restrictions on neonicotinoid use and developing insecticide resistance in aphid vectors. Development of genetic resistance is therefore critical to maintain viral control. The consortium has explored the genetic diversity found in beet relatives, identifying candidates exhibiting resistance and tolerance to virus yellows. A novel phenotyping approach has been developed to quantify resistance/tolerance traits, and to identify genes which protect against foliar damage. Using this unique toolkit, tolerance quantitative trait loci (QTL) will be introgressed into modern breeding material, with hybrids assessed for foliar health and yield and new resistant candidates will be characterised, QTL identified, and molecular markers developed for future breeding, ultimately producing new virus-resistant commercial varieties.

Main Objectives

- To identify and introgress 'broad spectrum' resistance of the 'virus yellows' complex into elite sugar beet material for future breeding programmes.
- To develop sugar beet hybrids tolerant to virus yellows and determine yield benefit for variety development.

Sponsor: **Innovate UK, BBRO, Syngenta, SESvanderHave, ADAS**

Project Leader: **Dr Mark Stevens**

Status: (year) **1** 2 3 4

Susceptible sugar beet variety showing symptoms of virus yellows

2015 inoculated field trial to identify tolerance and/or resistance to beet yellows virus

Outcomes and Achievements

- A number of wild/cultivated beet accessions have been identified as significantly more tolerant/resistant to BYV when compared to current commercial varieties.
- Molecular markers continue to be developed which can be used for marker assisted selection of tolerance/resistance traits in future breeding programmes.

Key Messages for Growers and Industry

Virus yellows resistant varieties will provide an alternative to insecticides to combat this important virus disease. Ultimately, the validated tolerance/resistance will be crossed into elite commercial varieties during the project and the resulting hybrids tested for yield performance.

Research Theme:

Crop Recovery

Crop Recovery

Harvesting quality is one of the principal themes that will be addressed by this pillar of BBRO activity over the coming years.

We have seen significant improvement in the proportion of the crop recovered by harvesters over the last 20 years with harvester losses decreasing from around 9% to closer to 2.5% over that period. The causes of harvester losses are multi-factorial, and it is not something which can be levelled at harvester contractors only. Successful crop recovery starts with achieving a uniform, weed free crop, grown on level seedbeds, with good disease control, careful harvesting, storage, loading and delivery - i.e. it is directly influenced by all stages of the sugar beet crop production cycle.

Harvester losses have plateaued in recent years and we now need to push again to drive for further improvement in this area. We will be working with all industry stakeholders including machinery manufacturers, growers and contractors to understand what the limiting factors are in reducing levels of losses, and then providing technical and practical support to help devise an action plan to address those issues. BBRO will apply previous knowledge known about crop harvesting, storage and delivery to support industry initiatives as well as direct training, demonstration and the promotion of best practice. Other harvesting-related work will involve research looking at the measurement of beet damage through the harvesting and handling process.

Over recent years much work has been undertaken into beet storage, both here in the UK and across Europe. At this time, further research into storage techniques is not viewed as a priority and instead our focus will be to ensure appropriate storage strategies and techniques are being consistently employed.

If crop recovery is to be maximised, then crop harvesting and delivery must be managed to ensure the storage period is optimised. The UK industry currently has few metrics to be able to manage this effectively and we will be working closely with growers and the processor to help bring greater clarity to this area of crop production. Of course, we recognise that the two biggest factors affecting sugar loss in storage are the duration of thermal time of stored beet and the quality of beet going into that store. In addition, excessive dirt leads to poor ventilation through beet clamps and consequently higher sugar losses. It also represents a significant inefficiency,

Project Lead:
Colin Walters

Agronomy based KE role:
Harvest and Storage,
Field trials delivery,
Tare house.

and cost, to the industry through additional haulage requirements and downstream processing cost at factories. Therefore, we will be examining the factors affecting dirt tare and developing approaches which will allow it to be more effectively managed.

