Sugar Beet Reference Book

British Beet BBRO Research Organisation

Including Crop Protection options for 2024

Contents

Photo sources: Adobe Photostock, BBRO, Blackthorn Arable Ltd, University of North Dakota, British Sugar plc, growers and IRS. Our thanks to all contributors.

About BBRO

The BBRO is a non-profit making company set up jointly by British Sugar plc (BS) and the National Farmers' Union (NFU). The objective of the BBRO is to deliver and implement research and knowledge transfer designed to increase the competitiveness and profitability of the UK sugar beet industry in a sustainable and environmentally acceptable manner.

BBRO has a strong team of scientists and field trials operators that work hard to conduct robust research projects and deliver technical information through a wide range of knowledge exchange activities e.g. technical publications, summer open days, winter conferences, demonstration farm events and a range of social media activities.

The BBRO Executive Board provides guidance on the strategic direction of the organisation and its members are responsible for setting the levy. Working alongside this, the Stakeholder Committee provides guidance on future industry priorities and oversees BBRO's funded programme of research and knowledge exchange activities.

BBRO values:

Approachable

Industry leading

Innovative

Trusted

To ensure BBRO's research programme remains aligned with the industry needs we welcome feedback or comments on any of our current activities or suggestions for new work that will help to deliver our strategic objectives. You can contact us via email at **info@bbro.co.uk**

Access to BBRO support

Access to BBRO Support

BBRO provide a number of opportunities for growers to access information and engage with research staff.

Advisory Bulletin and Beet Review

Providing timely updates on current issues during the growing season and articles of interest to growers. Available to download https://bbro.co.uk/publications/ or sign-up to the circulation list, https://bbro.co.uk/publications/sign-up/

Open Days

Chance to visit one of our science sites, view the RL varieties and speak to BBRO staff and supporting research partners.

BeetTech Events

Held in February. As the campaign comes to an end, we reflect on the past year, lessons learned and the latest key messages for growers from the BBRO science team and internationally renowned researchers.

BeetCast

Listen to our monthly podcast for an insight into the world of sugar beet research, timely grower updates and future forecasts to support UK beet growers.

Demonstration Farm Network

Exploring the application of new technologies and agronomic practices on a commercial scale. Demo Farm events are held annually across the growing area.

Training

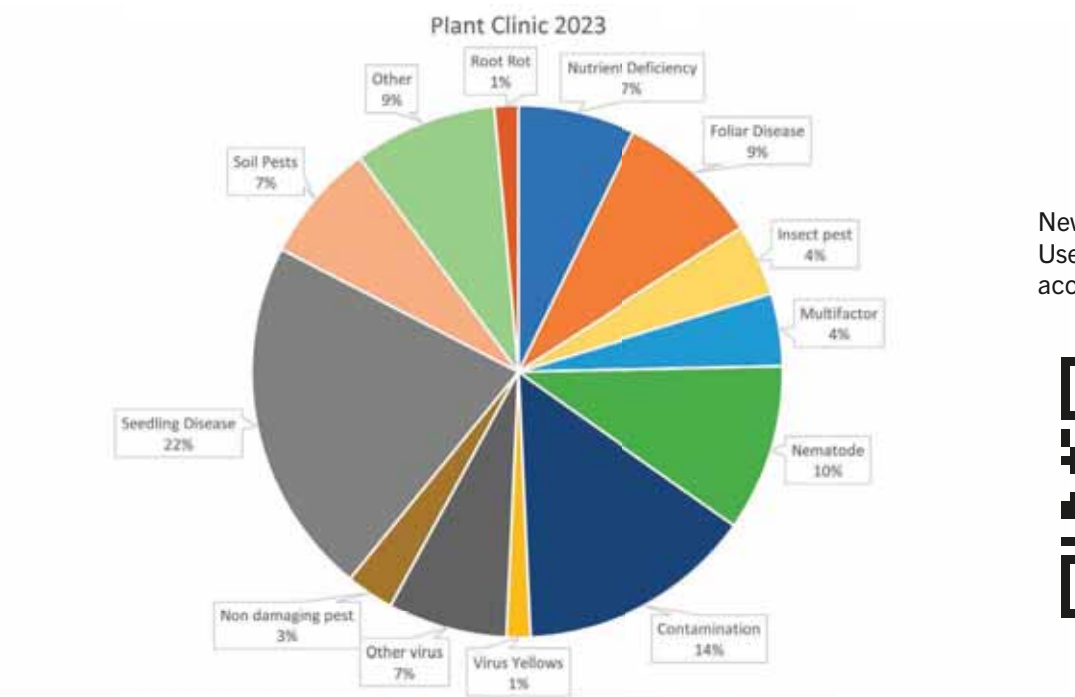
BBRO are building a portfolio of training opportunities utilising video, face to face and online events. Our Drill Operator Training course runs in February and is particularly popular.

BBRO also deliver the biennial Advanced Sugar Beet Production and Management Course, for individuals who wish to improve their fundamental understanding of sugar beet production.

Plant Clinic

Do you need help identifying or confirming a problem with your sugar beet crop?
We have facilities in our Norwich laboratory and glasshouses for a range of diagnostic tests from microscopic investigation of foliar diseases, virus detection, beet cyst nematode identification and germination tests.
The Plant Clinic enquiry form can be downloaded from the website at https://bbro.co.uk/research/plant-clinic/.
Please send enquiries with photographs to plantclinic@bbro.co.uk. We will assess your problem and advise you on what samples to send to the lab.

Results from 2023 plant clinic enquiries



New for 2024
Use the QR code below to access the plant clinic form

Website

Visit the BBRO website for a wealth of information; regular updates, industry news, events, project reports and access to all our publications and a number of tools to assist in growing the crop.

From April to June we will be releasing twice weekly data from the aphid survey, monitoring the prevalence of *Myzus persicae* across the growing region. From July onwards our attention will move to the Cercospora watch with regular updates and email alerts.

Variety Selection

Key Points:

- Using key information from the BBRO Recommended List is essential to help you make your variety choice.
- Select varieties with specific traits you require (these include bolting/BCN, Rhizomania and herbicide tolerance as well as partial tolerance to virus).
- Use variety ratings on foliar diseases to help make tactical selection in cases of high disease pressure and late harvesting situations.

As well as the RL trials, BBRO has its own variety trials programme assessing variety interactions with factors such as; disease, fungicide, virus and harvesting date. Results will be accessible via the BBRO website.

When deciding on a variety, a good place to start is with what you grew last season. What grew well on different soil types, establishment rates, early canopy vigour and the level of foliage disease and yield at different harvest dates. If you are not sure, aim to mark-out varieties in the field and monitor their performance this year and use our selection criteria on page 10.

Variety traits and selection

When selecting which variety to grow there is an increasing range of genetic traits to consider. This information can be found in the Recommended List of sugar beet varieties on the BBRO website.

Making sure you select the right variety for a given field or block of land is an important tactical decision and will have an impact on your final yield. Whilst root yield, sugar content and bolting are the key characteristics, other pest and disease traits are just as important, especially as changing weather patterns and loss of pesticide options makes their control more challenging.

Traits are briefly summarised as follows along with a decision-making chart. BBRO has a large programme of on-going work assessing additional variety traits. This includes virus yellows, BCN and drought.

Bolting

Sugar beet is a biennial plant that will only become reproductive (i.e. produce a flower, or as it is usually referred to in beet “a bolter”) once it has been exposed to low, vernalising temperatures (for bolting) and long days (for seed production). Temperatures between 3 and 12°C are the critical temperatures for vernalisation, with temperatures in the mid-range having greatest effect and those towards 12°C the least. As a rule-of-thumb around 40 days of vernalisation (where temperatures during the 24 hours are within this range) are required for beet to bolt. Vernalisation can start before the beet emerge; therefore, depth of drilling can have an effect on bolting. In some instances, high temperatures immediately after a cool vernalising day can neutralise this (devernalisation).

Early sown bolting (ESB) trials are sown separately to the main RL trials and are drilled sequentially from the last week of February to the 5th of March. The ESB figures are the number of bolters recorded from these earlier sowings for the last three years and should be used as a guide to compare varieties by growers sowing early and / or where high vernalisation (periods of cold) is expected.

Vernalisation data is provided in the supplementary table of the RL data on the BBRO website.

Establishment

Growers can use the establishment figures when calculating the seed rate required to produce their target plant population. In practice, the differences recorded between current varieties in trials are relatively small and those less than 4.2% are not statistically significant in the 2024 RL. In addition, growers need to consider that 'establishment' will vary between years (typically in the range 94 to 105%).

When selecting which variety to grow there is an increasing range of genetic traits to consider. This information can be found in the Recommended List of sugar beet varieties on the BBRO website.

Variety Selection

AYPR strain of rhizomania

Since 2007, some AYPR rhizomania strains have been identified at a few sites which continue to be monitored and breeders have developed varieties with enhanced resistance genes to the AYPR strains found at these sites. Yields of the AYPR varieties are determined in the normal RL trials, which are carried out in non-infested situations.

BCN

Beet cyst nematode (BCN) tolerant varieties are listed for use under BCN infested conditions but have yields suitable for use in non-infested fields.
The traits are currently based upon breeders' submissions the BCN varieties could be listed as resistant, tolerant or light tolerant to BCN infection. Only tolerant types are currently listed and marketed. These types can produce higher yields than conventional varieties under these conditions and cause lower multiplication of the nematode population compared to conventional varieties.

Foliar Disease

The current foliar disease data do not indicate tolerance or resistance, but simply leaf infection. The data in the RL table are ratings for Powdery mildew and Rust whilst those in the supplementary table are recorded as percentage leaf infection, including Cercospora.

Variety testing now include untreated and fungicide-treated trials to show the varietal performance under the natural infection of diseases. There are seasonal variations These results should be treated with reserve as the data tends to be variable. The three-year data table therefore provides a broader perspective on disease susceptibility.

Photo (above) Early signs of Cercospora

Definitions of susceptibility to pathogens

Susceptible: A variety that becomes infected by a pathogen and shows full symptoms of the disease; significant yield penalties may result.

Tolerant – A variety that is infected by a pathogen to the same extent as a susceptible variety, but expresses little or no symptoms.

Partially-resistant – A variety that is infected by a pathogen, but the pathogen is inhibited in its movement or multiplication.

Complete resistance (immunity) – A variety that is not affected by the pathogen at all.

Multiple resistance – Inclusion of more than one resistance genes to protect against different pests and/or diseases.

Variety Selection

ALS herbicide tolerance

The RL includes varieties that are tolerant to specific ALS herbicides (Conviso). In the RL trials these varieties were treated with conventional herbicides. It is expected that they will have higher yields when treated with the ALS rather than conventional herbicides. More details of the use of these varieties, including performance when treated with ALS herbicides, are available from the breeders.

Impurities

Impurities of the beet from each yield plot are measured in the tarehouse at Wissington at the same time as sugar content. The measurements use the current industry standard systems used for the commercial crop. These data are provided for information but at present there is no significant difference in impurities between the RL varieties.

Virus Yellows tolerance

Tolerance to any of the three yellowing viruses is not assessed in the RL trials although there are on-going BBRO trials to assess variety susceptivity to virus. The decision on whether to list a such a variety is currently based on breeder's claims. In the case of Maruscha KWS, this has partial tolerance to beet mild yellowing virus.

Guide to variety selection choices

STEP 1: Variety selection

Do you want to select for a specialist trait?

- AYPR resistance
- BCN tolerance
- CONVISO SMART (ALS herbicide tolerance)
- VIRUS Partial tolerance to Beet Mild Yellowing Virus

STEP 2: Select for drilling date

It is useful to have a variety that is suitable for early drilling when soil conditions allow an early start. If you don't have a suitable variety, use the bolter scores as a guide and aim to plant varieties with higher incidence of bolters last.

EARLY before mid-March ⟷ Normal drilling

STEP 3: Variety selection

Select for yield and refine your trait selection according to specific field and farm conditions

Sugar Content

Sugar content 2024 range is 16.7% – 17.5% (2024 . You may want to consider targeting higher sugar content varieties in fields which are likely to be harvested early and/or on land where there is a history of low sugar levels

Plant Establishment

Few significant differences between most varieties and usually a strong seasonal weather effect. It is worth checking the 3-year data sets to ensure you use a variety with consistent good establishment on land where production of a good seedbed is often challenging. Additionally, you can use the establishment figures when calculating the seed rate required to produce their target plant population

Foliar disease susceptibility

This is an important trait for managing foliar diseases, especially on deciding on fungicide programmes and for which varieties to use in higher disease pressure situations such as later harvested crops.

Using the RL 3-year percentage leaf infection values averaged across three diseases (rust, powdery mildew and cercospora) provides a good overall score of foliar disease susceptibility

Canopy vigour and growth habit

Differences in the vigour and growth habit of different varieties can have an agronomic effect. However, differences in growth habit can be specific to soil type and conditions and tend to be more pronounced on lighter and thinner soils compared to more fertile deeper soils.

Limited variety strip trial data shows that varieties with a more low growing habit can help provide better ground cover and weed control.

Varieties with fuller, upright, and more actively growing canopies in late summer (fewer senescing and dead lower leaves) have been linked to better autumn yield production

Seed Treatments

Seed and varieties

Seed treatment and pelleting involves several different technologies designed to improve the speed and uniformity of germination as well as early crop emergence and vigour.

Seed priming is a process of regulating the germination process by managing the temperature and seed moisture content. Seed is taken through the first biochemical processes within the initial stages of germination, bringing the seed closer to the point of germination.

Seed coating and pelleting ensures seed are uniform size and shape for easy handing and precision drilling and are the carriers of crop protection treatments such as fungicides and pesticides. Additionally, some seed treatments include elicitors and biostimulants which are designed to assist the plant with their natural defences against biotic and abiotic stresses and plant growth. These are not pesticides.

There are combinations of seed priming, coating and pelleting technologies used in the current range of products which will be listed on the seed order. In practice, seed technology has been shown to be effective but there are only small differences between products.

Seed treatment with fungicides and pesticides. All seed is treated with Tachigaren (Hymexazol) which protects the seedlings from seed and soil-borne diseases which cause Damping Off and Black Leg.

The use of Cruiser SB to provide control of aphid virus vectors is only possible if a derogation made under an emergency authorisation is approved. This is based on a national virus forecast in the early spring.

Seed are of different colours according to the seed treatment. This information is provided annually in the Seed Pack.

Seed can be treated with Force ST which contains the pyrethroid tefluthrin (non-neonicotinoid) and provides protection against a range of soil pests but not wireworm or aphid vectors of virus yellows.

Insecticide	Springtails	Symphylids	Millipedes	Pigmy beetle	Wireworm	Aphid vectors/ Virus Yellows
Force ST™	****	****	****	****	None	None

Seedling diseases:

Aphanomyces

When: Predominantly post-emergence

Symptoms: Grey/black legions on hypocotyls near soil line progress to blacked threadlike stems. Cotyledons do not usually wilt, and plants may recover, however thin stems increase the risk of breakage by wind damage

Risk: Warm, wet conditions, pH below 6.5 and Soil temperatures >15°C.

Severity: Depends on season but often seen in later sown crops when soil temperatures are warm and moist

Advice: Tachigaren seed treatments usually protect against aphanomyces infection

Phoma

When: Pre-emergence and post-emergence

Symptoms: Pre-emergence damping-off. Post-emergence symptoms; dark brown/ black necrosis on hypocotyls. Infected seedlings often survive but disease can persist in crown tissue resulting in root rots later in the season

Risk: Pre-emergence; cool (4-12°C), wet soils. Post-emergence; 16-20°C, wet soils

Severity: Dependant on above risk factors

Advice: Current seed treatments protect against seed borne phoma

Pythium spp.

When: Pre-emergence and post-emergence

Symptoms: Pre-emergence damping-off. Post-emergence symptoms; wilting and seedling death

Risk: Occurs over a wide temperature range, 5-35°C

Severity: Dependant on above risk factors

Advice: Tachigaren seed treatments will protect against pythium infection

Rhizoctonia

When: Pre-emergence and post-emergence

Symptoms: Pre-emergence damping-off. Post-emergence symptoms; wilting and seedling death

Risk: Soil temperatures above 20°C

Severity: Not a major problem in the UK at present

Advice: No registered products available

Soil Management

Key Points:

- Sugar beet is very sensitive to poor soil health, especially poor soil structure
- BBRO trials and monitoring of commercial crops, such as the BYC project, consistently identify soil health as one of the most important yield-limiting factors
- Improved soil structure and health is clearly linked to improved plant populations and resilience to stress, especially drought
- Production of a good quality and healthy seedbed is key to early and rapid canopy growth. Target a seedbed of 5-7cm depth, aiming for a minimum of 30% of particles <3mm around the seed to ensure moisture availability
- It is not possible to provide a 'blueprint' approach to cultivations. Decisions on subsoiling, ploughing and reduced tillage should be based on measuring soil health and conditions.

It is important to undertake soil testing for plant nutrients and pH to ensure good crop health. The tests do not, however, provide a measure of overall soil health. To understand how to measure soil health effectively and efficiently on farm, BBRO worked in collaboration with AHDB on the five-year Soil Biology and Soil Health (SBSH) Partnership (2017–2022) which led to the AHDB GREATSoils program.

To understand if we are improving or maintaining soil health BBRO recommends the soil health scorecard approach developed as part of this program.

This section will guide you through soil sampling, analysis and interpreting results using the soil health scorecard.

Inappropriate soil cultivations, incorrect timing of cultivations or carrying out cultivations under sub-optimal conditions can result in yield losses of 30% or more.

Part 1: Sampling strategy and frequency of sampling

Before embarking on a significant change on farm such as; reducing tillage intensity, increasing the use of manures or using cover crops it is important to gather good baseline data on soil health. This will enable you to track changes in soil health over time and assess if they are achieving what is expected.

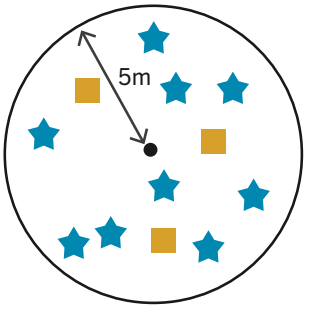
Annual assessments: physical assessments (such as digging soil pits to look at soil structure and compaction) as well as biological tests (such as earthworm counts) should, ideally, be done annually at the same time of year (usually spring and/or autumn).

Assessments every three to five years: chemical tests – for pH and major nutrients – should be conducted at least every three to five years.

Assessments less than every 5 years: soil organic matter changes relatively slowly. There is little point in conducting tests for soil organic matter more often than once every five years, potentially only every 10 years, unless significant amounts of organic materials have been applied annually.

Soil health scorecard

For the soil health scorecard, the guidance is to record a centre point for the assessment area and to take samples up to 5m away from it (at random points). For visual assessments of soil structure (VESS) and earthworms, take three samples (illustrated by the orange squares).
How to undertake a VESS is covered in part 2 and earthworm assessments in part 3.
For other indicators, take several samples (illustrated by the blue stars).
Analysing samples for soil nutrients, pH and organic matter is covered part 4.



Do not sample:

- Within six months of a lime or fertiliser application (except nitrogen)
- When the soil is very dry
- In headland or in the immediate vicinity of hedges, trees or other unusual features

Effective record-keeping

Keep good records, to track changes in soil health over time. Ideally, a file for each field should be kept. Laboratory results, notes on soil profile, soil structure assessments and yield figures are important. Additional information, such as comments on weather, soil conditions and ease of cultivation, is also worth keeping on record.

Soil Management

Part 2: Visual evaluation of soil Structure (VESS)

How to assess soil structure

Soils should be assessed when they are moist and soil aggregates are easier to break up by hand. Avoid assessing soils during prolonged spells of wet or dry weather. Wait at least one month after cultivations.