The technological quality of sugar beet also alters as the season progresses and particularly through the harvesting and storage phase of the crop production cycle. This process sees sucrose converted into other sugars and as such represents both a loss of paid yield to the growers and an increase in processing costs at the factory, and these other sugars also create processing issues. BBRO will be working to develop a capability to measure these non-sucrose elements of beet quality to provide the opportunity to identify the causes behind the changes in the technological quality and address those factors to the benefit of the growers and the processor.

To increase the profitability and sustainability of the UK sugar beet industry through reductions in soil tare..... **44**

To increase the profitability and sustainability of the UK sugar beet industry through reductions in soil tare

Project Summary

Large quantities of soil adhering to beet are delivered to factories during the campaign at considerable cost to the industry in transportation, removal and disposal. Improvements in the design and operation of harvesters and cleaner-loaders that allow better removal of the soil on-farm have mitigated this to some extent. Even so, soil tares in recent campaigns have amounted to around 350,000 tonnes (or the equivalent of 11,000 lorry loads) of soil delivered to British Sugar's factories each year at a cost in excess c. £2.5million to the industry.
The project seeks to determine whether soil tares can be decreased further by changing on-farm storage practices to increase the rate of drying of the soil on lifted beet, thus making more of it removable prior to delivery. The questions it seeks to resolve are: To what extent does store covering help the drying process? And will a reduction in the costs of soil transport and disposal outweigh the potential storage losses of sugar?

Sponsor: **BBRO**

Project Leader: **Colin Walters**

Status: (year) **1** 2 3 4

Main Objectives

- Building on UK and continental experience, Toptex sheets will be used to cover sugar beet stores at four sites on a range of soil types.
- Assessments of dirt tare and sugar content at lifting will be made, together with further assessments of sugar content and dirt tare at the point of delivery.
- Beet will be stored for up to thirty days only and at different times through the season to try to experience a range of lifting conditions.
- Any differences in dirt tare and sugar content will be measured with a view to understanding whether or not there is a net benefit of trying to reduce dirt tare in this way under UK conditions.

Key Messages for Growers and Industry

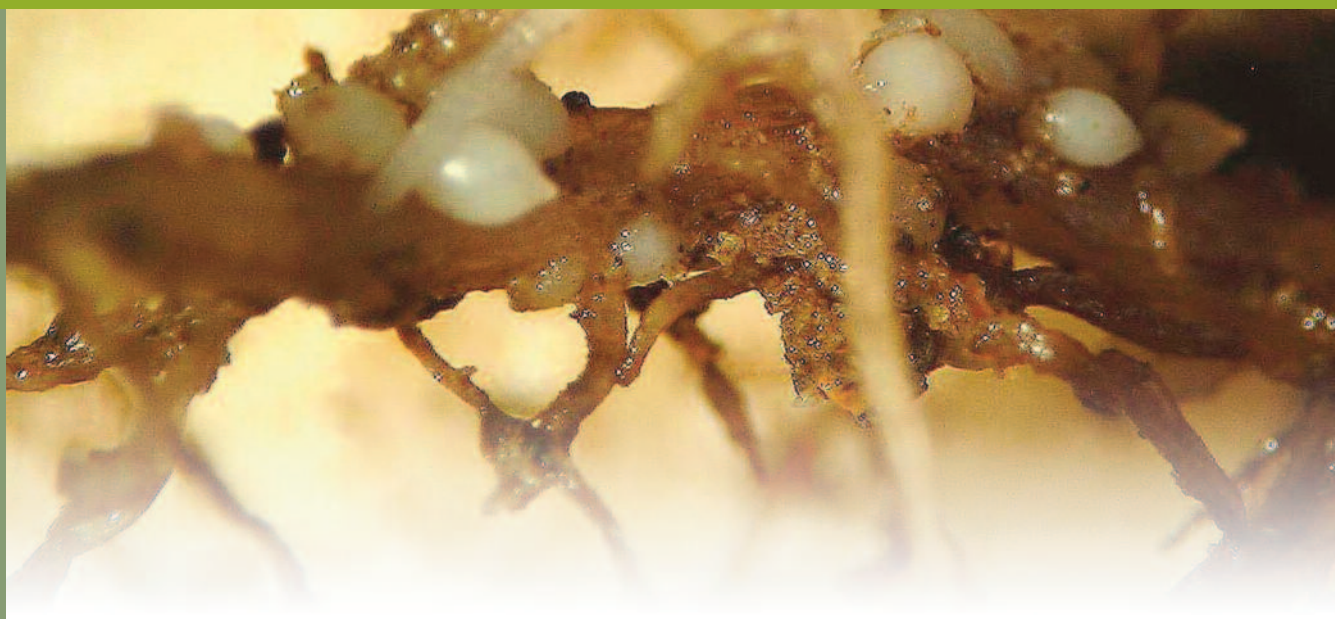
One year of work on this project has been completed and although the short campaign of 2015 curtailed any further work last year, the aim is to pick this project up again in 2016 as part of the pillar of work aimed at increasing crop recovery.

This project will continue to evaluate and fine tune storage techniques to further reduce delivered dirt tare.

Investing in the future

Developing the next generation of enthusiastic, applied crop scientists is crucial for the future success of UK agriculture. The training and exposure of these students to the latest thinking and technologies will ensure that the most appropriate skill sets are encouraged whilst evaluating and testing ideas and theories for the continued success of the UK sugar beet sector. Without the next crop of bright new minds the industry will be at risk from not keeping up with the rapidly developing technological revolution. Consequently, and as part of its ongoing review of priorities, the BBRO has invested your levy with several of the key UK Universities to develop these future scientists and currently supports four PhD students at the University of Nottingham and the University of Leeds. The following gives you a brief insight into the students and the projects they are working on.

Interactions between beet cyst nematode, sugar beet and brassica trap crops



Project Summary

The beet cyst nematode (BCN) can be a seriously damaging pest of sugar beet and brassica crops. Up to 75% yield loss can occur to beet fields in cases of extreme infestation.

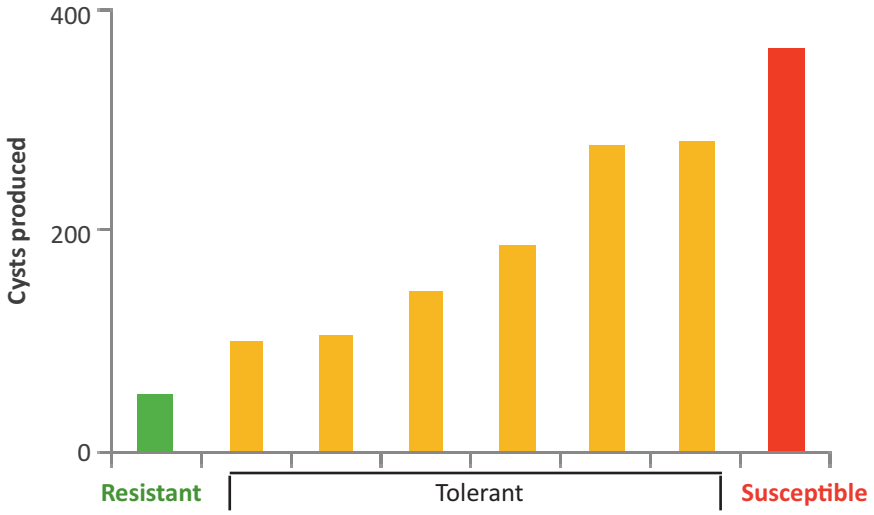
On average, 6% of the beet growing area is infested. This project aims to help growers with infested fields understand and manage the BCN threat. Currently long rotations allow for natural decline in BCN populations, but these are not always economical or practical. Recently the tolerant varieties have become available on the market and have increased yields on infested land. However, these do not reduce populations in the soil and are not a control method.