Step1: surface assessment

Assess the cover (grass sward, crop or residue) to identify moderate or poor areas that require futher assessment.

Good

- Good cover
- No standing water
- No poaching and/or deep wheelings

Moderate

- Poor cover (or with more weed species in grassland)
- Some standing water
- some poaching and/or deep wheelings

Poor

- Very poor cover and growth/sward quality
- Standing water and/or surface capping
- Severe poaching and/or deep wheelings

Step 2: soil block extraction

- Dig out one spade sized block of soil (depth approximately 30cm), cutting down on three sides
- Lever the block out, leaving one side undisturbed
- If the soil block falls apart easily, dig out one block and then a second next to it to assess
- Lay the block on a plastic sheet or tray

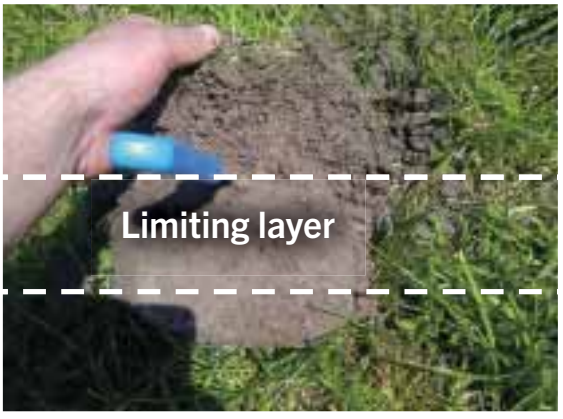
Top tip

Dig in 'good' (e.g. hedge bottom) and 'bad' (e.g. a gateway or tramline) areas to get familar with soil structure.

Step 3: soil assessment

Gently open the soil block by hand (like a book) to look for layers.

- If the structure is uniform, assess the block as a whole
- If there are two or more horizontal layers of differing structure, indentify the layer with the poorest structure (the limiting layer)
- Record the depth of this limiting layer and carry out the rest of the assessment on this layer



Break up the soil with your hands into smaller structural units or aggregates (soil clumps).
Using one hand, break up larger soil aggregrates to assess their strength. Consider their shape, porosity and roots.

Step 4: soil scoring

Assign a score using the descriptions and photos overleaf.

Step 5: management

Consider management options based on the soil structure score. Then reassess:

- After a change in management practice
- After grazing/trafficking on wet ground
- routinely every two years on grassland
- routinely after each rotation on arable land

Further information

See ahdb.org.uk/GREATsoils for more information (including management options).

The information here is based on the VESS method of soil structure assessment -sruc.ac.uk/vess

Score	Soil structure	Soil aggregates
Score 1: GOOD Crumbly (aggregates readily crumble with fingers).		
Score 2: GOOD Intact (aggregates easily break apart with one hand).		
Score 3: MODERATE Firm (most aggregates break apart with one hand).		
Score 4: POOR Compact (effort needed to break apart aggregates with one hand).		
Score 5: POOR Very compact (aggregates difficult to break apart with two hands).		

Photography credits: © SRUC

	Description	Management options
	Good soil structure, highly porous. Small, rounded, crumb-like aggregates (<6mm). Numerous, well-distributed roots down to spade depth. Sweet, earthy smell.	No management changes needed, continue routine monitoring.
	Good soil structure, mostly porous. Larger, rounded aggregates (2mm to 7cm). Numerous, well-distributed roots down to spade depth. Sweet earthy smell.	No management changes needed. Reassess annually on grassland. Continue rotational monitoring on arable land.
	Adequate soil structure, less visible pores. Rounded aggregates, with some angular (2mm to 10cm). Fewer roots distributed within soil aggregates. No noticeable smell.	Minimise traffic on wet ground. Infrastructure changes in grassland can help, e.g. back-fencing, multiple field entrances or tracks. Consider culitvation depth on arable land in autumn.
	Poor soil structure, very few pores. Mostly large angular aggregates (10cm). reduced rooting, clustered in large pores, earthworm channels and cracks between aggregates. Red/orange mottling may be present (sign of poor drainage). May have 'bad egg' smell.	Minimise traffic on wet ground. Check subsoil layers for compaction. Consider targeted cultivations under the right soil conditions. On grassland, consider using a sward slitter or aerator (<10 cm depth) and a sward lifter/top-soiler (10 to 30 cm depth). If the sward is poor, consider ploughing or reseeding. On arable land, consider improved drainage and diversifying crop rotations, especially the inclusion of no-till periods (e.g. ley-arable rotations)
	Poor soil structure, very few pores. Very large angular or platy aggregates (10cm). Few roots,if any, restricted to the surface, down large pores, following eathworm channels or cracks. May be grey/blue in colour, or with orange mottling (sign of poor drainage) Strong 'bad egg' smell.	Minimise traffic on wet ground. Check subsoil layers for compaction. Consider targeted cultivations under the right soil conditions. On grassland, consider using a sward slitter or aerator (<10 cm depth) and a sward lifter/top-soiler (10 to 30 cm depth). If the sward is poor, consider ploughing or reseeding. On arable land, consider improved drainage and diversifying crop rotations, especially the inclusion of no-till periods (e.g. ley-arable rotations).

Soil Management

FACTSHEET

GREATSOILS

Authors

Jacqueline Stroud, Rothamsted Research
jacqueline.stroud@rothamsted.ac.uk

Amanda Bennett, AHDB
amanda.bennett@ahdb.org.uk

How to count earthworms

Importance

Earthworms improve plant productivity, are principally responsible for engineering the soil environment and are an important food source for native birds such as the song thrush. There are up to 10 common earthworm species in agricultural soils and these can be grouped into three ecological types: epigeic, endogeic and anecic earthworms – each group having a unique and important function. Earthworms are an indicator of soil health, being impacted by pH, waterlogging, compaction, tillage, rotation and organic matter management.

What do earthworms tell us?

- **A good presence of earthworms across a field** means the benefits are likely to be widespread
- **High numbers of earthworms** indicate the potential for significant benefits to plant productivity
- **The presence of each ecological group** indicates the potential for specific earthworm benefits, such as carbon cycling, nutrient mobilisation and/or water infiltration

How to identify earthworms

Epigeic (litter-dwelling earthworms)

- Dark red-headed worms
- Small (<8cm) in size, typically about the length of a matchstick
- Often fast-moving (most likely to escape from the worm pot!)

Sensitive to: Tillage (detrimental) and organic matter management such as manure applications (beneficial)

Roles: Carbon cycling and prey for native birds

Endogeic (topsoil earthworms)

- Pale-coloured and green worms (not red)
- Small to medium size
- Often curl up when handled, and green worms may emit a yellow fluid
- The most common earthworm group found in arable fields

Sensitive to: Organic matter management (beneficial)

Roles: Soil aggregation and nutrient mobilisation for plants

Anecic (deep burrowing earthworms)

- Dark red or black-headed worms
- Large size (>8cm), typically similar size to a pencil
- Make deep vertical tunnels, up to 2m
- Often found below surface earthworm castsor midden residue piles
- Feed at night, foraging the soil surfacearound their burrow for litter
- Commonly found in grassland but often absent from ploughed fields and where there is no surface litter

Sensitive to: Tillage (detrimental) and organic matter management such as manure applications and straw return (beneficial)

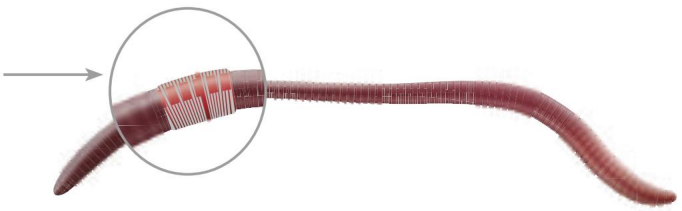
Roles: Deep burrows that improve aeration, water infiltration and root development

Identifying adults and juveniles

Adult earthworms have a clearly developed **saddle** (reproductive ring) and juveniles do not.

You may need to rinse worms with water to determine if a saddle is present.

Size is not a good indicator of maturity as adult earthworms typically range in size from 2cm to 15cm, depending on species.



Soil Management

Assessing earthworm populations in just 60 minutes

When is it best to count earthworms?

Spring and autumn are the best times to carry out earthworm assessments.

Timing the sampling after warm, wet conditions often provides the best earthworm population estimates.

How to assess the earthworm populations

Tools: Spade, pot, bottle of water, mat and a record sheet available to download at **ahdb.org.uk/greatsoils**

Procedure: Dig 10 soil pits per field following a standard W-shape field-sampling pattern. Aim to spend five minutes hand-sorting the soil from each pit.

1 Dig out a soil pit (20cm x 20cm x 20cm) and place soil on mat

2 Hand-sort the soil, placing each whole earthworm into the pot

3 Count and record the total number of earthworms

4 Separate earthworms into adults and juveniles

5 Return juveniles to the soil pit

6 Count and record the number of each type of adult earthworm

7 Return earthworms to the soil pit and backfill with soil

8 Repeat steps 1–7, until 10 soil pits per field have been assessed

BBRO would like to acknowledge the support and resources supplied by the AHDB in this publication which was procuded as part of the Great Soils project.

Further information

For more information on soil management and increasing earthworm numbers, visit **ahdb.org.uk/greatsoils**

Authors

Jacqueline Stroud, Rothamsted Research
jacqueline.stroud@rothamsted.ac.uk

Amanda Bennett, AHDB
amanda.bennett@ahdb.org.uk

Produced for you by:

AHDB
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

T 024 7669 2051
E comms@ahdb.org.uk
W ahdb.org.uk
@TheAHDB

If you no longer wish to receive this information, please email us on **comms@ahdb.org.uk**

GREATSOILS

Soil Management

Part 4: Analysing soil for nutrients, pH and organic matter

(Defined as the blue stars on the sampling diagram)

What can a soil sample show?

Laboratory analysis of a representative soil sample will provide valuable information on the level of:

- Phosphate
- Potash
- Magnesium
- pH
- Soil organic matter
- Micronutrients

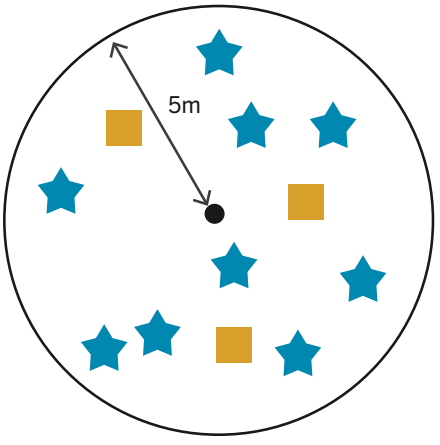
How to collect a soil sample for nutrient analysis for the soil health scorecard

In arable and horticultural rotations: at each soil health scorecard assessment location collect a subsample (core) to 15 cm depth using a gouge corer or screw auger (blue stars on the sampling map below).

However, if the land is min-tilled, phosphate and potash will tend to accumulate near the soil surface, and a 15cm sample will overestimate nutrient concentrations to normal plough depth. In this case, samples are better taken to about 23cm.

To minimise the impact of local variation (e.g. the presence of old fertiliser granules), mix samples collected from the sampling area in a clean bag or bucket to form a bulked sample. Send a well-mixed representative subsample to the laboratory for analysis. Use appropriate packaging (normally available from the laboratory) and label samples clearly, providing as much information about the field and crop as possible.

This approach applies to sampling specifically for the soil health scorecard. To analyse soil for crop nutrient management or pH for liming the whole field will need to be sampled in a grid or W pattern.



Part 5: Using the soil health scorecard

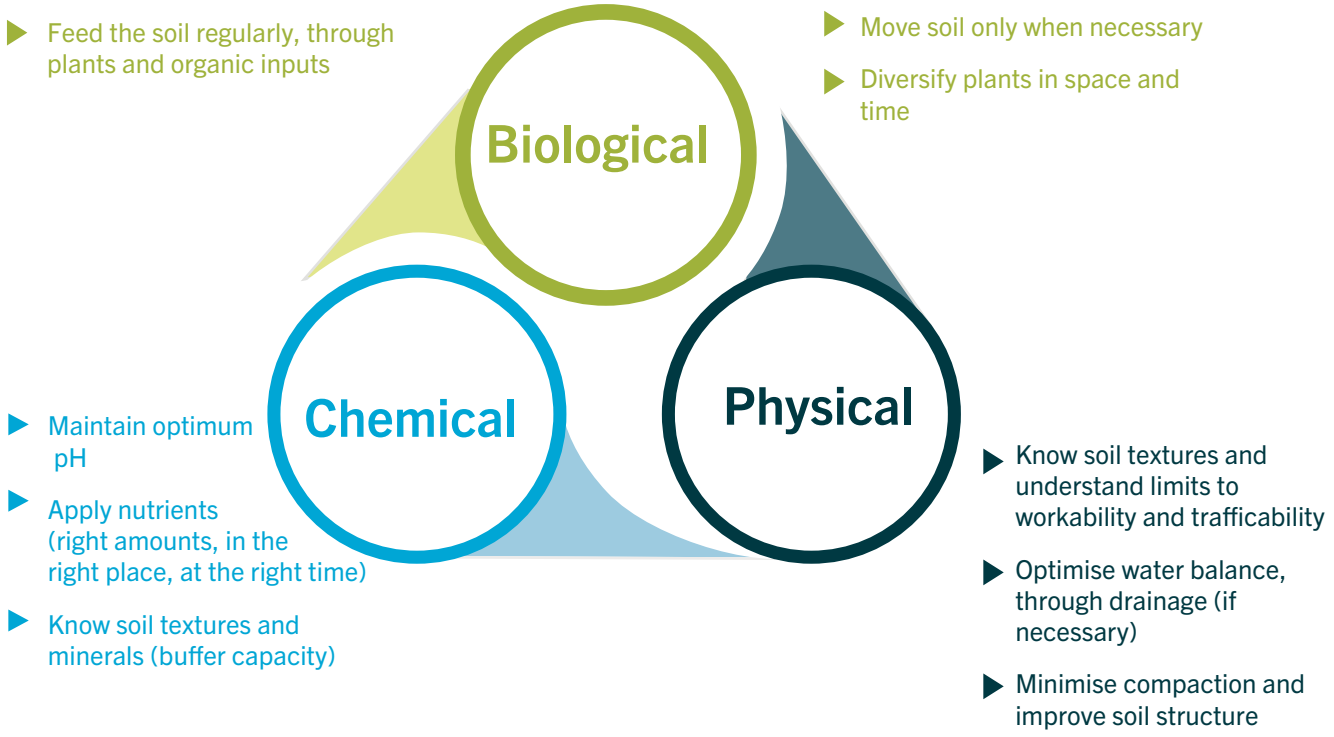
Once you have your score card indicators:

1. Soil structure – using VESS (Visual Evaluation of Soil Structure).
2. pH.
3. Extractable nutrients (phosphorus (P), potassium (K) and magnesium (Mg)).
4. Earthworms.
5. Soil organic matter.

You can access the soil health score card spreadsheet at The soil health scorecard | AHDB.
When your information is entered it will flag your information as Red, Amber or Green.

- Red - Investigate
- Amber - Review
- Green – Monitor

The amber and red results can then be explored in more detail with the score card providing initial signposting and links to further information on the relevant topic. A simple overview of how the three key elements of soil health (biological, chemical and physical) and the key factors that affect them are shown below.



Soil Management

Ploughing

Ploughing should be carried out with the aim of producing a level finish for uniform soil weathering.

Ploughing at the correct time and under the correct conditions should allow for just one cultivation pass in the spring.

The optimum timing of ploughing depends on the soil type and prevailing weather conditions.

Heavy soils:

Plough before the end of October to maximise soil weathering.

Plough under dry conditions. Under wet conditions a smeared layer can be formed, particularly where the tractor furrow wheel is slipping. This can result in drainage problems and restricted root growth in the spring.

Heavy soils tend to leave an uneven surface when ploughed leading to the formation of hollows, which can reduce the benefit of overwinter soil weathering. In such instances it is advisable to carry out a cultivation to level the surface and break up the furrow slice. A furrow cracker or narrow ring furrow press have been shown to be beneficial in these circumstances.

Medium soils:

Plough from mid-October onwards with the aim of finishing before January.

Aim to produce a level finish but avoid the surface being too fine because a weak structure can cause furrows to run together and slumping to occur.

Soils that have slumped take longer to dry out in the spring, potentially delaying drilling.

Light soils:

Plough shortly before drilling to reduce the risk of drying, slumping and erosion.

The use of a wide ring press helps to improve consolidation and creates a rough soil surface to reduce the risk of soil erosion.

Spring cultivations

Aim for just one pass in the spring to create a level consolidated seedbed. A level seedbed is essential to reduce losses at harvest and allow seed to soil contact.

Timing is very important; go as early as possible but ensure soil moisture is at the correct level to prevent excessive compaction.

To reduce the risk of compaction, maximise vehicle footprint with wider tyres, dual wheels and reducing the tyre pressures. Look to minimise tractor weight with selection or remove all unnecessary ballast weights.

After spring cultivations and before drilling, consider doing a test dig to check for soil conditions and structure at depth.

Under optimum conditions

- Use a combination harrow working at a depth of 7-9cm (to create 5-7cm depth of seedbed)
- If a second pass is required, ensure low ground pressure to reduce excessive compaction

Non-inversion tillage

- Ideally before using this system for sugar beet, non-inversion tillage should have been used on two cereal crops. This allows organic matter and biological activity to accumulate in the upper layers of the topsoil
- After harvesting the cereal crop, either bale and remove the straw or chop and spread. Aim for the straw to be spread as evenly as possible and for the stubble length to be around 15cm
- A shallow cultivation may be required to encourage weed germination before the main cultivation

Under less than optimum conditions on heavy soils

- Use a combination harrow on the front of the tractor and a power harrow behind to carry out two passes in one travel of the field
- If an ideal seedbed cannot be created, consider rolling after drilling

Plant establishment has been shown to be higher in seedbeds that have a range of aggregate sizes with the majority less than 3mm. This allows aggregates to pack tightly together whilst still providing plenty of air gaps, ensuring good seed-soil contact for early root development and moisture retention. Seedbeds with large aggregate sizes (cloddy) will result in variable seed depth, poor water retention and poor soil-seed and root contact. Check the quality of the seedbed, which in some cases may warrant leaving until a better aggregate size can be produced.