One potential option is using radish species which are resistant to the nematode to reduce populations prior to beet crops being planted, a technique known as trap cropping.

Main Objectives

- Understand the differences between susceptible and BCN tolerant beet varieties.
- Assess the trap crop varieties available on the market to see whether they will work in the UK.
- Understand how other host species, such as oil seed rape (OSR), interact with BCN in rotations with beet.

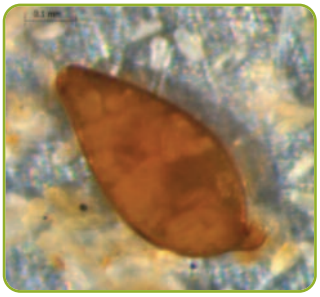
Sponsor:	**The University of Nottingham & BBRO**
Project Leader:	**Dr Debbie Sparkes & Dr Mark Stevens**
PhD Student:	**Alastair Wright**
Status: (year)	1 **2** 3 4



A controlled environment study showing how variety choice affects BCN reproduction.

The European resistant (R) variety produced the fewest cysts and the susceptible (S) the most. The tolerant varieties showed a great range in their responses.

Infective BCN juvenile



BCN cyst containing eggs

Outcomes and Achievements

- Beet varieties have been screened in controlled environment studies to understand their physiology and BCN susceptibility (graph above).
- Work is now moving on to look at larger scale work and to investigate responses of beet to infestation.

Key Messages for Growers and Industry

BCN is still a threat to the British sugar beet industry, and could become more severe in the future. By the end of this project, results will be available to help growers decide on appropriate varieties, rotations and the use of trap crops to manage BCN thereby maximising their yields of both beet and other host crops.