Early Crop Nutrition

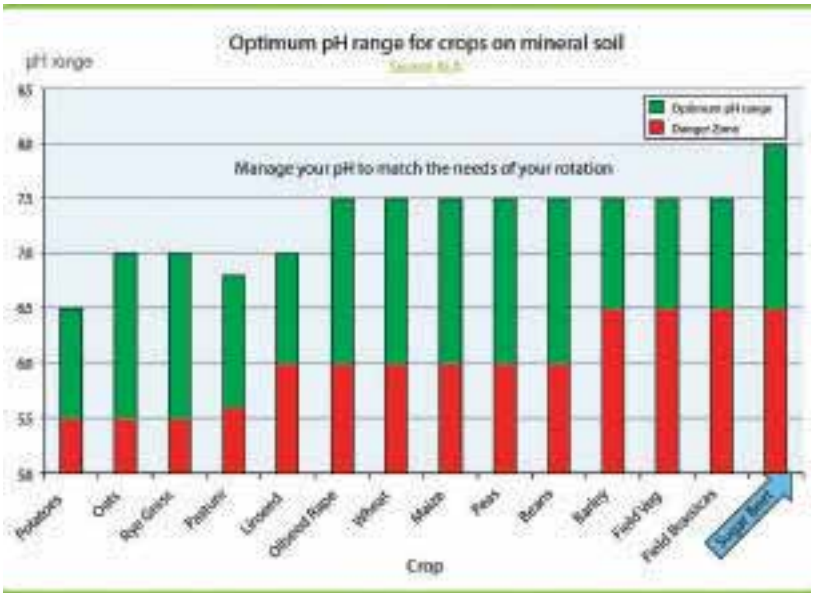
Lime and pH

Key Points:

- Lime is required to correct soil pH to maximise yield of sugar beet (and many other crops)
- Mild yield effects can be seen on mineral soils below pH 6.5
- Serious effects of soil acidity occur on the soils below pH 6.0
- Low pH (acidic soil) reduces the activity of earthworms in the soil
- It is risky to rely on a composite soil sample pH result as few soils are truly uniform for pH
- Calcium is a major nutrient - a 70t/ha crop contains over 100kg of calcium
- Liming on many soils is an essential rotational investment
- Low pH limits the availability of essential nutrients (depressing yield)
- Select a liming product that is both reactive and long lasting
- Apply in good time to allow thorough mixing into the top 20cm

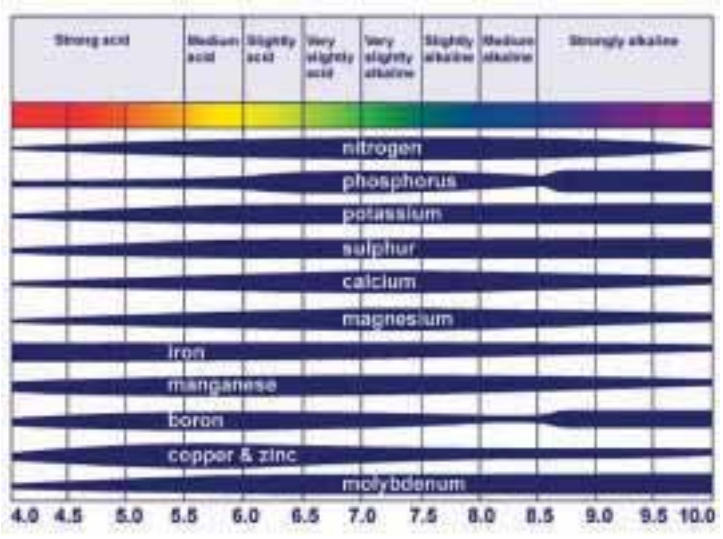
Current crop situation

Graph illustrates that c.25% sugar beet land is limed ahead of cropping. This will provide rotational liming benefit to other pH sensitive crops, such as barley, brassicas and maize – however, all crops will benefit.



Role of liming

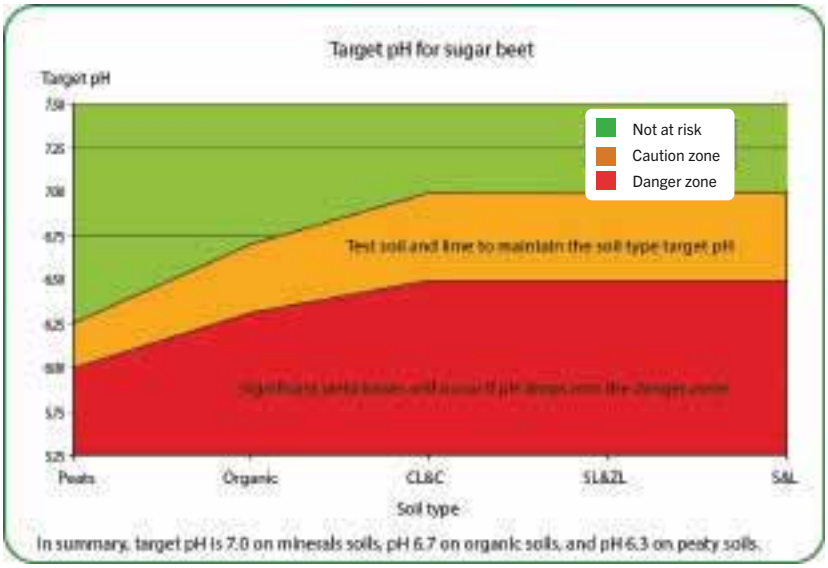
The correct soil pH is a fundamental requirement for the availability of macro and micro nutrients, and will significantly influence the efficient utilisation of nutrients applied from fertilisers and organic manures/materials.
(Reference: image (right): Roques, S., Kendall, S., Smith, K., Price, P.N. and Berry, P., 2013. A review of the non-NPKS nutrient requirements of UK cereals and oilseed rape. HGCA.



Soil type and optimum pH range

A managed soil pH programme should ensure the most pH sensitive crops are protected from risk of yield loss due to i) low pH and ii) compromised nutrient availability; and, therefore, the following guide identifies the green and amber pH ranges by soil type. Lower optimum pHs are required on the organic and peat soils in response to their unique Cation Exchange Capacity (CEC).

Neglecting soil pH will only lead to consequential yield loss across the rotation.



Product selection

Check product specification for neutralising value and size, ensuring you choose a fine product that will be reactive and correct pH more rapidly. Finely ground products (>40% passing 0.15mm) are preferable.

Most good limestone and chalk products (calcium carbonate) should offer this level of fineness (or reactivity) in combination with c.50% neutralising value (NV) compared to pure CaO equivalent (calcium oxide).

LimeX is an extremely fine precipitate of calcium carbonate with >85% passing 0.15mm and an average NV of 30% CaO. This offers very rapid and lasting pH correction as a direct function of surface area. This also contains P_2O_5, MgO and SO_3 to support least cost crop production when applied overall for pH management and calcium supply.

Avoid coarse, hard materials as particles >1.3mm may offer no liming value in practice.

Timing of application

Ideally lime products should be applied 12-18 months before pH sensitive crops to ensure thorough incorporation of the liming product with the soil. However, finer, more reactive products such as LimeX or ground chalk and limestone products with >40% passing 0.15mm can be applied successfully in the autumn before cropping with sugar beet.

Rate of application

If primary cultivations are deeper than 20cm, application rates should be increased pro-rata to avoid dilution and hence a reduced efficiency of the pH increase.

Generic application rate tables can be found at aglime.org.uk assuming a 54%NV product with 40% passing 0.15mm.

For LimeX70, please use the following guide:

Soil Type	Arable 20cm depth t/ha (t/ac)	Grassland 15cm depth t/ha (t/ac)
Sands	6.0 (2.5)	5.0 (2.0)
Light	7.0 (3.0)	5.0 (2.0)
Medium and Clay	8.0 (3.3)	6.0 (2.5)
Organic	10.0 (4.0)	7.0 (3.0)
Peat and Peaty	16.0 (6.5)	7.0 (3.0)

Information on LimeX45 can be found at **limex.co.uk**

Additional benefits

LimeX products also contain valuable nutrients and when applied overall can be taken into account within the nutrient management plan (NMP):

Minimum nutrient content kg/t

Element	LimeX70	LimeX45
P_2O_5	10	7
MgO	7	5
SO_3	6	4

Soil pH testing and mapping

Ideally fields should be grid sampled to show the range of 'as found' soil pH. Sampling on a 60m x 60m grid will provide 2.5 samples/ha (1/ac) from which an objective decision to lime, or not, can be determined. An example of which is shown below.

Soil Pests & Diseases

Free living nematode

When: Seedlings and immature plants during wet springs

Symptoms: Free living nematode (FLN) damage, known widely as Docking disorder, is caused by a range of nematode types, mainly stubby root nematodes (*Trichodorus spp.* & *Paratricodorus spp*.) and needle nematodes (*Longidorus spp.*). Feeding by FLN results in stunted growth and plant development

Risk: FLN is most prevalent on light, sandy soil types and will appear in patches in commercial crops. Seedlings and young plants are most at risk and will suffer most in a wet spring, where the water-table is high and the nematodes are therefore active in the rooting zone of the plants

Severity: Yield losses under FLN can be very severe (50%+) as well as reducing the levels of recoverable yield due to the fanged roots being broken at harvest and increased soil tares

Photo: FLN damaged beet (left) vs nematicide treated beet (right)

Advice: Soil tests can be conducted to identify FLN. Please contact BBRO directly at plantclinic@bbro.co.uk for more advice and to be put in touch with a commercial testing service. Testing for FLN must follow very precise protocols and be taken with the correct equipment and correct time of the year to provide the most reliable detection of these nematode species. It is important to note that this testing is different to that used to BCN and that the nematodes are very fragile and samples should be gently handled once collected.

Control: Historically, growers on high risk soil types would consider using a

nematicide, most recently Vydate which was used for the last time in sugar beet in 2021 after being banned in 2020. Fortunately, a new product, NEMguard DE has recently been authorised for use in sugar beet which has been available since 2022. This product is a biologically derived garlic-based nematicide which can be applied in a similar fashion to Vydate via granule applicator kits on drills. Currently, BBRO recommend using NEMguard DE at 10kg/ha which should provide an economic means of protecting your crops. In high risk situations the rate can be increased to 20kg/ha, which is the maximum approved on-label rate. BBRO will continue to research the best rate to use over the coming years.

Early sowing and dry springs offer good opportunities for a crop to establish before the nematodes become active as soil temperatures increase in the spring. However, unfortunately, these cannot be relied upon. Since these nematodes are general grazers, and therefore have a wide host range, it is also difficult to manage them by changing rotations. Additional cultivations can offer some level of control since the shearing action can break up some of the nematodes.

Beet cyst nematode

When: May to November, in which up to three generations develop

Symptoms: White immature females are visible on root hairs of mature plants. These develop into mature (brown) cysts which detach from the root and contain up to 600 eggs which hatch over the next 5-10 years. As latter populations develop, and populations increase, the nematode interrupts the normal rooting of the plant and leads to a 'bearded' appearance. This results in an insufficient supply of water to the plant and causes wilting. BCN will occur in patches in infested fields and is often spotted when only these patches wilt

Risk: BCN is most harmful on organic, loamy and sandy soils but is found in all factory areas. Severe infestation on a susceptible variety can cause up to 60% yield loss and beet will appear fanged and have high soil tares. White cysts are spotted throughout the summer and are approximately the size of a grain of sand

Severity: Varies both within and between fields. Infested fields should be identified by soil sampling. Use long rotations avoiding host species used to control populations. Host species include crop species such as other beet species, most brassicas and soya bean but also common weeds such as fat hen and shepherd's purse

Advice: No chemical controls are currently licensed. Yield losses can be managed by selecting BCN tolerant varieties, but this will not prevent nematode populations from increasing. Recent BBRO trials suggest resistant brassica trap crops may be useful, but not all varieties of mustard or radish are equally effective. Thus, trap cropping should be used cautiously. Where possible use a BCN tolerant variety, observe good farm hygiene and wash equipment between fields where practicable. Long rotations (5+ years without a host) will always be the best form of BCN control.

Photo: BCN susceptible plant (left) and tolerant (right)

Soil Pests & Diseases

Cutworm

When: April to June

Symptoms: Cutworms feed from the plants at the soil surface, or just below. Seedlings are at high risk since they can gnaw through the stem base. More mature plants will have pitted holes on the storage root. Larvae feed at night

Risk: Rarely enough to destroy a crop, but some species pose a significant threat to newly emerged beet

Severity: The extent of the severity of cutworms on the current UK sugar beet crop is not known

Advice: No established threshold, pyrethroids can be used to control cutworm

Leather Jacket

When: Seedlings (feeding occurs up to June)

Symptoms: Lower leaves, petioles, stems and roots of seedlings are eaten by larvae

Risk: Damage is sporadic and feeding tends to occur on damp and warm nights

Severity: Widespread in damp areas of fields and commonly occur after grass crops

Advice: No products registered in sugar beet

Millipedes

When: Seedlings and immature plants

Symptoms: Millipedes feed on the roots and stems of seedlings below the soil and can lead to plant death

Risk: Millipede damage can slow plant growth and exacerbate damage from other pests (specifically springtails, symphylids and pygmy beetles)

Severity: Most damaging on high organic and open soils

Advice: Plants are tolerant of damage once they reach four leaf stage. Early establishment will help protect yields

Slugs and snails

When: All plant stages, particularly vulnerable in spring and autumn

Symptoms: Feeding damage can occur below the soil surface and also to stems and leaves. Slime trails can often also be found on the leaves

Risk: Plants are at greatest risk in damp springs and autumn. Particularly numerous after oilseed rape and pea crops, due to ample organic matter to sustain populations.

Severity: Dependent on weather and cultivation techniques

Advice: Cultural control and appropriate use of slug pellets (ferric phosphate)

Springtail

When: Seedlings

Symptoms: Small pits are found on cotyledons from foliar feeding species. This damage is of no economic importance. Pits on the roots, prior to emergence, caused by soil inhabiting species can lead to uneven and stunted emergence and seedling death

Risk: Damaging soil dwelling species are white and are found mainly on heavy and organic soils

Severity: They only pose a serious threat to seedlings (pre and post emergence) and are active at temperatures as low as 7°C

Advice: Use of Force ST treated seed should provide protection

Symphylid

When: Seedlings and immature plants

Symptoms: Roots, stem and root hairs are eaten by symphylids. This results in poor establishment due to plant death and surviving plants have stunted growth

Risk: Favour sugar beet and can survive for multiple years in the soil. They move up and down the soil profile, preferring moist soil layers

Severity: Will vary across fields. Symphylids float in water and can be checked for by crumbling field soil into a container of water

Advice: Use of Force ST treated seed should provide protection

Wireworm

When: April – July

Symptoms: Main tap root or stem of young plants is eaten through and kills the plant. On older plants the larvae may mine into the storage root

Risk: Beet grown up to three years after grass is at greatest risk but can also attack beet crops after cereals, especially on chalky soils

Severity: Infected fields will contain larvae of various ages that result in adults emerging each year

Advice: Dry soils are good controls of eggs and larvae and avoid growing beet after grasses, clover and Lucerne

Soil Pests & Diseases

Fusarium rot

When: Middle June onwards

Symptoms: Black rot on the external root surface

Risk: Warm soils (optimum disease development 27°C)

Severity: Losses can be severe when fusarium rot is present particularly if left in clamps

Advice: Avoid storing rotten roots

Rhizoctonia (root rot)

When: Middle June onwards

Symptoms: Dry rot spots gradually deepen and disrupt the beet close to the soil surface. Patchy infested areas are typical

Risk: Wet, poorly drained soils. Optimum temperature of 25-33°C

Severity: Yield losses range from negligible to more than 50%

Advice: No treatment for root rot. Avoid close rotations of susceptible crops (eg maize, beans)

Rhizomania

When: June onwards

Symptoms: Prolific lateral root growth, stunted tap root with darkened vascular rings when cut. Foliage of affected plants readily wilt, particularly under drought conditions

Risk: Saturated soils and warm temperatures between 15-28°C favour the infection of roots with **Polymyxa betae** - the agent which transmits the rhizomania virus into its host

Severity: Can decrease by up to 80%, aggressive AYPR strains of rhizomania can overcome 'partial resistant' Rz1 varieties

Advice: Select an AYPR resistant variety in fields known to be infected with this aggressive strain

Violet root rot

When: Late in the season

Symptoms: Purple spots/red mycelial growth on root surface. Root rot has characteristic purple tinge, generally found in circular patches within the field

Risk: Temperatures above 13°C. Close rotation of susceptible species (e.g. potato, carrots)

Severity: Generally doesn't affect whole fields or destroy plants, but does lower root yield and sugar content

Advice: No treatment. Avoid close rotations of susceptible crops, control susceptible weed hosts (eg bindweed, sowthistle). Avoid storing rotten roots

Cover crops

There is increasing evidence that the use of cover crops in arable rotations has a positive impact on soil health. Work on cover crops has demonstrated how they can improve the physical structure of the soil as well as improving soil biology and chemistry (nutrients) . The use of an autumn established cover crop before sugar beet is therefore a good option but it important to balance the advantages of cover crop against the risk introducing a 'green bridge' for pests, diseases, and virus. This risk can be reduced by ensuring that the use of species such as brassicas are kept to a minimum and ensuring a good 5-6 week break between destroying the cover crop and drilling sugar beet in high-risk situations.

Getting cover crops established in good conditions to produce sufficient above ground biomass and below ground root mass is key to how effective they are. The ability to sow cover crops into soils with sufficient moisture and warmth should be a key factor in deciding whether to have a cover crop or what species to grow.

A BBRO survey of 12 sugar beet crops following a cover crop was undertaken in 2017 & 18. Replicated yield digs were undertaken to estimate the yield in areas where there had been a cover crop grown and where the land had been left in stubble before sugar beet.

The table below shows the number of sugar beet crops where the yield was increased.

	% of beet crops showing positive yield benefits
All fields with one cover crop	42%
Fields with more than one cover crop in the rotation	50%
Fields with reduced tillage regimes and cover crop(s)	58%

This reinforces the message that there may not always be a yield increase in your sugar beet crop following a cover crop. However, the chances of seeing a positive yield effect appear to be better over the longer term where more cover crops have been grown in the rotation and/or where cover crops are used in conjunction with reduced tillage approaches. There is broader evidence from other studies that also support these interactions: increasing organic matter inputs such as cover crops and reduced tillage can act together to promote improved soil structure, increased biomass, biological activity, and diversity of soil organisms.

Overwinter cover crop guidelines

- Be clear about what you want them to do before selecting your cover crop species. For example, improving soil structure, increasing organic matter or nutrient retention.
- Always, assess soil structure and health as a starting point. You can find information on the BBRO website on how to do this. This may help signpost what you want the cover crop to achieve. Remember that this may vary between fields.
- There is little evidence on the value of more expensive formulated multi-species mixes compared to simpler and cheaper mixes of 1-3 species, some of which can be sourced and prepared on-farm.
- Production of early cover crop biomass is key so target drilling into moisture as early as possible. Wait until rain to establish cover crops.
- Legumes fix nitrogen and BBRO trials have shown in cover crops with well-established legume species this can amount to 40 kg N/ha. Trials have shown that a high proportion of this nitrogen will be available with 4-6 weeks to the following crop.
- Don't skimp on seed rates. Link seed rates to soil conditions. Increase the seed rate in dry conditions and for later drilled crops. This may need to be as high as 30-40kg/ha for vetches and clovers which can be difficult to establish.
- Remember, target a 5-6-week gap between destruction and drilling sugar beet to reduce green bridging by pests and disease.

Beet Cyst Nematode and cover crops

Be aware of the risk of harbouring BCN on your cover crops as it is hosted by a wide range of Brassica species and can rapidly multiply on some cover crops, especially when planted early into warm soils, harming your future beet crop.

Recent BBRO research recommends the use of resistant brassica trap crops on infested fields, which will prevent significant population build-up, but reliable population reductions were not found from all varieties tested over two years of trials. Make sure you know the variety is resistant.

If you're concerned about BCN on your cover crops, pull up the roots and check for the characteristic white cysts. If found, destroy the cover crop immediately to prevent BCN numbers increasing, aiming for a 5–6-week gap between destroying the cover crop and drilling sugar beet and grow a BCN tolerant variety of sugar beet.

Drilling

Key Points:

- Soil temperature and moisture levels are key to determining when to drill
- Drilling should commence as soon as soil conditions allow for effective cultivations, without detrimental effect to soil structure
- Your cultivation strategy should allow for the completion of drilling by the end of March (should conditions allow)
- Drilling after mid-April could lead to yield losses of over 4 adjusted t/ha per week on average. However, crops drilled slightly later into good seedbeds, as opposed to earlier into poor seedbeds, often emerge and establish quicker. Don't drill by date alone

Establishing a uniform population of 100,000 established plants per hectare is arguably the single most important factor that drives high yields in sugar beet crops.

Hitting this 'target' requires a combination of a good seed bed and accurate drilling of seed into the seedbed.