Understanding water uptake in sugar beet

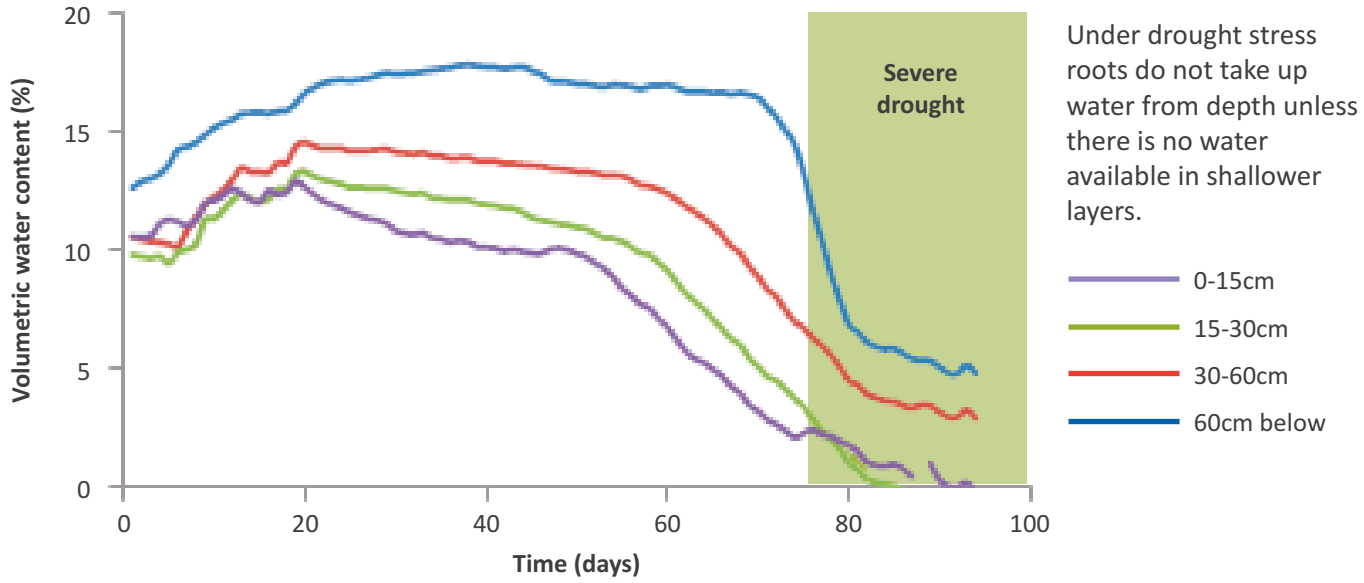
Project Summary

The focus of this project is to understand water uptake in sugar beet. Drought is a serious threat to sugar beet yield in the UK and therefore more insight is needed. In this project we will look at the constraints to water uptake with a focus mainly on roots. The aim is to identify the main constraints and possibly find ways of resolving these limitations. This project links closely with the 'Understanding plant/soil interactions to improve sugar beet productivity' project.

Main Objectives

- To understand why sugar beet take up very little water from depth.
- To identify the main limitations to water uptake by the sugar beet crop focussing on root physiology and soil constraints.

Sponsor: **The University of Nottingham & BBRO**
Project Leader: **Dr Debbie Sparkes**
PhD Student: **Tamara Fitters**
Status: (year) 1 **2** 3 4



The graph shows that at the point of entering the severe drought stage the soil depth of 15cm held a water content of 2.5% however the soil at the lowest depth of 60cm and below held a water content of 12.5%.

Outcomes and Achievements

- Watering regime had a major impact on sugar beet root distribution with depth.
- While sugar beet roots reached deep soil layers early in the experiment, no water was taken up from depth until the upper layers had been exhausted (figure above).
- Compaction had a major impact on sugar beet root growth and water uptake in 1m columns.

Key Messages for Growers and Industry

Sugar beet crops seem to be capable of growing deep roots but they do not take up water from depth until drought stress occurs. This might be caused by limitations in the root, a slow stomatal response or both (and possibly other factors). It is important to see what is happening in sugar beet during drought and that way understand the mechanisms behind the drought response. Experiments so far have been limited to 1m columns in the glasshouse. This year we will be monitoring root growth and water uptake in the field and in large (1.2 m^2) boxes.

The effect of cover crops on soil structure and subsequent growth of sugar beet

Project Summary

This project will examine the effect of cover crops on soil structure and yield of the subsequent sugar beet crop. Spring drilling, as used for sugar beet, offers the opportunity for a cover crop during the previous autumn and winter. There are a number of claims about the growth and uses of cover crops and how these fit in with farming practices. Using a combination of glasshouse and field experiments, this project will look at the growth of different cover crop species, their impact on soil structure and how these changes to the soil impact the growth and yield of sugar beet.

Main Objectives

- Investigate the impact of cover crops on soil structure.
- Explore the effect of soil type and weather conditions on the success of cover crops.
- Examine the effects of cover crops on the following sugar beet crop.

Sponsor:	**The University of Nottingham & BBRO**
Project Leader:	**Dr Debbie Sparkes**
PhD Student:	**Jake Richards**
Status: (year)	**1** 2 3 4

Outcomes and Achievements (please note project started September 2015)

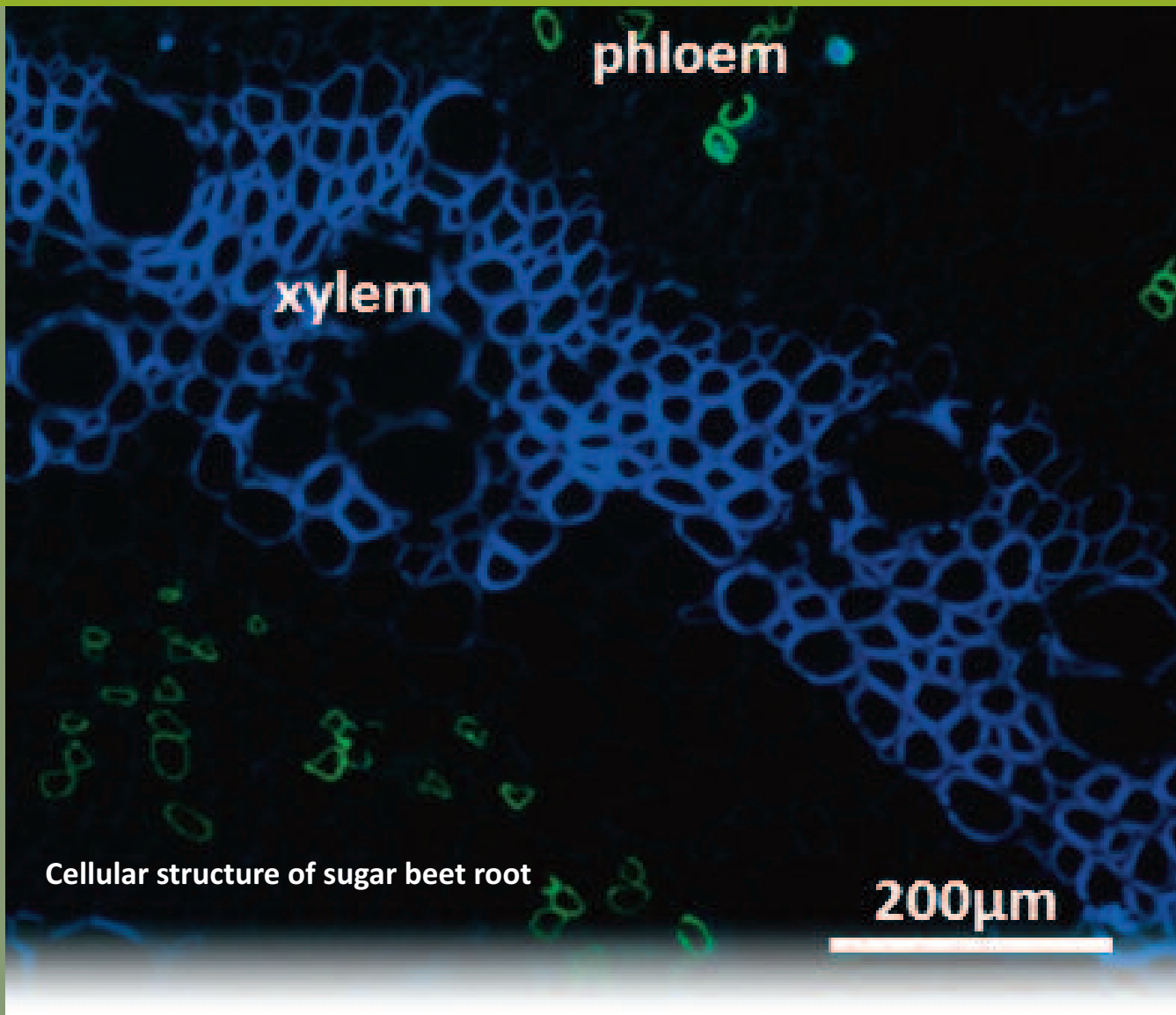
- Monitored the effect of cover crops on soil structure on two farms in Norfolk with contrasting soil types (sand and clay).
- Glasshouse experiment established in March 2016 to examine the effect of different cover crop species on soil structure (photos below).

Glasshouse assessments on various cover crops

Key Messages for Growers and Industry

During this project, we aim to gain a better understanding of the effect of cover crop species on soil structure and the impact this has on the subsequent sugar beet crop. This will be achieved by a combination of glasshouse experiments, to give a greater understanding of what cover crops are capable of, and field experiments where the fundamental findings can be tested on-farm.