Seed spacing

Ideal spacing is 15 to 18cm for 50cm row and 17 to 20cm for 45cm rows. Aim for a minimum of 1.25 units/ha*; use a higher seed rate in poor seed bed conditions (see charts on page 43)

Seed spacing should be checked regularly whilst drilling, adjusting if necessary. Poor seed spacing will be obvious at early stage of establishment, so remember to go back and check you got it right

Plan to drill different varieties as distinct blocks rather than mixing varieties across drill units. This will allow you to monitor and manage different varieties appropriately. This may be important for the application of herbicides and fungicides as well as harvesting

Drilling depth

Before drilling starts, set all units to the same depth. Seed should be placed into moist soil, ideally drilled between 2cm and 3cm depth. Check drilling depth regularly as it will vary within fields as well as between each field

Drilling depth should be increased in dry conditions to ensure seed is placed into moist soil

Ensure that all seed is well covered to help avoid mouse damage

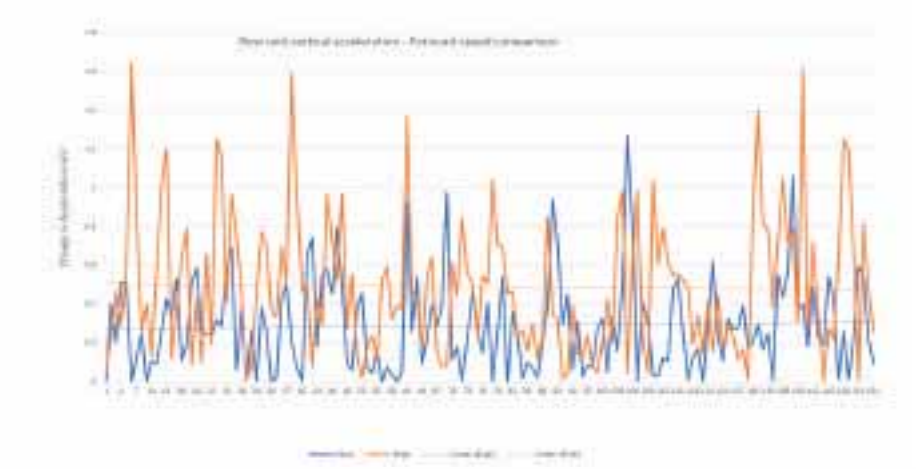
*** Subject to any restrictions placed on neonicotinoid treated seed.**

Further Reference

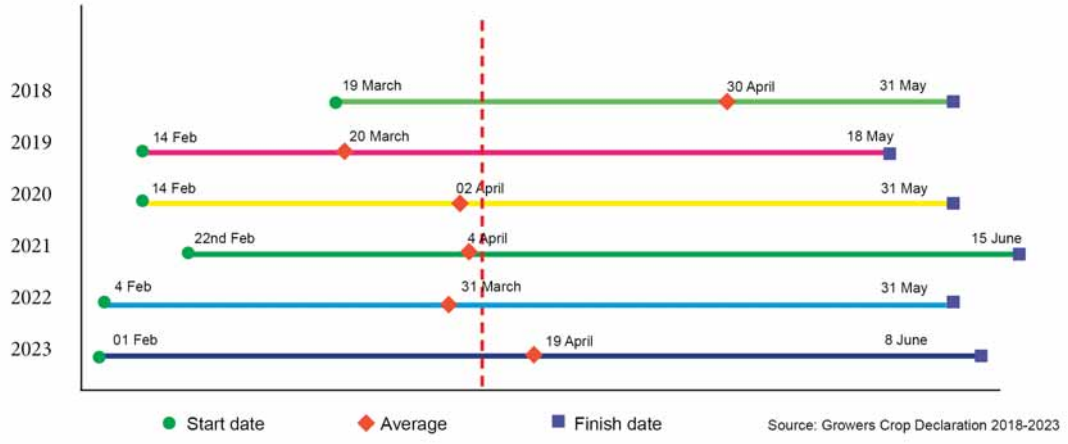
BBRO Drilling and Establishment Guide available via the BBRO website

Drilling speed

Optimum drilling speed is between 5 and 8kph (3 to 5mph). The following graph highlights the impact of forward speed on row unit performance. To ensure optimum placement it is vital to travel at a suitable forward speed relative to seed bed conditions and cell wheel or seed disc fitted.



Current Crop Situation: Record of drilling dates, 2018-23



Land should be prepared in advance of drilling, ensuring a level seedbed and good soil structure. A poor uneven seedbed can lead to yield loss through reduced establishment and increased harvester losses.

Pay particular attention to soil temperature. Seed germination will start where soil temperatures are above 3°C but will be slow below 5°C. Germination can be adversely affected if heavy rainfall occurs within 48 hours of drilling.

Plant Population

Key Points:

- It is critical that plant populations do not fall below the target **100,000** established plants/ha in any part of the field if recovered yields are to be maximised
- Planting too few seeds will leave your crop at risk of fewer than expected established plants caused by severe weather or pest attack
- Plant establishment is frequently lower on headlands and parts of fields where seedbeds are poor. Higher seed rates should be considered in these areas
- Drilling at **1.25 units/ha*** will achieve the target plant population of 100,000 plants/ha where plant establishment is expected to be **80%**

Optimum plant populations

BBRO trials have confirmed that a target plant population for UK growing conditions to produce maximum yields is to establish **100,000 plants on every hectare sown**. Drilling at **1.25 units/ha*** will achieve this where plant establishment is expected to be **80%**. Every effort should be taken to maximise establishment, and consideration of the impact of weeds, pests and diseases as well as soil condition and cultivation should be made.

The target of **100,000 established plants/ha** should be evenly distributed.

- With low-yielding sites there is a tendency for a more rapid fall-off in yields at lower populations than for higher yielding sites
- For most crops, benefits of optimal populations come from improved leaf cover and radiation interception
- There has been some indication from survey data that yields continue to increase at populations higher than the current target on fertile silt and peat soils
- Identification of the cause of poor areas of establishment can help prevent problems occurring in the future
- The average plant population can mask variability within the field
- Fertile silt and peat soils produce larger, lusher leaf canopies and the benefits of greater plant numbers are more likely to be due to changes in the proportions of dry matter partitioned to tops and roots and root dry matter to sugar

*** Subject to any restrictions placed on neonicotinoid treated seed.**

Factors affecting field populations

Plant population is a function of:

- Number of seeds sown
- % germination
- Losses during emergence and post-emergence up to the six-leaf stage when a plant is said to be established (i.e. likely to survive and produce a harvestable root)

In practice it is necessary to predict % establishment from a knowledge of existing and expected factors which affect germination and seedling growth:

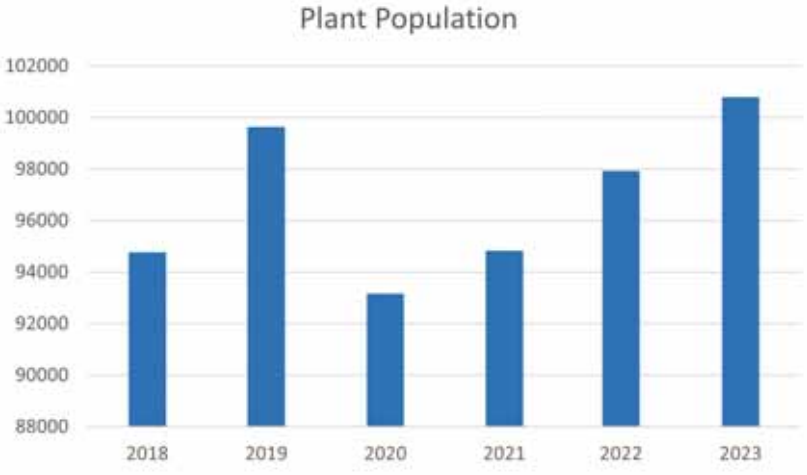
- Typically seed sold in the UK has around 95% laboratory germination
- Germination in the field depends on the quality, future temperature and soil moisture content of the seedbed
- Uncovered or shallowly drilled seed is at risk from predation by mice
- Soil capping or crusting might impede emergence. The better the seedbed structure the more easily it can cope with heavy rainfall
- Seedlings can be prone to pest and disease attack pre and post-emergence
- Birds and small mammals graze seedlings and sometimes remove the growing point
- Seedlings may be at risk from extreme weather events eg frost

Typically, commercial in-field establishment is 80%

Good, even populations mean:

- More effective weed control – due to improved crop competition
- Better sugar %
- Lower impurities
- Efficient harvesting with less loss of large or small roots, lower breakages and optimised topping due to more uniform crown height

Current crop situation:



Plant Population

Field observations and seed rate decisions

The crop is referred to as established once it has reached the six-leaf stage.

Determine your final established plant populations by carrying out 10 or more plant counts at the six true leaf stage on several different areas of a field to obtain an average figure.

50cm row spacing (20 inch)

Measure or pace out a 20m row of sugar beet and count the number of plants in that 20m row, then carry out the following calculation:

Number of plants in a 20m row x 1000 = plant population (000's of plants/ha)

Repeat this 10 times per field in different areas to give you a representative average.

45cm row spacing (18 inch)

Measure or pace out a 22m row of sugar beet and count the number of plants in that 22m row, then carry out the following calculation:

Number of plants in a 22m row x 1000 = plant population (000's of plants/ha)

Repeat this 10 times per field in different areas to give you a representative average.

Plants/20m	50	60	70	80	90	100
Average plant population (Plants/ha x 1,000)						
50cm row	50	60	70	80	90	100
45cm row	56	67	78	89	100	111
Below optimum	Optimum			Above optimum		

Investigate the reason for poor establishment if the figure falls below 70%. Use this knowledge to help to make a better estimate of the seed rates required in future years.

Seed rates for optimum population

Row width: Most sugar beet is drilled using 50 or 45cm rows. Consider row width to fit in with equipment used in the field.

Seed spacing: Ideal spacing is 16cm but use your predicted establishment together with the tables (**below**) to choose the required seed spacing for your establishment conditions.

Establishment – 000's plant/ha based on 50cm row widths							
Seed spacing cm	14	15	16	17	18	19	20
Seed units/ha (one unit = 100,000 seeds)	1.43	1.33	**1.25**	1.18	1.11	1.05	1.00
90%	129	120	113	106	100	95	90
80%	114	107	100	94	89	84	80
70%	100	93	88	82	78	74	70
60%	86	80	75	71	67	63	60
50%	71	67	63	59	56	53	50
40%	57	53	50	47	44	42	40

Establishment – 000's plant/ha based on 45cm row widths								
Seed spacing cm	14	15	16	17	18	19	20	21
Seed units/ha (one unit = 100,000 seeds)	1.59	1.48	1.39	**1.31**	1.23	1.17	1.11	1.06
90%	143	133	125	118	110	105	100	95
80%	127	118	111	105	98	94	89	85
70%	111	104	97	92	86	82	78	74
60%	95	88	83	79	74	70	67	64
50%	79	74	69	65	61	58	55	53
40%	64	59	56	52	49	47	44	42

Plant populations above optimal requirements that can still produce maximum yields but not maximum profit.

Optimum plant populations (within 5% of 100,000 plants/ha).

Plant populations below optimal requirements that may not produce maximum yields.

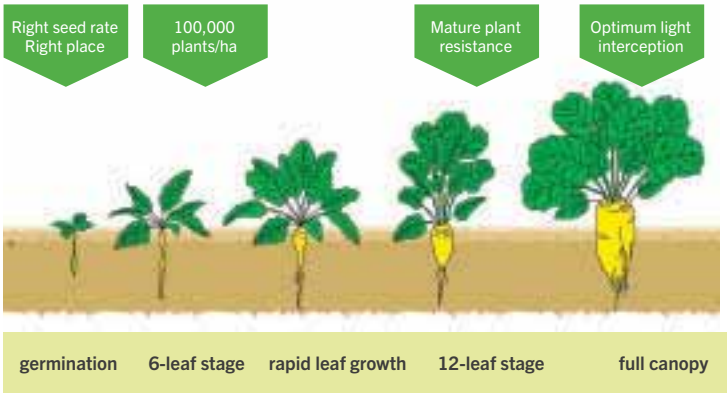
Establishment

Rapid canopy development

Key Points:

- Once the crop has established, rapid canopy growth is vital for reaching key growth stages as quickly as possible
- At the 12-leaf stage plants become more resistant to virus
- At the full canopy stage light interception is optimised

Targeting key sugar beet growth stages

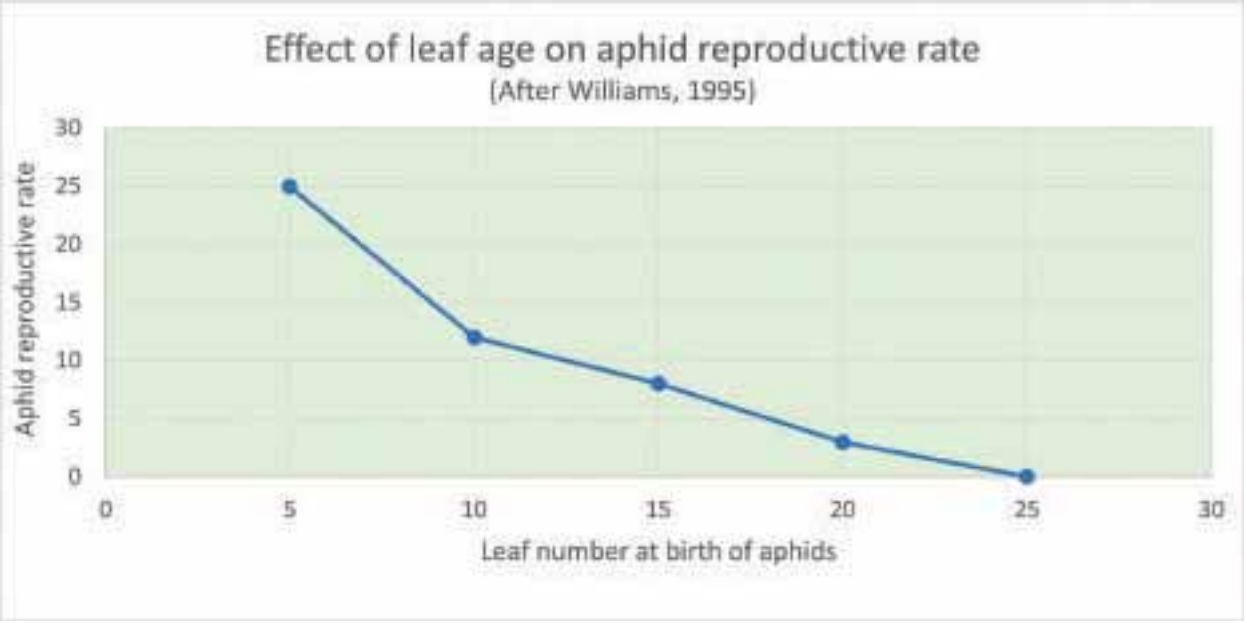


Optimum light interception by the crop canopy

The target date for this is the summer solstice, third week of June, when the sun is at its highest and solar radiation is at a maximum. The target is to have a Leaf Area Index of 3 which equates to >90% ground cover by this date.

Mature plant resistance

Changes associated with the development and maturity of leaves, result in fewer aphids being able to feed and reproduce successfully. These changes occur around the 12-leaf stage of development. On crops drilled in the middle of March this will usually be around the middle of June. The secondary spread of virus, and therefore the impact on yield has been shown to be much reduced on crops that have reached this crop growth stage.



Rapid canopy development - Check list

To ensure crops develop canopies as quickly as possible, pay attention to the detail on ALL of the following points:

- [ ] Good seedbed conditions for rapid even seedling establishment and development
- [ ] Good underlying soil structure below the seedbed. Sustained plant growth requires both adequate drainage in wet conditions and good moisture retention in dry conditions
- [ ] Avoid soil compaction
- [ ] Ensure sufficient nitrogen is applied early enough to drive leaf growth and canopy expansion
- [ ] Avoid herbicide damage as this will, depending on the severity, significantly delay canopy growth
- [ ] Ensure any micronutrient deficiencies such as manganese are identified and treated with foliar applications at an early stage*

*For further info see pages 54-55

Crop Nutrition

Key Points:

- Apply N fertiliser using the recommendations table (**below**) but making allowances for N applied in organic manures
- It is important to ensure sufficient N is applied early enough to drive canopy development
- P, K, Mg and Na should be applied using soil analysis results (**see below**)
- Application of P, K, Mg and Na fertilisers should be made in good soil conditions to minimise damage to soil structure

(For more details on crop nutrition please refer to RB209, section 4.)

Major Nutrient Recommendations (Kg/Ha)

	Soil Index	0	1	2	3	4	5
Nitrogen	Mineral soils	120	120	100	80	0	0
	Organic soils					40	0
	Peaty soils						0
P, K, Mg & Na	Phosphate (P_2O_5)	110	80	50	0		
	Potash (K_2O)	160	130	100	0		
	Magnesium (MgO)	150	75	0	0		
	Sodium (Na_2O) (using K Index)*	200	200	100	0		

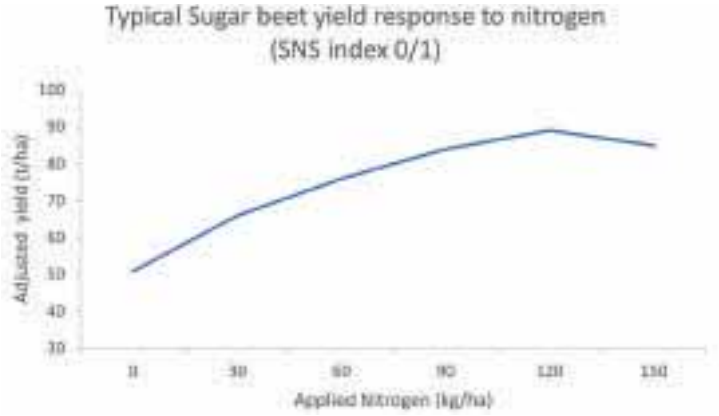
Sugar beet crops require adequate and timely supplies of nutrients to achieve maximum yields, especially during the early months of their growth.

Nitrogen

Nitrogen (N) is a major component of the proteins and enzymes that drive plant growth. It is essential for the rapid development of the leaf canopy and the capture of solar radiation during the early stages of sugar beet growth.

As an example, a typical sandy loam soil with less than 2% organic mater, receiving no organic manure will have 60kg N/ha available after a cereal crop and a further 60kg N/ha may be mineralised during the season. Along with 120kg N/ha of applied N fertiliser this would provide a total of 240kg N/ha, sufficient to support maximum yield. Sufficient N is therefore required during the early stages of growth to enable shoots to acquire the 90-120 kg N/ha required to produce the three units of leaf area index needed to fully cover the soil and maximise radiation interception. Excessive or late uptake of N do not increase yield, only beet impurities.

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



Nitrogen placement

Placement of some of the nitrogen requirement (banded 5-10 cm below and to the side of the seed) has shown that crops can access and utilise N more efficiently. Typically, placement of 40-60 kg N/ha is placed at drilling, the remainder being applied at emergence. This frequently improves early canopy development and in some instances plant population. Yield responses of 10-20% have been recorded. Yield responses tend to be greater in dry springs/seedbeds.

Additionally, a reduction in overall nitrogen rates of 15% have been achieved where placing nitrogen in a band to the side and below the seed. Commercial strip trials have shown that reduced rates from 120 to 100 kg N/ha can be achieved. There is limited data on reducing rates more than this using placement techniques.

Crop Nutrition

Potassium

Potassium (K) is the main cellular solute that allows plant tissues to regulate their water content and osmotic balance. This maintains the cellular rigidity (turgor) needed to drive the growth and control the photosynthetic activity of the leaf canopy. It also acts as an activator of the enzymes involved in the production and transport of sugars. Under some circumstances sodium (Na) may replace K as an osmotic solute.