Genetic influences of sugar beet cell wall composition on bio-refining



Cellular structure of sugar beet root

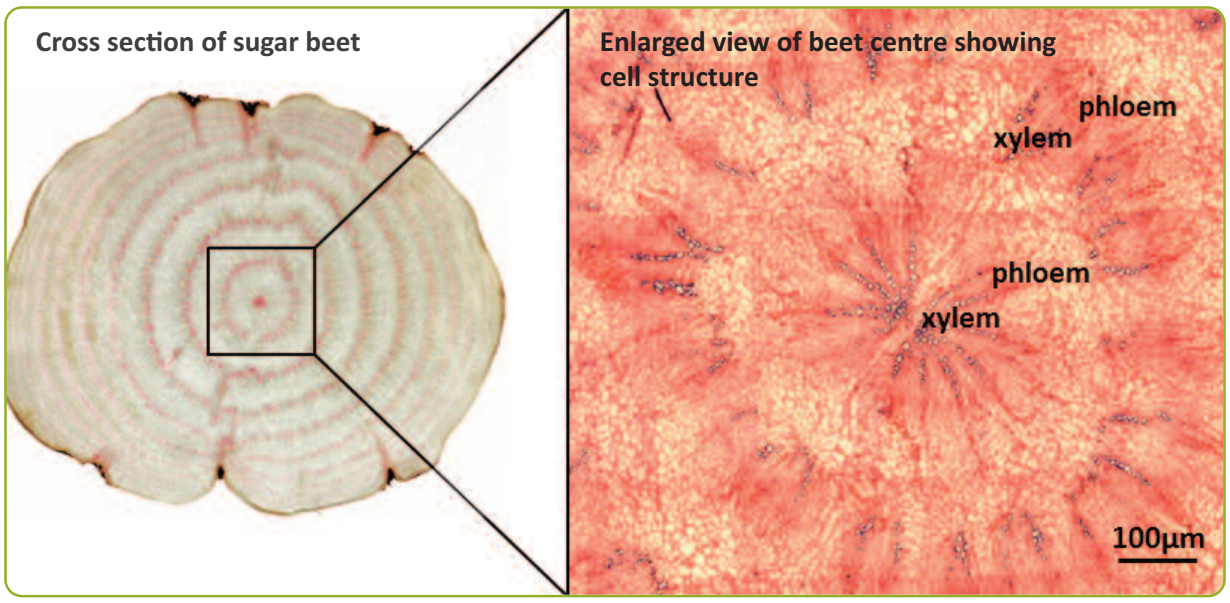
Project Summary

Sugar beet cell wall composition is unusual when compared to other plant species. This project investigates the complex anatomy of sugar beet roots and cell wall development and the abstraction of high energy values such as sucrose, fibre and biofuels from the pulp. It will map the structure of roots and cell wall architecture over the growth period and the relative positions of important cell types such as vascular tissues and sugar storage cells; helping to understand the cell wall structure, varietal differences and the decomposition of sugar beet pulp.

Sponsor:	**The University of Nottingham & BBRO**
Project Leader:	**Dr Belinda Townsend and Professor Paul Knox**
PhD Student:	**Rachel O'Neil**
Status: (year)	1 2 3 **4**

Main Objectives

- To increase dry matter content and tailor dry matter composition for industry needs.
- Identify key cells within the root using biological markers.
- Identify characteristics that have an effect on the structural properties of sugar beet cells.

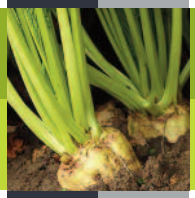


Outcomes and Achievements

- Further identification of key characteristics of the sugar beet cell wall using novel monoclonal antibodies as molecular markers and assessing the abundance of specific features throughout root development.
- Specific features of the sugar beet root cell walls have been highlighted gaining an exclusive insight into the chemical structure and *in situ* positions of these key cells.
- These methods are being used to characterise sugar assimilation and the nature of sucrose versus non-sucrose dry matter and potential developmental shifts in resource allocation and carbohydrate storage.