Well grown sugar beet crops contain 350-500kg K/ha, two-thirds of which is used by the shoot and one third present in the storage root at harvest. This is equivalent to soil index 2-. Yields will be reduced on lower K index soils if insufficient potash is applied.

Sugar beet crops require a concentration of 120 to 180mg of exchangeable K/g soil to achieve maximum sugar yield. This is equivalent to a Soil Index of 2-, and almost half of the potential sugar yield is lost on soils that are at K Index 1, and three quarters on those at K Index 0.

Sugar beet is often the crop in the rotation used to adjust P and K status of the soil for the rotation as a whole, however, applying fresh K prior to sugar beet rarely increases it yields even on low K-Index soils.

Recommendations

These are based on the following considerations:

- On K-index 0 and 1 soils, sufficient fertiliser K is applied to replace the K removed in the harvested beet with extra being given to raise Index to 2-. This may not always be possible on very sandy soils whose clay content is insufficient to retain the added K
- On K-Index 2 soils only the K removed in the harvested beet is replaced
- No fertiliser K needs to be applied to soils of K-Index 3 and above

These recommendations require the current K status of the soil to be known from soil sampling and analysis. The amounts of K removed in the harvested beet can be estimated from the tarehouse data of loads delivered to the factory (contact British Sugar to access this information). Alternatively, approximate offtakes can be calculated by using the Potash Development Association's conversion factor of 1.8kg K_2O/t beet, but this ratio is extremely variable.

Sodium

Sugar beet is one of the few crops that tolerate **Sodium (Na)** and can use it as an alternative osmotic solute to potassium. Large amounts of agricultural salt have, therefore, been applied to UK sugar beet as a cheap alternative or addition to a K fertiliser for many years.

The two nutrients are not, however, completely interchangeable. Recent research has shown that sugar beet grown on soils that are low in both exchangeable K and Na respond to applied sodium. Furthermore, it has now been shown that very little of the applied Na fertiliser is taken up when crops are adequately supplied with K.

It is, therefore, probable that agricultural salt is currently being applied in many situations where it is unlikely to benefit the crop. Recent surveys, show that much of the UK's sugar beet is grown on soils with K Indices of 2 and above but these also receive an average of 160-170kg Na/ha which will be of little benefit.

Na can partly replace Potash in the nutrition of sugar beet when soils contain too little crop available Potash. An application of 200kg Na_2O/ha is recommended for beet grown on soils at K Index 0 and 1. On K Index 2 soils it is only necessary to apply 100kg Na_2O/ha when the soil contains less than 25mg Na/kg. Fen peats, silts and clays usually contain sufficient sodium and no sodium fertiliser is recommended. Sodium, at the recommended rate, has no adverse effect on soil structure even on soils of low structural stability.

Crop Nutrition

Phosphorus (Phosphate)

Phosphorus (P) is essential in plants for:

- Plant cell membranes
- Genetic material (DNA)
- Compounds involved in the capture and transfer of energy during photosynthesis
- Enzymes involved in protein synthesis
- Involved in the formation and transport of sugars

Well grown sugar beet crops contain about 80kg P/ha, distributed almost equally between the shoot and the storage root. Trials with long established differences in soil P show that the concentration required for maximum sugar yield is 15-20mg of P/g soil (i.e. Soil P Index 2).

Surveys suggest that over 90% of the national sugar beet area is currently at, or above, P Index 2. Most of these soils continue to receive and average of around 60kg P/ha which is sufficient to maintain them at this level.

Magnesium

Magnesium (Mg) is the central metallic ion of chlorophyll and an essential co-factor for energy transfer, and so essential for photosynthesis and respiration.

Well grown sugar beet crops contain around 23kg Mg/ha, almost three quarters of which is in the shoot. Trials show that crops require a minimum of 50mg of exchangeable Mg/kg soil (Mg Index 2) to produce maximum yield.

Surveys suggest that three quarters of the current national sugar beet area is currently at, or above, Mg index 2.

Sulphur

Sulphur (S) is a structural component of enzyme proteins, the sulpholipids of cell membranes, and plant polysaccharides.

The uptake of S by well grown crops is around 50 to 70kg S/ha and those of a high yielding crop closer to 100kg S/ha. Crops may suffer from sulphur deficiency especially higher yielding crops grown on sensitive soils (sands, sandy loams and shallow soils) and where there is no routine use of organic manures in the rotation. Where deficiency is possible, previous trials of 10kg S/ha (25kg SO_3) was as effective as higher rates. Higher rates of sulphur (40-50kg SO_3) are likely to be needed where the yield is expected be greater than 80-90t/ha.

Recommendations

Sulphate containing fertilisers are likely to be needed in sugar beet crops grown on sands, sandy loams and shallow soils, where there is no routine use of organic manures. Consider applying 25-50kg SO_3/ha, depending on the likelihood of deficiency. This can be estimated by the appearance/history of deficiency symptoms appearing in more sensitive crops such as oilseed rape and barley.

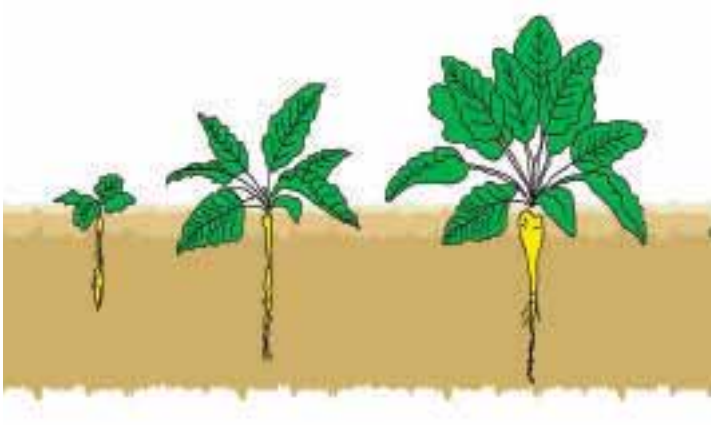
Photo: Sulphur deficiency in sugar beet is characterised by small stunted pale green plants, often with small and slightly cupped leaf margins.

Crop Nutrition

Guidelines for foliar nutrient application

BBRO trials have shown that sugar beet grown in fertile and healthy soils, especially where organic manure/ammendments and cover crops have been applied or grown regularly, with the exception of manganese and magnesium and soils with specifc deficiencies, that other foliar nutrients are not usually required routinely. However, especially in the early stages of canopy growth from the 4-leaf stage (BBCH 14) up to the 12- leaf stage (approximatley 40-50% crop cover BBCH34-35) nutrient deficiencies can occur under certain circumstances. These include:

- Recovery from drought, herbicide or frost damage
- Periods of rapid growth, particularly after a dry or cold period
- Dry and/or cobbly seedbeds where early rooting and water and nutrients uptake has been poor
- Where there are soil structural (compaction, slumping, water logging) issues
- Where roots may be damaged due to soil pest (BCN issues)



Early growth stages of canopy development (BBCH 12-18) are the key target for foliar applications and their use can be broadly split into three strategies:

1) Most sugar beet crops

Manganese

- Minimum of 1-2 applications during early canopy growth starting from BBCH 14 repeating at 7-14 days
- Target 1 kg Mn/ha in normal growing conditions
- Target 2 kg Mn/ha where there is a higher likelihood of deficiency: rapidly growing crops (all soil types) organic and sandy soils, high pH, after liming, fluffy seedbeds. During cold, wet conditions
- Remember symptoms can be transient depending on the growing conditions but don't wait for severe symtoms to show

Magnesium

- Where magesium has been soil applied, routine use of foliar magnesium may not be required however, where there is a history of magnesium deficiencies, foliar application will help early canopy growth. Target light sandy, more acid soils or where crops are sitting in cold wet soils
- Target 1-2 kg/Mg/ha, repeating at 7-10 days

2) Crops on light and thin soils, especially in dry conditions

Manganese and **Magnesium** apply as above (using higher rates)

Boron

- Consider applying boron, as deficiency can reduce new shoot growth
  Target 1-2 kg boron/ha, especially early growth stages BBCH 14-18

Sulphur

- Target crops in dry conditions on light sandy soils with no history of organic manure application. Sulphur deficiency can result in slow and pale canopy development.
- Target 2-3 kg S/ha from BBCH 14 onwards, repeating at 7-14 days

Recent trial work has indicated that the application of Calcium (0.5kg Ca/ha) at BBCH 14-18 improved susceptibility to drought. BBRO work is on-going on calcium

3) Where canopy development has been compromised by poor seedbed conditions, herbicides, frost damage or by soil pests such as nematode or early disease infection, consider foliar application of:

Manganese

Magnesium

Sulphur

Boron

Phosphorous

- Higher risk soils include low organic matter, acid & very calcareous soils. Low P soils and cold and wet soils Phosphate is essential for early rooting and leaf growth. Target an application of 2kg P/ha

Nitrogen

- In cases where root uptake has been badly affected, foliar nitrogen can help with supply of nitrogen for new leaf growth. Target a 'little and often' approach, applying 3-6kg N/ha at each application. Be careful with urea-based products and applying to crops under hot and full sunlight conditions, to reduce the risk of scorch

Crop Nutrition

Additional Notes

Zinc deficiency is not routinely seen in sugar beet crops but more likely to occur in organic soils, where large amounts of phosphate have been applied, high pH soils and in cold, wet growing conditions.

Copper deficiency is also not routinely seen in sugar beet crops but more likely to occur in organic and chalky soils and is sometimes associated with high amounts of nitrogen in the soil.

Sulphur deficiency may also occur in poorly aerated and waterlogged soils. Plants low in sulphur cannot make full use of nitrogen, so sulphur deficiency symptoms are often very similar to those of nitrogen such as low chlorophyll production and pale plants. However, the distinguishing feature is that due to poor plant mobility, sulphur deficiency symptoms appear first in the youngest leaves as opposed to nitrogen which tend to show in older leaves first.

Foliar biostimulants - BBRO trials have tested a range of different products over a number of types and seasons. Whilst occasional responses were measured, the work concluded that in healthy growing crops there is no consistent yield response to their use. Occasional improvements in foliage vigour and canopy 'greeness' were observed but these were generally poorly related to increased root yield and sugar content. Some products contain major nutrients such as nitrogen and micronutrients as well as the biostimulant element. The use of foliar biostimulants to aid the recovery from a specific weather, soil or pest issue has not been investigated fully. There is however grower testimony that this can be of value.

Application of foliar nutrients - early canopies

Target application to actively growing canopies, where possible avoiding high tempeartures and full sun. Higher humidity also encourages leaf uptake. Don't apply to wilted crops or to crops which are likely to wilt. Target the recovery period when the crops starts actively growing again. Check compatibilites with herbicides and pesticides before using as a tank mix.

Application of foliar nutrients - established canopies

There is little work which has assessed the use of foliar nutrients applied to crops later than stages BBCH 35 (50% crop cover) in sugar beet. Early canopy develoment and plant establishment are considered key to yield and the greatest cost-benefit. Treatment of, or recovery from a specific problem such as severe foilar pest, hail damage or flooding may be aided but each case requires a specific solution.

Late foliar application nitrogen - later harvested crops

BBRO has investigated this aspect and concluded that there is no requirement for this. Frequently, later applications of nitrogen will encourage more top canopy growth and greener crops but not lead to an improvement in root yield or sugar content. Remember, high nitrogen levels can decrease sugar content and increase impurity levels.

Most common deficiencies

Boron

The first signs of boron deficiency are brown corky patches with transverse cracks on the upper surface of the petiole and a network of small cracks on the outer leaves. Gradually these outer leaves turn yellow, and the heart leaves turn black and die. This blackening can extend to the crown.

Magnesium

Pale yellowing of the leaf appears between the veins at the upper margin. In severely affected plants the edges blacken and eventually disintegrate. Older leaves will show the symptoms first.

Manganese

Usually seen early spring as small, pale yellowish areas on the leaves. The yellowing can affect the whole interveinal space of the leaf leaving the green veins highly visible. Young leaves are first to show symptoms.

Weed control

Supporting our crops to establish faster growing canopies is the cornerstone to increasing sugar beet yield. Removing the competition for light, nutrients and moisture not only drives rapid canopy development of young sugar beet plants, but also helps to create healthy active plants that are more tolerant to pests and diseases. Remember, your crop is in a race to the 12-leaf stage of maturity, when plants start to become more resistant against virus too.

Key points for your 2024 weed control strategy:

- Greater monitoring of weeds and weed growth stages
- First spray timing is critical
- Consider a pre-emergence herbicide where conditions allow
- Monitor the crop carefully for growth stage and stress levels to minimise herbicide damage. Be wary of large diurnal fluctuations in temperatures
- Be flexible on your approach to the choice of actives and rates of use
- Consider tailoring your herbicides to deal with specific weed issues
- Don’t delay in controlling fat hen
- Select rates of phenmedipham carefully in relation to weeds and conditions
- Consider the use of adjuvants, but be mindful of conditions of use
- Mechanical hoeing may be an option - be prepared!

Identification of weed species.

It is not always easy to correctly identify weeds, especially at the cotyledon stage. The result of mis-identification can result in unsatisfactory or indeed no weed control.

Weed species	Distinguishing features	Comments
Fat hen confused with orache	Fat hen has broader cotyledons than orache, undersides are often bright purple. Photo. 1 The undersides of orache cotyledons are generally brighter green than those of fat-hen. Photo. 2	Orache is considered more difficult to control than fat hen. Higher rates of contact chemistry e.g. phenmedipham and ethofumesate may be required plus an adjuvant.
Ivy-leaved speedwell confused with cleavers	Cleavers have large cotyledons that end in a 'cleavage' whereas ivy-leaved speedwell cotyledons end with a 'knob'. Photos. 3 and 4.	Cleavers are more responsive to herbicides once they reach 1st whorl stage. Use triflusulfuron-methyl for cleavers and quinmerac and phenmedipham for ivy-leaved speedwells.
Black-bindweed confused with field bindweed	Black-bindweed has long cotyledons with short stalks but field bindweed cotyledons are notched at the tip. The true leaves are different in shape. Photo 5	Black-bindweed can be controlled using phenmedipham, lenacil and ethofumesate. Field bindweed will not be controlled in beet crops with herbicides, at the best suppression will occur.

Weed control

Timing of first spray

There is a saying “it is not what you spray but when” and to some extent that is true, as timing spray applications to when the weeds are at the cotyledon/1st true leaf stage is an important factor in post-emergence sprays. If weeds get beyond this, it then becomes increasingly difficult, if not impossible with some weed species to obtain adequate control.

Weather conditions before and after spraying

When plants are growing rapidly, they have less wax on the leaf surface so herbicides can enter more easily. However, with prolonged wind, cold and dry conditions wax layers will build up and weed control can become more difficult. Higher than average temperatures tend to result in easier weed control with lower rates of actives, but could also lead to the crop showing signs of stress if the rates selected are too high. Rates of product, choice and rates of adjuvants all need to be adjusted according to weather conditions at and after spraying.

Incorrect use of phenmedipham

Since the non-renewal of desmedipham there is more reliance on phenmedipham use. However, remember that 1g of desmedipham is not equal to 1g of phenmedipham. Trials have indicated that at least double the amount of phenmedipham will be required, but weather conditions and weed species present will all play a part. In adverse conditions, even higher rates of phenmedipham will be required.

Phenmedipham is purely a contact material and activity does not depend on absorption into the leaves, but on timing of application. If temperatures exceed 21°C and there is high light intensity, then crop selectivity is reduced. Where very light rain <1.0 mm /hour occurs then activity on speedwells for instance can be improved; this is due to phenmedipham penetrating into the leaf axils. However, avoid heavier rain as this can lead to wash off and reduced efficacy. Generally, phenmedipham is partnered with other actives or at least an adjuvant.

Too long an interval between spray applications

Be aware of the impact of delayed herbicide use, particularly if you are trying to link in with other spray programmes. Fat hen can emerge and get to 4 true leaves within 10 to 14 days, so it is imperative that fields are checked regularly, and recommendations adjusted when sprays are delayed.

Should a pre-emergence herbicide be used?

The use of a pre-emergence residual herbicide generally lengthens the time available to apply post-emergence sprays. Pre-emergence sprays will also sensitise weeds. Where black-grass is expected then a pre-emergence spray containing ethofumesate should always be considered. There are some weeds such as mayweeds, knotgrass and fat hen where a pre-emergence spray containing metamitron is useful, as it helps to build up the residual levels within the overall spray programme. If there is any doubt in the ability to apply a timely first post-emergence spray, then consider using a pre-emergence spray straight after drilling when the soil is moist.

What actives are available for ABLW control in 2024?

The basic "building block actives" of ABLW control in beet crops are now phenmedipham, ethofumesate and metamitron and one or more of these actives are generally used at each spray timing. Apart from these being available as 'straights' there are also formulated products available that consist of a combination of these and other actives. The advantage of using formulated products mean less cans but using straights can give more flexibility in tailoring rates according to the situation. Whether a product can be used pre and post-emergence may also be an important consideration to make.

Weed Control

Consider a pre-emergence application straight after drilling when the soil is moist:

- Gives flexibility in timing of post-emergence sprays
- Helps where large populations of troublesome weeds are expected (eg black grass)

Adopt a post-emergence system matched to spray capacity, management input and weed species present

Adjuvant oils:

- Can improve weed control but can also reduce selectivity of herbicide products
- Are of most benefit when weeds are large or 'waxy' (most likely to occur after periods of hot dry weather)
- Should always be used as recommended on the label (eg metamitron [Goltix 70 SC] alone, cycloxydim [Laser])
- Can increase risk of crop damage when beet under stress (eg after wind blow, frost, pest or previous herbicide damage)
- As temperatures increase, so does risk of damage – use table on the right as guide for dose of oil
- Current formulations of broad-leaved herbicides are generally well constructed and do not require an adjuvant to improve weed control (eg Betanal maxxPro) but these will often have a recommendation for addition of an adjuvant when low doses are used or weeds are likely to be particularly difficult to control

Vary dose of oil according to temperature	
Max. temp (°C) on day of spraying	Dose of adjuvant oil l/ha
Up to 14	1.0
14 to 18	0.75
18 to 21	0.50
Above 21	Not recommended

Check out the latest guidance on herbicide selection and adjuvant oils

Resistant black-grass control in sugar beet

- Sugar beet provides an excellent rotational opportunity to target black-grass control
- Aim for an integrated approach combining cultural and herbicidal methods
- After harvest allow black-grass seedlings to chit and remove them before winter ploughing
- Apply glyphosate pre-drilling to remove black-grass prior to seedbed preparation
- Also consider using pre-emergence sprays of ethofumesate and metamitron
- Post-emergence treatments containing triflusulfuron-methyl (e.g. Debut/Shiro) and ethofumesate appear to show useful increased black-grass control (limited data)
- In your overall programme aim to combine at least 2-4 different modes of action
- Target post-emergence black-grass control at small plants (1 to 3 leaf stage). Control is dramatically reduced once black-grass plants have begun to tiller

ACCase black-grass

- ACCase inhibitor graminicides may still offer some control, depending on degree of resistance, when used as part of a programme. For more information see the Weed Resistance Action Group (WRAG) website, www.ahdb.org.uk/knowledge-library/wrag
- Use a pre-emergence minimum dose of ethofumesate at 500 g a.i./ha + metamitron at 1400 g a.i./ha. Hold some ethofumesate in 'reserve' for post-emergence applications
- Use a post-emergence programme which includes ethofumesate and metamitron
- A maximum permitted total does of 1.0kg of ethofumesate over a three year period on the same field
- Check ethofumesate product labels for permitted maximum individual doses as these vary

Sugar beet herbicides with activity against 'ACCase' black-grass

HRAC Group	MOA (mode of action)	Chemical Family	Active Ingredient	Product (examples)
2 (B)	Inhibition of acetolactate synthase ALS	sulfonylureas	triflusulfuron-methyl	Debut Shiro Kaskad
5 (C_1)	Inhibition of photosynthesis at photosystem II	triazinones	metamitron	Bettix Flo Target Flo Defiant SC Goltix 70 SC Glotron 700 SC
15 (N)	Inhibition of lipid synthesis	benzofurans	ethofumesate	Efeckt Ethofol Oblix 500

Weed beet

Key points

- *Just one weed beet or bolter per square metre can reduce crop yields by 11% through shading and competition for water and nutrients*
- *Weed beet host pests and diseases such as beet cyst nematode, rhizomania and foliar diseases*
- *On average 1,500 viable weed beet seeds are produced per weed beet plant*
- *Control costs increase rapidly with weed beet numbers and a control strategy should be in place prior to drilling*
- *Seed which is ploughed in becomes dormant and can remain viable in the soil for twenty plus years*
- *Lengthening the rotation can reduce the numbers of weed beet present in the sugar beet crop*
- *Ask your British Sugar Contract Manager for details of weed beet contractors*

Physical control - key stages of weed beet control

Pre-flowering

At this stage weed beet and bolters should be pulled, have the stem broken close to the root and left on top of the crop to die.

Open flower

Post pollination

After flowering, plants will potentially have set seed and should be removed from field to prevent mature seed falling in the field.

Maturing seed

Where a severe problem is expected, consider delaying drilling to allow weed beet to be controlled in a stale seedbed with a non-selective herbicide or sow a herbicide tolerant variety (Conviso Smart).
Choose a variety with a low bolting characteristic (particularly with early drilling), as uncontrolled bolters can produce large quantities of seed and reduce yield by shading.

Control methods

Tractor hoeing

Is most effective before the weed beet have more than four leaves, as the chance of resetting is reduced.

Hand pulling

Is the most effective method of control, remove plants from the field if they have completed flowering – 'if in doubt, carry them out'.

Weed wiping

Should be completed by the time roots are of a harvestable size to avoid rotten weed beet reaching the factory or causing contamination in storage.

Cutting

Is the least effective method but the only real option where levels of weed beet and bolters are above 10,000/ha. If cutting is done using an efficient three cut programme, high levels of control can be achieved. Two cuts will be less effective. When harvesting, aim to minimise losses, as crowns and whole roots left in the ground can flower and set seed in following crops.

Delay cultivations after harvest as around 60% of seed can be eaten by birds and mice.

Herbicide tolerant technology – CONVISO® Smart

The CONVISO® Smart herbicide tolerant technology system is proving to provide effective control of weed beet but the timing of the herbicide is key and sometimes a delayed application of CONVISO Smart herbicide following an initial conventional 'holding' spray is the most effective approach. The system involves herbicide tolerant varieties used in conjunction with CONVISO ONE, a dedicated herbicide based on ALS inhibitors and a formulation of foramsulfuron and thiencarbazone-methyl. The system aims to reduce the number of herbicide applications necessary to control weeds with minimal associated effects on sugar beet plants. Understanding your target weed species and getting the timing correct is key to the successful use of the technology.

Dose rate is a single application of 1L/Ha applied in 150-300 L/Ha water.
Timing of application is linked to key indicator weed species such as fat hen at the 2-4 true leaf.

Stewardship

- *The CONVISO® Smart system requires a 10-metre aquatic buffer zone*
- *At planting, thorough cleaning out of the drill is essential when switching between varieties, as is marking and recording each variety location*
- *Plan for bolter removal from every field, this may involve going through the crop multiple times*
- *For spraying, thorough cleaning of the tank using a proprietary spray cleaner when switching between Conviso One and conventional sprays is essential*
- *Post-harvest, ploughing is recommended following a Conviso® Smart sugar beet crop, monitor groundkeepers that are showing signs of new growth, and use a non-ALS-based herbicide to treat*
- *For following crops, please refer to label or Bayer/KWS and your agronomist for guidance*

Irrigation

A review of the economics of sugar beet irrigation in England was carried out by Cranfield University in 2017-18, it aimed to:

- Quantify the response of sugar beet to irrigation and the economics of irrigating sugar beet through an extensive literature review
- Assess sugar beet irrigation needs and yield response to irrigation on different soil types using the sugar beet growth model 'BeetGro' and historic weather data
- Estimate the financial net benefits of irrigation

The 'BeetGro' sugar model (Qi et al., 2005) was run for five locations in England (Bury St Edmunds, Cantley, Wissington, Newark and Knaresborough) and four soil types (Sand, Loamy Sand, Sandy Loam and Clay Loam) from 1900 – 2014, to simulate sugar yield with and without irrigation under a range of alternative irrigation schedules. The long-term average modelled sugar yield increase from irrigation ranged from 0.3 t/ha at Knaresborough on a clay loam soil to 2.7 t/ha at Cantley on a sand soil. (All yield responses are in tonnes of sugar/ha and not adjusted tonnes/ha.)

1 Sugar yields show a modest increase under irrigation in most years and on most soil types in the beet growing areas of England, but the largest increases occur in dry summers and on the lightest soils.

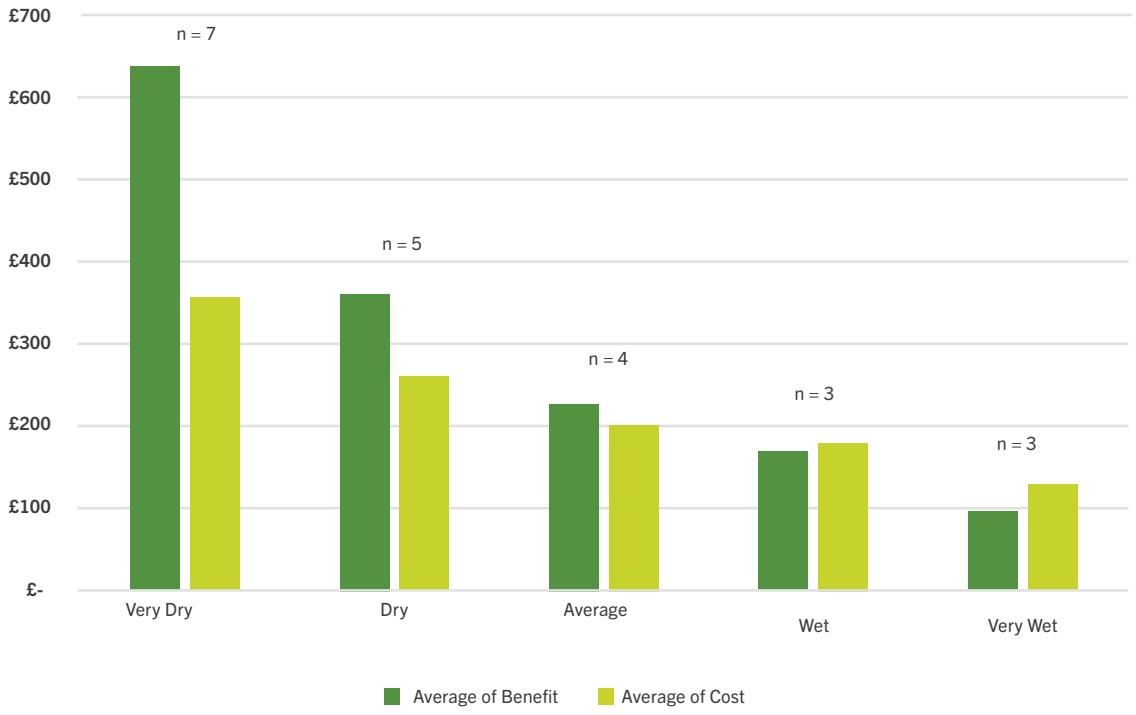
2. The increase in yield required to cover the cost of irrigation will differ between years and farms. In the Cranfield report for 2017-18 the cost of applying one 25mm irrigation with a hose-reel irrigator and rain-gun was typically £53/ha comprising labour, tractor use, water cost and diesel for pumping. At the 2017-18 sugar price it was estimated that a 0.3t/ha increase in sugar yield would be needed to cover this cost of irrigation.

3. The net benefit of irrigating depends on the weather. In a "wet" year, one or two irrigation applications could be made, but the increase in sugar yield would not be sufficient to cover the cost of irrigating, whereas in a "very dry" summer (expected, on average once in five years) an irrigated crop would generate an additional £250 - £300/ha compared to a rain fed crop after the cost of irrigating has been deducted.

4. Irrigating in June and July shows the greatest benefit and generates a net benefit in all but the wettest years. However, this is the time of year when other crops on the farm are also demanding irrigation water and decisions about which crop to prioritise will depend on which shows a greater financial response.

5. Irrigating sugar beet in August or September, in general, does not result in sufficient sugar yield increase to offset the cost of irrigating.

6. At 2022 sugar prices and weather, the benefit from irrigating sugar beet in England is not sufficient to justify the cost of investment in irrigation infrastructure (boreholes, pumps, pipes, hose-reels, etc.) for sugar alone, but irrigating sugar beet in a dry June or July can be beneficial if water, equipment and labour are available.



Estimated benefit and cost of irrigation, £/ha, at Bury St Edmunds on loamy sand soil (1900 – 2014) in years of different summer rainfall. n is the average number of irrigations.

Aphid and Virus Yellows control

BBRO's Virus Yellows Tactics23

1

WITHOUT FAIL YOU MUST:

Remove or destroy any beet growth on clamps or in spoil heaps. Remove any energy/fodder beet in the vicinity of sown crops and destroy any cover crops well ahead of drilling.

2

ADDITIONAL THINGS YOU CAN DO TO PROTECT YOUR CROP:

Encourage beneficials to your farm. Consider using under-sown barley (see page 70) especially where an early aphid migration is expected.

3

DO THE BASICS BRILLIANTLY:

Good seed bed preparation and appropriate seed rates to give optimal plant population of 100,000 plants/ha. Drill as soon as conditions are right, focusing on drill accuracy. Ensure adequate nutrition for rapid growth, carefully targeting weed control whilst avoiding herbicide damage.

4

CHECK YOUR CROP FOR APHIDS AT AN EARLY STAGE:

Keep up to date with latest info on aphids from BBRO. The cold winter, will reduce both the number of aphids and delay their migration which will reduce the impact of Virus Yellows considerably. The derogation for the use of Cruiser SB may not be triggered, so it is vital that you check your crops regularly from emergence onwards.

5

CHECK – DOES YOUR CROP NEED A FOLIAR INSECTICIDE?

Check your crops daily to assess whether the threshold of 1 green wingless aphid per 4 plants triggers the need for a foliar insecticide. Don't delay in applying where required.

Virus Yellows is a complex of 3 viruses; Beet mild yellowing virus (BMYV) and Beet chlorosis virus (BChV) which are closely related, with the third virus being Beet yellows (BYV). These viruses are transmitted when the aphid feeds, with the peach potato aphid *(Myzus persicae)* being the main concern.

Infected crops will show yellow patches in the field. However, the symptoms of yellowing can be confused with many other symptoms such as drought and nutritional deficiencies.

Reduce all potential sources of aphids and virus

- Ensure there is no beet, especially AD beet left growing in the vicinity of your crop. Check and control any leaf growth on piles of fodder beet.
- Ensure all pre-season cover crops are destroyed at least 5 weeks ahead of drilling beet.
- A difficult harvesting campaign can result in beet being left in the ground. Check for and destroy any growth on beet ground keepers in field. Check spoil heaps and destroy any leaf growth here also. Remember these will act as sources of foliar diseases such as cercospora too.
- Monitor other potential host crops on the farm to assess the risk of potential sources of virus. Some weeds can host both the virus and the aphids. Check the BBRO website for more information on virus host crops and weeds

Good beet crop establishment

Aphids prefer and are more effective vectors of virus in young immature beet plants. Gappy crops are more attractive to aphids. Uniform crops with high plant populations (>80,000/ha) tend to lose less yield due to virus compared to crops with poor plant populations. Select your seed rate to match conditions. Aim to produce the best possible seed bed for good moisture retention and plant establishment.

Don't miss the opportunity to sow the crop early when conditions are good but ensure you choose a low bolting variety if drilling before mid-March. Avoid dry cloddy/cobbly seed beds. Use the weather forecast to decide whether it is worth waiting for conditions to improve before you establish your seed bed. Be patient, remember crops in good seed beds develop more quickly and often overtake crops that were drilled earlier into poor soil structure.

Rapid canopy development is key. Remember, from the 12-leaf stage onwards (circa 40% crop cover) the crop starts to become more resistant to virus transmission.

Ensure sufficient nitrogen and phosphorus are available to plants from early emergence. Placed N & P have been shown to improve early canopy development. Don't delay in applying foliar manganese and magnesium to young plants and if dry, consider applying boron and sulphur as well.

Select your herbicides carefully, especially in relation to weather conditions to avoid damaging the growth of the crop.

Monitor your crop

Check the BBRO website for aphid warnings in your area. We will be providing regular aphid reports from the yellow water pan network and from a team of people scouting the crops for aphids and the level of beneficial insects.

However, as beet crops emerge, it is **essential** that you monitor your own crop regularly for aphids. Don't rely solely on the more general information or on what has been reported in other areas.

Aphid distribution can be very variable, within fields, between adjacent fields and certainly in fields at different locations across the farm.

Check open and more exposed areas of fields as well as near field margins and headlands.

Check for aphids:

1. on heart leaves (especially in windy and cool conditions)
2. within the folds at leaf margins
3. on the underside of leaves

The threshold for applying an aphicide is based on the number of green wingless aphids in your crop. BBRO recommend counting aphids on 12 plants in 5 different locations across the field. If the threshold of 1 green wingless aphid per 4 plants up to the 12-leaf stage is reached, then treatment is justified.

If triggered the Cruiser SB seed treatment will be applied at the rate of 45g/100,000 seeds, this has been shown to maintain protection for up to 10 weeks from drilling, depending on the size of aphid migration. Start checking crops before this period has elapsed.

Apply a foliar insecticide, only if needed

- Count the number of green wingless aphids per plant; at least 12 plants in 5 locations across the field.
- Use the threshold trigger for spraying of **1 green wingless aphid per 4 plants** (3 green wingless aphids per 12 plants) up to the 12-leaf stage. If the crop has more than 12 leaves, use the threshold trigger for spraying of one green wingless aphid per plant.
- Spray if threshold reached in any area of the field.
- Products available for forthcoming season will be notified in the Advisory Bulletin
- Others to be confirmed subject to EA or other approval.

Know your aphids

Myzus persicae

These aphids are vectors of the yellowing viruses. You do not need to identify aphid species to determine if your crop is at threshold, just look for green wingless aphids.

Host species

Myzus persicae has a large range of host plants. These include: brassicas, potatoes, legumes, lettuce and sugar beet. Further virus hosts listed below:

Beet yellowing virus (BYV)	*Beet mild yellowing virus (BMYV)*
Common chickweed *(Stellaria media)*	Scarlet pimpernel *(Anagallis arvensis)*
Common orache *(Atriplex patula)*	Shepherd's purse *(Capsella bursa-pastoris)*
Common poppy *(Papaver rhoeas)*	Corn marigold *(Chrysanthemum segetum)*
Common purslane *(Portulaca oleracea)*	Red dead-nettle *(Laminum purpureum)*
Corn spurry *(Spergula arvensis)*	Common poppy *(Papaver rhoeas)*
Garden orache *(Atriplex hortensis)*	Groundsel *(Senecio vulgaris)*
Red dead-nettle *(Laminum purpureum)*	Corn spurry *(Spergula arvensis)*
	Common chickweed *(Stellaria media)*
	Field pansy *(Viola arvensis)*

Virus yellows

When: June onwards

Symptoms: Thick, brittle yellow leaves

Risk: Mild, dry conditions which favour the aphid vectors

Severity: Previous trials show yield losses of up to 30% with BMYV and up to 47% with BYV

Advice: Currently, one application of flonicamid (Teppeki or Afinto) and one application of acetamiprid (Insyst) is authorised for the control of virus-carrying aphids. The BBRO does not recommend the use of pyrethroid and carbamate insecticides on virus-carrying aphids as 80% of peach-potato aphids are resistant

Encourage natural aphid predators (beneficial insects)

Hedgerow and field margins have been shown to support beneficials that contribute to reducing aphid numbers. Numbers of beneficials increase when prey numbers are high, so control tends to lag behind. Increasing beneficials in the field margins will give them a 'head start'. When the aphid migration is very early, as in 2020 and beneficial numbers low, virus transmission will be exacerbated.

Consider establishing field margins or drill strips with plant species which encourage beneficial insects such as; ladybirds, ground beetles, lacewings, hover flies and parasitic wasps. Early establishment of field margins will help to build beneficial numbers earlier in the season.

Use a mix of grasses and wild flowers in field margins to provide ground cover and sources of food for beneficials. Information on plant species that encourage beneficials can be found on the BBRO website.

There is limited data on the tactic of releasing beneficials into crops to predate on aphids. The number of predators and the timing of release is critical, especially if aimed at reducing early virus transmission. It is likely to be an expensive option to establish sufficient numbers of predators. BBRO are currently evaluating this as an option for IPM.

Avoid using pyrethroid foliar insecticides during the season. Aphids are widely resistant to these and BBRO work has shown that the use of these reduce the number of beneficials, therefore increasing the aphid numbers.

The best course of action is to check your crops regularly.

The good guys

Lacewings (Chrysopa spp.)

The adults are delicate green or brown insects with large ‘lacy’ wings. Individual white eggs are found laid on the ends of inch-long stiff threads. It is the larvae (which look like little alligators) that destroy most of the pests. They are sometimes called ‘aphid lions’ for their habit of dining on aphids. A single larva has been shown to consume up to 300 aphids a week. They also feed on mites, other small insects and insect eggs. Alongside ladybirds, lacewing larvae are one of the most voracious of aphid feeders.

Photos left: lacewing larva and fully grown adult

Photos above: Ladybird larva and adult enjoying an aphid lunch

Ladybirds

Widely known as voracious aphid predators, ladybirds are beetles in the family Coccinellidae and they range in size from 1 to 10mm and are round or oval in shape.

Ladybird larvae all have a similar elongated body shape with three pairs of obvious legs, most are black or dark grey, some have yellow or orange markings and many have hairs or spikes. The ladybird life cycle begins with an egg. The female tends to lays a cluster of five to 30 eggs and usually deposits these on the underside of leaves, where there are also suitable prey for the offspring to eat when they hatch. In spring or early summer, a single female ladybird can produce more than 1,000 eggs. Scientists believe ladybirds lay both fertile and infertile eggs in the cluster. When aphids are in limited supply, the newly hatched larvae will feed on the infertile eggs.In two to 10 days, ladybird larvae emerge from their eggs. Species and environmental variables such as temperature can shorten or lengthen this timeframe. Ladybird larvae look somewhat like tiny crocodiles, with elongated. bumpy bodies which are black with brightly coloured spots or bands. In the larval stage, ladybird feed voraciously. In the two weeks it takes to become fully grown, a single larva can consume 350 to 400 aphids.

Photos left: Hoverfly larva and adult

Hoverflies

Also known as syrphid fly, hoverfly or flower fly. Adults look like small bees that hover over plants and dart quickly away. They don't sting! They lay eggs (white, oval, laid singly or in groups on leaves) which hatch into green, yellow, brown, orange, or white half-inch maggots that look like caterpillars. They raise up on their hind legs to catch and feed on aphids, mealybugs and others.