Key Messages for Growers and Industry

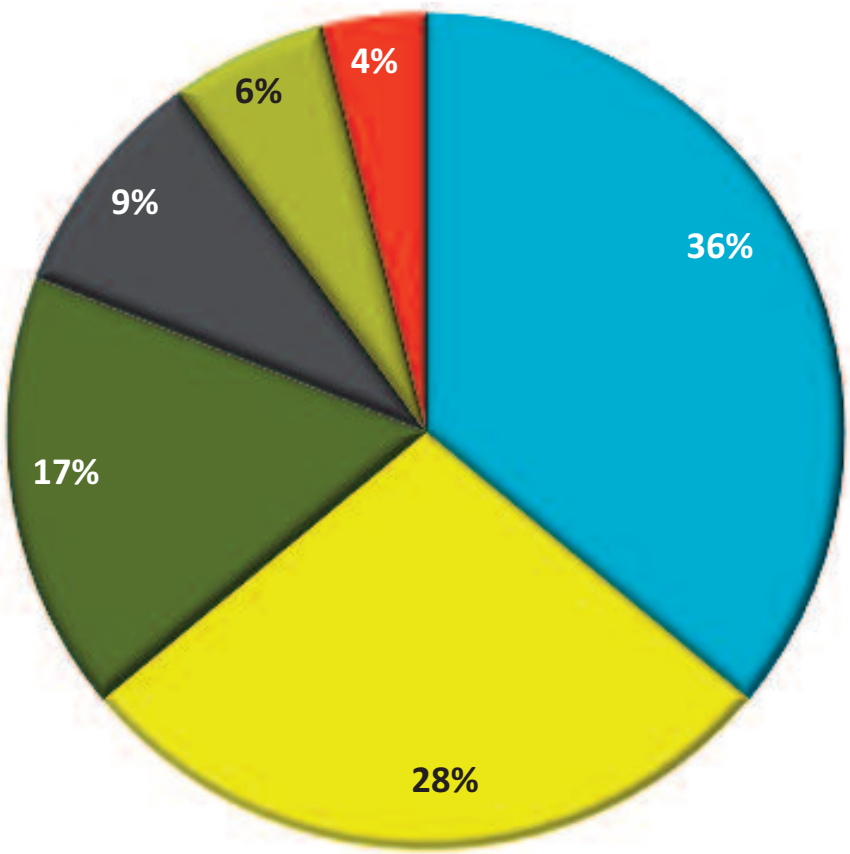
Knowledge of the characteristics and structure of key cells within the sugar beet roots will be used as a basis to improve sugar yields and unlock the potential of additional uses for sugar beet pulp.



How the levy is spent

BBRO implements and commissions work on behalf of the UK sugar beet industry. Funds to support this work are received from the growers levy, processor and external research bodies. The following chart shows the areas of spending for the 2016/17 crop.

BBRO Budgeted Spend by Area 2016-2017



Crop Stability	**£1,037,840**
Crop Progression	**£793,211**
Knowledge Exchange	**£471,454**
Overheads	**£257,795**
Commercial Work	**£183,397**
Crop Recovery	**£100,515**
Total Spend	**£2,844,212**


HarperAdams
Frontier
Hutchinsons
Agrifac
British
Sugar
EastonOtleyCollege
LionSeeds
Limagrain
ABSugar
MorleyAgricultural
Bayer
CTM
SESVanderHave
AICC
UniversityLeeds
NorwichResearchPark
BCPC
Agrovista
LincolnUniversity
Vervaet
InnovateUK
Procam
JamesHutton
Kverneland
OxfordAgCrop
ArmstongFisher
FERA
Adama
FelixCobbaldTrust
NFU
BASF
Vicon
Holmer
AHDB
AIC
Performance
BurkardManufacturing
NewcastleUniversity
Ropa
ReadingUniversity
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