Parasitic Wasps

These are parasites of a variety of insects. They do not sting! The stingers have been adapted to allow the females to lay their eggs in the bodies of insect pests. The eggs then hatch and the young feed on the pests from the inside, killing them. After they have killed the pests, they leave hollow 'mummies'.

Braconid wasps feed on moth, beetle and aphids and other insect pupae and adults. If you see lots of white capsules on the backs of a caterpillar, these are the braconid cocoons… leave the dying caterpillar alone! Ichneumonid wasps control moth, butterfly, beetle and aphids.

Trichogramma wasps lay their eggs in the eggs of moths (hungry caterpillars-to-be), killing them and turning them black.Parasitic wasps have been used as biological control agents in protected crop production for many years. The parasitic chalcidoid wasp (*Aphidus spp.*) is widely used and has been estimated to consume over 200 aphids per week.

Ground beetles

Ground beetles are common in crops and there are a large number of species in which adults will eat aphids. The common red soldier beetle is a medium-sized, narrow beetle commonly found on open-structured flowers, such as daises, cow parsley and hogweed during the summer. Adults feed on aphids and eat pollen and nectar. The adults spend much of their short, summer lives mating and can often be seen in pairs.

The common red soldier beetle has a narrow, rectangular body and longish antennae. It is bright orangey-red with black marks near the tips of the wing cases. There are about 40 species of soldier beetle in the UK, displaying various colour combinations of black, red and orange.

Damsel bugs *Nabis spp*

These feed on aphids, leafhoppers, plant bugs, and even small caterpillars as adults and nymphs. They are usually dull brown and resemble other plant bugs that are pests. Their heads are usually longer and narrower than most plant feeding species.

DON'T BE TEMPTED BY PYRETHROIDS!

OVER 80% OF PEACH POTATO APHIDS** (MYZUS PERSICAE) **ARE RESISTANT TO PYRETHROIDS

Use of an under-sown barley cover crop

There are some limited data that shows having an under-sown barley cover crop can reduce virus symptoms when there is an early aphid migration. This is thought to be associated with reducing the ability of the aphids to identify young beet crops, thus diverting them away.

This tactic is considered to be most effective when aphids arrive early in crops with small canopies and may be less effective when aphids migrate into the crop later in the season with more established canopies.

Aim to drill barley at a seed rate of 50-60kg/ha, 5-7 days before drilling beet. If using the barley to also stabilise windblow you will clearly need to drill the barley earlier.

Ensure the beet canopy is well established, ideally beyond the 4-6 leaf stage, before destroying the barley. The decision will need to be based on how vigorous the cover crop is and the forecasted weather conditions, to assess how quickly the cover will be killed. We have measured reduction in beet yields where the cover crop has been destroyed too late, allowing it to compete with the beet crop.

Use of graminicides as opposed to more general herbicides with adjuvants will reduce the risk of herbicide damage to the beet. Remember to allow some time for the herbicide to work fully. It is crucial to get timely destruction to prevent competition with the beet.

Use of Conviso® SMART beet varieties may be an option but don't compromise herbicide timings for the control of other weeds.

Foliar disease control

Foliar disease can be challenging especially with cercospora infection increasing and the impact of climate change. Whilst we focus on cercospora, it is vital that we don't lose sight of the overall key actions that should underpin your foliar disease control programme.

Eight-point plan for autumn disease management

1. Know what disease(s) are in your crop in order to select the best fungicide options (see back pages for available fungicides).
2. Cercospora leaf spot appears to be an increasing problem in the UK and strains of this fungus are potentially resistant (due to QoI resistance) to strobilurin fungicides. If in doubt contact the BBRO for help with disease identification.
3. As seen from previous BBRO trials, do not apply fungicides too early, wait for early symptoms to show.
4. Conversely, do not apply products too late otherwise effective disease control will be difficult for the remainder of the season.
5. Always follow label recommendations for applying products at the correct growth stage.
6. Ensure the gap between the first and second, or second and third applications, is kept to within 28 days to prevent significant re-infection occurring between treatments.
7. Ensure water volume recommendations are adhered to and are not cut back.
8. Know where specific varieties are sown within fields to monitor any variety-disease interactions.

Cercospora leaf spot

Cercospora leaf spot has become more established as a prevalent foliar disease in the UK over the last few seasons. The characteristic circular spots or lesions associated with the disease are quite distinct and typically once more than 5% of foliage is covered, there is an economic loss with root weight, sugars and impurities affected. Under conditions of high temperature and rainfall, cercospora spreads very rapidly increasing both in incidence and severity of symptoms. High levels of leaf wetness are associated with rapid disease progression. Severe infection can result in significant loss of the canopy. Plants often respond by producing leaf re-growth which is associated with a loss of sugar content in the root.

A BBRO study has shown that there are isolates of the fungus that are resistant to fungicides and traditional sugar beet fungicides may not provide sufficient levels of control. Isolates collected in the Cambridge area showed resistant to strobilurins and some insensitivity to the triazoles.

When: Mid July to October

Symptoms: Circular spots 3-5mm in diameter with necrotic, tan-grey coloured centres and reddish-brown border. Spots coalesce, leading to severe defoliation

Risk: Warm wet weather, with temperatures above 25°C

Severity: Potentially an increasing problem in the UK due to the increase in annual summer temperatures. In other countries yield losses have been known to exceed 50%

Advice: Increasing resistance to strobilurin and triazole products is limiting the effectiveness of fungicide control programmes against this fungal pathogen

The fungus overwinters on infected beet, old leaf residue in the soil and on some weeds such as bindweed. During warm (20-26°C) and humid (90-100%) weather, the fungus produces conidia which are then spread, primarily by the wind. Conidia then germinate and develop lesions on the leaves. Again, warm temperatures, 25-35°C and high humidity (90-100%) and/or high leaf wetness are key.

Foliar disease control

Cercospora control strategy

- The reduction and removal of sources of infection from previously cercospora-affected crops is important. Leaf residue/trash, groundkeepers, growth on spoil heaps and weed beet can be sources. Survival has been shown to be greater following shallow tillage compared to deeper or inversion tillage. Where beet has been grown in close rotation (less than 4 years) there will a higher risk of disease carry over. AD beet, especially those crops left in the ground for longer will also carry a high risk of being infective sources.

- Monitoring the weather is vital to predict initial infection. BBRO will provide regular updates on this during 2024, using a network of in-crop weather stations and weather forecasts. Information will be posted on the BBRO website and via regular editions of the BBRO Advisory Bulletin.

- Ensuring crops are protected in high-risk periods will be key. When high risk periods are predicted, crops should be monitored closely for the first sign of symptoms. Fungicides should be applied at the first signs of cercospora symptoms and not before.

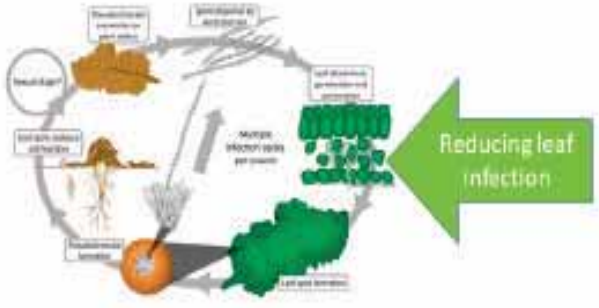
- Keep the interval between fungicide applications to within 28 days when the risk remains high. It is likely that more than two fungicides will be required. This will depend on the interval between sprays (weather-related risk) the susceptibility of the crop, and the harvest date.

- Crops affected by other diseases, drought stress and in particular virus yellows are likely to be more susceptible to cercospora.

- If the crop is wilted, remember that fungicides are more effective when applied to a turgid hydrated canopy.

There are differences between varieties in their susceptibility to cercospora. BBRO provides information on the varietal susceptibility. Check the BBRO website https://bbro.co.uk/on-farm/cercospora-risk/.

There are new fungicides targeted for the UK (introduced in 2023 and forthcoming). Trials have shown that these will provide more effective control of cercospora than traditional sugar beet fungicides.
BBRO will release the latest information on these when they become available.



- Assess risk in crop (In-field weather stations)
- Forecast risk (Weatherquest)
- High risk = warning to check crops for symptoms and when to start fungicide programmes
- BBRO Bulletin, website & text alerts to high risk areas (post codes)

CERCOSPORA
Early Warning Alert
Please consult the BBRO website for further information

Daily Infection Values (DIV)				
Hours/day >90% humidity	Temperature °C			
	16	20	24	28
5	0	1	1	3
10	0	2	3	4
15	0	4	4	7
20	0	5	6	7

2 consecutive days with DIV >7 = High red
2 consecutive days with DIV 6 = Marginal amber
2 consecutive days with DIV <6 = low green

Foliar disease control

Foliar Diseases

Downy mildew

When: Early spring, potentially recurring in autumn

Symptoms: Heart leaves thicken and become distorted. Undersides of leaves become covered with purple/grey downy spores. This spreads to upper leaf surfaces in wet conditions

Risk: Cool, wet conditions. Optimum temperature of 7-15°C, humidity >60%

Severity: Usually low, although heavy losses have been reported

Advice: Selecting appropriate varieties has been shown to be effective

Powdery mildew

When: July to early autumn

Symptoms: Grey mould on crop, starting on outer leaves

Risk: Mild winters, dry and warm conditions. Low resistance variety

Severity: Potentially one the most yield damaging foliar disease in sugar beet, in the UK. Early infections can reduce yields by up to 20%

Advice: Apply first foliar spray at the end of July/early August as soon as disease infection is seen

Ramularia

When: Mid to late autumn

Symptoms: Angular leaf spots with central silvery cells and sometimes a dark outer margin on older leaves. Spots are larger than those of cercospora

Risk: Cooler (17-20°C) and wet conditions

Severity: Usually very low

Advice: Rarely worth applying fungicides against ramularia alone, but if it is part of a multiple infection then control can be achieved by the use of triazole or triazole plus strobilurin fungicides

Rust

When: July onwards

Symptoms: Small orange/brown pustules on leaf surface, later defoliation can occur after frost

Risk: Damp conditions and temperatures between 15-22°C. Low resistance variety

Severity: Up to 10-14% yield reductions

Advice: Treat as soon as disease appears, this is usually mid-August to mid-September but can be earlier

Silvering Disease

When: May to August

Symptoms: Blue-grey matt colour with increasing silvering of the leaf surface as the leaf grows. Leaf can be seen to crack (similar to hailstone or Silver Y moth caterpillar damage). Occasional yellowing of vein leaves

Risk: Disease caused by a bacterium which appears to be associated with seed. Low number of cases seen in the UK

Severity: Single plants affected, at a low level in-field. Infected beet could yield up to 50% less

Advice: Contact the BBRO Plant Clinic if silvering disease suspected

Stemphylium

When: July to September

Symptoms: Disease starts with small, discrete, irregular yellow spots (0.5-2mm across). The spots begin to die from the centre forming brown spots 1-3mm across. Heavily infested leaves die and more yellow spots appear on new leaves. Progressive leaf loss follows in August to September with subsequent yield loss

Risk: Wet summers (high humidity) and other stress factors (eg BCN or low pH)

Severity: 22% - 42% yield loss shown in Dutch trials

Advice: Send leaf samples to the BBRO plant clinic for identification. If stemphylium is confirmed in your crop, assess the extent of the disease before deciding if appropriate to spray

Foliar Pests

Beet Moth

When: Usually summer/early autumn

Symptoms: Heart leaf petioles are superficially eaten, mined and linked together with silken threads.

Risk: Usually low levels in the UK, but this has proved to be weather dependent (as in 2022)

Severity: When the attack is severe, heart leaves blacken and die, potentially leading to a hollow crown.

Advice: Very limited products registered in the UK, but good on-farm hygiene can help to reduce overwintering of the caterpillar

Capsids

When: Seedlings - young plants

Symptoms: Cotyledons and leaves can become xxxx and yellow, especially above the puncture wounds.

Risk: Damage is rarely widespread and very few plants will be infested across a field

Severity: Usually only severe on headlands

Advice: No products registered in sugar beet

Flea Beetle

When: Seedlings – Mature plants

Symptoms: Small pits, caused by feeding, can be seen on top and underneath leaves. Holes will develop from these pits as the leaf expands

Risk: Cold, dry and sunny spring conditions which lead to slow plant growth place the sugar beet at greatest risk

Severity: Widespread pest which has greatest effect on seedlings

Advice: No established threshold, pyrethroids can be used to control

Leaf miner

When: Late spring to early autumn, in which two or three generations develop

Symptoms: White eggs laid onto beet leaves. Eggs hatch and larvae mine into the leaf, causing blisters to form on the surface. First generation most harmful and severe infestations can kill plants. Larvae pupate and adults emerge which then lay more eggs onto the host plants. Later generations feed on the older, outer leaves and can be problematic affecting autumn growth potential of crops

Risk: Surveys of leaf miner in recent years has seen the pest move across the UK from east to west and may be less of a problem than in previous years

Severity: Yield losses of up to 9% from the second and third generations

Advice: Several pyrethroids are approved for leaf miner control but caution should be observed due to impact on beneficial insects and these treatments will not control aphids due to their resistance to these products

Pygmy Beetle

When: Seedlings – 6 leaf stage

Symptoms: Small black pits on the seedlings from feeding by beetle. This can then allow for invasion by parasitic fungi. Feeding can also lead to delayed growth

Risk: Highest risk in areas of intense beet cultivation

Severity: Of greatest risk in fenland areas

Advice: Long rotations will reduce severity. Plants most at risk when immature

Silver-Y Moth caterpillar

When: Summer and autumn

Symptoms: Young caterpillars will do little damage, however, older caterpillars can skeletonise a sugar beet plant and strip it of most leaf material

Risk: Usually occur in small numbers and do not often cause widespread yield losses. However, skeltonised plants can suffer severe yield loss

Severity: In the UK, large populations are rare

Advice: A pyrethroid can be used to control if threshold of 5 caterpillars per plant reached

Thrips

When: Seedlings and immature plants

Symptoms: Thrips break cell surface on young leaves, which turn red/brown. Heart leaves are particularly affected as they are still curled

Risk: Fields near alliums or brassicas most at risk. Damage is highest in cold dry springs when the crop is developing slowly. However, most crops will grow away from the pest once the weather warms

Severity: Plants not killed, but growth significantly reduced.

Advice: No products registered in sugar beet

Tortoise Beetle

When: Seedlings - mature plants - summer

Symptoms: The young larvae eat the underside and inner tissue of the leaf leaving the top surface like a window. This then dries and cracks to leave holes and can skeletonise the leaves

Risk: Warm springs are favourable

Severity: In severe cases affected crops can be defoliated

Advice: No products registered

Harvest

Key Points:

- Planning is key; your harvesting programme should be developed in conjunction with your harvesting contractor, haulier and British Sugar Contract Manager
- Operate a ‘just in time’ harvesting and delivery approach for as long as possible
- When selecting which field to harvest first consider: soil type, field access and crop potential, to balance the benefits of early lifting whilst optimising yield performance
- Handle beet gently to prevent bruising and sugar loss
- Crop growth can increase yield by up to 40% from September to December

Operate a ‘just in time’ harvesting and delivery approach for as long as possible. This will ensure that stocks on farm are kept to a minimum, allowing maximum growth and minimising sugar losses after harvest.

Crops with the poorest yield potential should be harvested first; leave the better crops for later lifting.

Handle beet gently to prevent bruising and sugar loss. Bruised beet will respire rapidly.

Foliar diseases should be controlled to maintain a healthy leaf canopy and benefit from late-season growth as well as protecting against frost.

Harvester operators should be fully trained and familiar with equipment. Maintenance is critical and harvesters should be fully serviced and any worn parts renewed where necessary.

Carry out regular assessments during harvester operations.

Crowning Losses

Over-crowning causes the highest level of yield losses, with approximately 1t/ha lost for every 5% of beet over-crowned.

UNDER-CROWNED

Petiole > 2cm

Target < 5%

OPTIMAL CROWNING

Petiole < 2cm | Defoliated

Target < 90%

OVER-CROWNED

Crown material removed

Target < 5%

Assessing root damage levels for yield loss

Measure the diameter of root damage in at least 20 representative roots, ideally 100 roots per sample		
Root breakage diameter (cm)	**For every 10% of roots in each Sample**	**Yield loss t/ha**
2-4	10%	0.5
4-6	10%	1.0
6-8	10%	2.0
8-10	10%	3.0

Remember, as well as the physical loss of yield, root damage will also accelerate the rate of sugar loss in storage. Trials have shown that in cases of severe root damage, this maybe 3X greater than in undamaged roots, especially when temperature are warmer. Make sure damage levels are low in crops destined for longer-term storage.

Harvest

Harvester Set-up: DRY SOIL CONDITIONS

Type of loss/damage	Suggested setting changes
Whole root losses	• Set lifting mechanism deeper • Decrease forward speed • Check condition of shares - if worn, replace or repair if possible
Root tails broken off at lifting	• Reduce forward speed
Root damage - chipping, breakage and cracking in the cleaning mechanism	• Set lifting mechanism deeper • Fit turbine gate plates • Reduce turbine speed • Fit ringed turbines and/or more helper tines • Consider increasing or decreasing forward speed

Harvester Set-up: WET SOIL CONDITIONS

Type of loss/damage	Suggested setting changes
Whole root losses	• Increase or decrease forward speed • Set lifting mechanisms deeper • Replace discs with shares or close discs
Root tails broken off at lifting	• Adjust depth of lifting mechanism - raise/lower
Root damage - chipping, breakage and cracking in the cleaning mechanism	• Reduce turbine speed • Increase forward speed • Check lifting accuracy
Excessive soil adhering to harvested roots	• Increase turbine speed • Remove gate plates • Fit pigtines instead of railed gates • Raise lifting mechanism • Increase turbine gate gaps

Harvester Set-up: CROP CONDITIONS

Type of loss/damage	Suggested setting changes
Small beet	• Fit gate plates • Close turbine finger wheel gaps • Close oppel wheel or shear gap if beet are left in-field. 6kg of lost root equates to 1t/ha of lost yield
Gappy beet	• Open discs and move further from skids • Reduce scalper arm pressure • Increase topper height to allow for larger beet
High weed infestation	• Increase gap between turbine and gates • Increase angle of roller bed • Replace flails on topper • Ensure topper knives are sharp, if blunt, sharpen or replace • Side discharge tops and green material

In-field storage considerations

The main risk to in-field storage is frost. The chart below shows the level of root damage that might be expected for different levels of frost.

Temp °C	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-14	-15
Days															
1															
2															
3															
4															
5															
6															
7															

No damage Crown and minor root damage Extensive root damage

Storage

Average losses in clamp are circa 0.1% of total sugar volume per day but **BBRO storage trials** have shown that **best practice** techniques can result in just **0.039% of total sugar volume loss per day**.

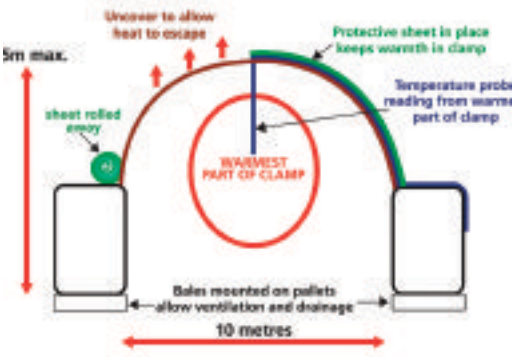
If storage is managed poorly, the result can be very serious and lead to load rejections and beet becoming unsaleable with a total loss of value.

On-farm hygiene is crucial. Make sure clamp areas are clean before storage commences. Check spoil heaps and any beet piles left on farm for leaf growth and destroy (or deliver).

All clamps

- When planning a Maus clamp, calculate the estimated tonnage and length of clamp, to avoid overspill into unsuitable areas
- Clamps should be built in an open area to aid ventilation and cooling
- Choose a firm, well-drained site which will be suitable for loading and unloading
- Never push beet up the face of the clamp. This will break beet, compact the clamp and in turn restrict air movement, allow heat to build-up and increase the rate of sugar loss
- Sugar beet stores best where it has only minimal damage from harvesting

Cross section of a traditional clamp



Early season clamp

Early in the season beet should be in a clamp for no more than a few days, and certainly less than two weeks. These clamps should not be covered or have retaining walls.

Short-term clamps are designed to give maximum surface area and therefore cooling to reduce sugar loss through respiration.

Clamps should be made up of individual loads and be no more than 2m high.

Pushing up clamps with buckets/blades should be avoided as this will increase damage and respiration.

Trailers should stop at the edge of the Beet clamp as a level surface is not required, this will reduce further beet damage.

Late season clamp

Late season long-term clamps should be no more than 2.5m high with a level surface so there are no frost pockets.

Clamps should be built using straw retaining walls. Bales should be placed on pallets with the open end facing outward to aid ventilation.

Only use clamp sheets if the ground temperature is forecast to be below -3°C.

Clamp sheets are made of polyfelt which not only offer protection but also allow the beet to breathe.

A-shaped clamp - for self-propelled cleaner-loaders

Where a self-propelled cleaner-loader is used, clamps should be built in an 'A' shape of the correct width to allow the machine to operate effectively. Planning for a Maus clamp should be done pre-drilling to ensure sufficient headland is drilled for the harvester to access.

Clamps are normally built on the headland but consideration needs to be given for machinery to access the clamp easily.

A-shaped clamps are best built with a harvester rather than a trailer to avoid rutting in the clamp base.

Crop Protection options - 2024

BBRO have collated the following pesticide control options to help you make informed decisions around protecting your crop from pests, weeds and diseases.

All the enclosed information is based on manufacturers' current recommendations and sponsored work carried out by the British Beet Research Organisation. The range and status of products is constantly changing, it is therefore not possible to ensure every product is represented.

ONLY USE APPROVED PRODUCTS AND ALWAYS

READ THE LABEL AND COMPLY WITH THE INSTRUCTIONS.

BBRO would like to thank all manufacturers for assisting with the information included in the charts which are deemed correct as of the 1st January 2024.

BBRO Plant Clinic

Do you need help identifying or confirming a problem with your sugar beet crop?

We have facilities in our Norwich laboratory and glasshouses for a range of diagnostic tests from microscopic investigation of foliar diseases, virus detection, beet cyst nematode identification and germination tests.

The Plant Clinic enquiry form can be downloaded from the website at https://bbro.co.uk/research/plant-clinic/ or using the QR code above. Please send enquiries with photographs to plantclinic@bbro.co.uk. We will assess your problem and advise you on what samples to send to the lab.

Please send samples to:

BBRO, Plant Clinic, Centrum, Norwich Research Park, Colney, Norwich. Norfolk. NR4 7UG.

Crop hygiene crucial

Green bridging of pests, diseases and viruses is clearly a challenge to sugar beet, as it is to other crops on the farm. As our climate changes and our pesticide armoury is reduced further, new and changing pest and disease portfolios and pressures can be expected in the UK. Improving our biosecurity against pests, diseases and viruses, therefore, should become a higher priority and a core element of our integrated crop protection strategies. Hopefully, this article provides a few facts on which you can act, but successful implementation on the farm requires attention to detail, training and great communication to ensure there can be a successful team approach.

- **minimise harvester losses** to reduce potential sources of regrowth
- **monitor spoil heaps** and destroy any growth
- **eliminate groundkeepers**
- **stop aphids green-bridging virus** destroy winter cover crops at least 5weeks before you drill
- **control crop volunteers and virus-hosting weeds** with well-timed herbicides and cultivations

Weed control

Actives for pre and post-emergence applications

Active(s)	Product examples	Residual	Contact	Pre-emergence	Post-emergence	HRAC (2020)	Strengths
Single Actives							
Clopyralid	Dow Shield 400, Vivendi 200, Clayton Cocoon		✓		✓	4	Black-bindweed, Mayweeds, Thistles, Volunteer potatoes,
Ethofumesate	Efeckt, Ethofol, Oblix 500	✓	✓	✓	✓	15	Annual meadow grass, Black-bindweed, Chickweed, Cleavers, Fat hen, Knotgrass, Orache
Lenacil	Venzar 500SC	✓			✓	5	Black-bindweed, Brassica species, Knotgrass, Persicaria
Metamitron	Bettix Flo, Target Flo, Defiant SC, Goltix 70 SC, Glotron 700 SC, Clayton Neutron	✓	✓	✓	✓	5	Annual meadow grass, Fat hen, Knotgrass, Mayweeds, Orache, Small nettle
Phenmedipham	Beetup Flo, Betasana SC		✓		✓	5	Black-bindweed, Charlock, Fat hen, Ivy-leaved speedwell
Triflusulfuron-methyl	Debut, Shiro, Kaskad		✓		✓	2	Brassica species, Cleavers, Fool's parsley, Mayweeds
Mixtures							
Formasulfuron	CONVISO one		✓		✓	2	Broad spectrum, BLW and grassweeds
Thiencarbazone-methyl		✓	✓		✓	2	
Phenmedipham	Betanal Tandem		✓		✓	5	Annual meadow grass, Black-bindweed, Charlock, Chickweed (common), Cleavers, Fat-hen, Ivy-leaved speedwell, Knotgrass, Orache (common)
Ethofumesate		✓	✓		✓	15	
Metamitron +	Goltix Titan	✓	✓	✓	✓	5	Annual meadow grass, Fat hen, Knotgrass, Mayweeds, Orache, Small nettle
Quinmerac		✓		✓	✓	4	
Dimethenamid-p +	Topkat, Tanaris	✓			✓	15	Annual meadow grass, Cleavers, Cranesbill, Fool's parsley, Ivy-leaved speedwell, Poppy, Shepherd's purse
Quinmerac		✓			✓	4	
Metamitron +	Oblix MT	✓	✓	✓	✓	5	Annual meadow grass, Fat hen, Knotgrass, Mayweeds, Orache, Small nettle, Black-bindweed, Chickweed, Cleavers.
Ethofumesate		✓	✓			15	

Post-emergence herbicide systems

System	Components	Management	Weed size	Flexibility
Standard managed approach	Contact + Residual	(High) Selected for weeds present	Expanded cotyledon Pre-em often used	10 - 14 days between sprays
FAR	F - Phenmedipham A - Activator R - Residual Low rates	(Low) Some input on later sprays	Early cotyledon	Meticulous timing every 7 (early on) to 10 days
'Active' - manufacturer programmes	Formulated products - several a.i's + residual	(Medium) Broad spectrum	Early cotyledon	Flexible Wider spray window
Broadacre	Triflusulfuron-methyl + high rates contact & residuals	(Medium) Broad spectrum, ivy-leaved speedwell	First true-leaves 1cm	Aim to use 2 'big hits' 14 days apart
CONVISO® Smart	Herbicide tolerant variety CONVISO One herbicide	(medium) Broad spectrum	2-4 leaves of fat-hen	Flexible

Pre-emergence selective broad-leaved weed control

- Use this chart as an aid to the choice of pre-emergence broad-leaved herbicide products approved for use on the UK sugar beet crop following the principles of ‘Good Agricultural Practice’.
- This chart is a guide and does not override any statements made in manufacturers’ technical literature or on product labels.

ONLY USE APPROVED PRODUCTS, ALWAYS READ THE LABEL AND COMPLY WITH THE INSTRUCTIONS

Example products	Oblix MT Torero Volcano	Goltix 70 SC Bettix Flo Target Flo Defiant SC	Efeckt Oblix 500 Ethofol	Goltix Titan
Active ingredient	**ethofumesate + metamitron**	**metamitron**	**ethofumesate**	**quinmerac + metamitron**
Max total dose/ha	**6.0l**	**5.0l**	2.0l	**3.0l**
Max individual dose/ha	**2.0l**	**2.0l* 3.0l****	**2.0l**	**3.0l**
Annual meadow grass	S	S	S	S
Annual/small nettle	MS	S	S	S
Black bindweed	MR	MR	S	NC
Black nightshade	MS	MR	MS	MR
Charlock	S	S	MS	MS
Chickweed, common	MS	S	S	MS
Cleavers	MS	R	S	MS
Common poppy	S	S	MS	NC
Corn marigold	MS	S	NC	S
Corn spurrey	MS	S	S	S
Creeping thistle	NC	NC	NC	NC
Dock, seedling	MS	S	NC	S
Fat-hen	S	S	S	S
Field pansy	S	S	MS	MS
Field penny cress	S	S	MS	S
Field speedwell, common	S	S	MS	S
Fool's parsley	MR	S	R	S
Forget-me-not	S	S	NC	S
Fumitory, common	S	MS	S	MR
Groundsel	S	S	S	S
Hemp-nettle	S	NC	S	NC
Ivy-leaved speedwell	MS	MS	R	MS
Knotgrass	S	S	S	NC
Mayweed spp	S	S	S	S
Orache, common	S	S	S	S
Pale persicaria	S	MS	S	MS
Parsley-piert	NC	NC	NC	NC
Red dead nettle	S	MS	R	S
Redshank	S	MS	S	MS
Runch	S	MR	S	NC
Scarlet pimpernel	S	MR	S	S
Shepherd's-purse	S	S	S	S
Sow thistle	NC	NC	S	NC
Sun spurge	S	S	NC	S
Volunteer oilseed rape	NC	S	MS	S
Volunteer potatoes	NC	NC	NC	NC
White campion	NC	NC	NC	NC

* Goltix 70 SC
** Bettix Flo, Target Flo, Defiant SC
Product rates differ according to individual product labels.

The information is based on manufacturers' current recommendations and from British Beet Research Organisation sponsored work.
S = Susceptible **MS** = Moderately susceptible **MR** = Moderately resistant **R** = Resistant **NC** = No claim of control

Herbicide resistance in grass weeds

Herbicide resistance affects black-grass, Italian ryegrass, wild-oats and bromes. Levels of resistance are most widespread in black-grass and susceptible black-grass is very rare particularly where herbicides are used in the rotation. In Italian ryegrass the main type of resistance encountered is enhanced metabolism with some ACCase target site and ALS target site present.

There are three types of resistance:

Enhanced metabolism – sometimes known as non-target site resistance. Herbicides are detoxified by the plant. This is the most common mechanism in grass weeds in the UK and affects most herbicides to varying degrees, but complete loss of control is rare. Levels tend to increase slowly.

ACCase target site – This blocks the site of action specific to 'fop, 'dim' and 'den' herbicides (HRAC group 1). It can often result in poor control and can increase rapidly.

ALS target site – this blocks the site of action of sulfonylurea and related herbicides (HRAC group 2). It can often result in poor control and is increasing rapidly.

Resistant grass weed control in sugar beet

- Sugar beet provides an excellent rotational opportunity to target. grass weeds such as black-grass and Italian ryegrass.
- Do you know if the grass weeds are resistant to herbicides?
- Have you seen a gradual decline in control over several years, after spraying are healthy plants found next to dead ones?
- Collect seed and send to ADAS for testing.

Aim for an integrated approach utilising cultivations and herbicides in the wide window between harvest of the previous crop and drilling the sugar beet crop. Plan your cultivations - Where are the seeds in the seedbank profile? Was the previous crop clean or dirty? Are you cultivating to bury weed seeds or are you bringing them up to the surface?

After harvest allow black-grass seedlings to chit and remove them before cultivating.

Apply glyphosate prior to preparation of the final seedbed. The optimum timing for spraying is one to two leaves with the minimum dose rate of glyphosate at 540g ai/ha. If applied to tillered plants this should increase to a minimum 720g ai/ha with 1080g ai/ha glyphosate recommended for well established plants. A maximum of 2 applications should be made to a stale seed bed to reduce the risk of resistance development. Avoid repeat applications of glyphosate to surviving weeds. Manage survivors with an alternative method of control, such as cultivation. Avoid applications of glyphosate during the stem extension phase of growth as activity is likely to be compromised. For more information please refer to WRAG 'Guidelines for minimising the risk of glyphosate resistance in UK'.

Consider using a pre-emergence herbicide of ethofumesate (500g ai/ha) + metamitron (1400g ai/ha). This rate allows for holding some ethofumesate in reserve for post-emergence applications. Resistant grass weeds are most susceptible to re-emergence herbicides but conditions need to be moist for maximum effectiveness.

There is a maximum total permitted dose of ethofumesate of 1000g ai/ha over a 3-year period on the same field.

Post emergence sprays should target small grass weeds (1-2 leaves) and effectiveness decreases as weeds begin to tiller. Mixtures containing triflusulfuron-methyl (HRAC group 2), metamitron (HRAC group 5) and ethofumesate (HRAC group 15) have shown useful black-grass control. Post-emergence graminicides such as Laser are most likely to be affected by herbicide resistance. Currently the graminicide, clethodim (e.g. Centurion Max), is less affected by herbicide resistance than other HRAC group 1 herbicides as it is affected much more by the Aspartate-2078-Glycine mutation, which is still relatively rare in the UK compared to the more common Isoleucine-1781-Leucine mutation.

Herbicide resistance in grass weeds

- Apply glyphosate pre-drilling to remove black-grass prior to seedbed preparation.
- Consider using pre-emergence sprays of ethofumesate and metamitron.
- Post-emergence treatments containing triflusulfuron-methyl (e.g. Debut/Shiro/Kaskad) and ethofumesate appear to show useful increased control of sensitive strains of black-grass (limited data).
- In your overall programme aim to combine at least 2-4 different modes of action.
- Target post-emergence black-grass control at small plants (1 to 3 leaf stage). Control is dramatically reduced once black-grass plants have begun to tiller.

Clethodim can provide useful control of black-grass

Pre and post-emergence grass weed control

- An aid to the choice of grass weed herbicide products approved for use on the UK sugar beet crop following the principles of 'Good Agricultural Practice'.
- This chart is a guide and does not override any statements made in manufacturers' technical literature or on product labels.

Example products	Active(s)	Growth Stage of Crop	sAMG	Black-grass**	Brome spp.	Common couch	Italian rye-grass*	Onion couch	Perennial rye-grass***	Rough meadow grass	Volunteer cereals	Wild oat*	Rate Range (per ha)
Selective weed control													
Centurion Max Select Prime Balistik	clethodim	Fully expanded cotyledons	S	S	MS	NC	S	NC	NC	NC	S	S	1.0l
Efeckt Ethol Oblix 500	ethofumesate	Pre and post	S	S	MS	NC	R	NC	R	NC	NC	MS	*
Falcon	propaquizafop	2 true leaves	MS	S	S	S	S	NC	S	NC	S	S	0.7-1.5l
Fusilade Max	fluazifop-P-butyl	1 true leaf	NC	S	S	S	S	NC	S	NC	S	S	1.0-3.0l
Goltix 70 SC	metamitron	Pre	S	MR	NC	NC	NC	NC	NC	NC	NC	R	*
Bettix Flo Target Flo Defiant SC		Post	S	S	NC	NC	NC	NC	NC	NC	GC	S	
Laser (+ oil)	cycloxydim	2 true leaves	R	S	S	S	S	S	S	MR	S	S	0.5-2.25l
Oblix MT	metamitron + ethufumesate	Pre and post	S	S	MS	NC	NC	NC	NC	NC	NC	NC	*
Panarex Rango	quizalofop-P-tefuryl	2 true leaves	NC	S	NC	S	S	NC	S	NC	S	S	0.5-2.25l
Pilot Ultra/Targa Super	quizalofop-p-ethyl	2 true leaves	NC	S	S	S	S	NC	S	NC	S	S	0.75-2.5l
Targa Super													0.8-2.5l
Targa Max	quizalofop-p-ethyl	2 true leaves	NC	S	S	S	S	NC	S	NC	S	S	0.4-1.25l
Conviso One ****	Foramsulfuron + thiencarbazone	4 true leaves	S	S	NC	S	S	NC	S	S	S	S	1.0L

*** Product rates differ according to timing and tank mix partners, please refer to product labels**
**** Some strains of annual grasses e.g. black-grass, Italian rye-grass and wild oats have developed resistance to some herbicides, leading to poorer control.**
***** From seed only**
******Conviso® One only to be used on Conviso® Smart varieties**
S = Susceptible **MS** = Moderately susceptible **MR** = Moderately resistant **R** = Resistant **NC** = No claim of control **GC** = Growth check

Post-emergence broad-leaved weed control

- An aid to the choice of post-emergence broad-leaved herbicide products approved for use on the UK sugar beet crop following the principles of 'Good Agricultural Practice'.
- This chart is a guide and does not include all available products and does not override any statements made in manufacturers' literature regarding tank mixes or on product labels.
- Correct choice and timing of the first post-emergence spray is critical. Use a sequence of sprays which applies:

  1) Contact activity to control existing weeds. 2) Residual activity to prevent weeds germinating beyonod the final spray application.

Minimum beet crop growth stage	Maximum weed growth stage	Examples of products/actives available see Herbicide restrictions chart	Rate per hectare	COMMENTS	
				Strengths	Weaknesses
No restrictions (after drilling)	Cotyledon	Betasana SC	2.0l to 3.0l	Charlock, black-bindweed, fat hen, ivy leaved speedwell	No residual activity, AMG, cleavers, knotgrass
		Betsana SC + Efeckt + metamitron	0.5 +0 .2 + 0.5	Safe to crop and broad spectrum	Holding spray only
		Betasana SC + metamitron	1.5l +1.0l	Common chickweed, black-bindweed Mayweed spp, small nettle, knotgrass, pansy, AMG	Use as a holding spray
Expanded cotyledons	Expanded cotyledons to just beyond	Betanal Tandem + Oil	1.0/ha + 1.0l/ha	Speedwell + Fat hen	
		Betasana SC + Venzar 500 SC	1.75l+0.4l	Black-bindweed, charlock, Vol. OSR – 1 true leaf	AMG, cleavers, black nightshade
		Betasana SC + metamitron + Efeckt + oil	2.0 +1.0 + 0.3	Broad spectrum	Volunteer potatoes. thistles
		Betasana SC + metamitron + oil	1.75l+1.5l	Field pansy, knotgrass, Vol. OSR – 1 true leaf	Results can be variable
		Debut/Shiro + Venzar 500 SC + Betasana SC or Effeckt + oil	20g + 0.4l + 1.5l or 0.4	Cleavers (1st whorl), mayweed spp, small nettle, brassica spp, fool's parsley, black-bindweed, knotgrass	Pansy
		Tanaris/Topkat	0.3 fb 0.6 fb 0.6	Annual meadow grass. cleavers, poppy, dead nettle, speedwells, fool's parsley, crane's-bill, black nightshade	Black-bindweed, pansy, fumitory, knotgrass, shepherd's purse, fat hen, charlock, volunteer OSR
		Tanaris/Topkat + metamitron	0.3+1.0 / 0.6+1.0 / 0.6+1.0	Additional to above; mayweeds, shepherd's purse, fumitory, fat hen	Annual mercury, black-bindweed

Only use approved products, always read the label and comply with the instructions

Please use this chart in conjunction with the Herbicide restrictions and useful information chart.

Minimum beet crop growth stage	Maximum weed growth stage	Examples of products/actives available see Herbicide restrictions and useful information chart	Rate per hectre	COMMENTS	
				Strengths	Weaknesses
1st pair true leaves at least 1cm long	One true leaf	metamitron + Dow Shield 400/Vivendi 200 + oil	1.0l + 0.25l/0.5l	Mayweed spp, creeping thistle, vol potatoes	
		Betasana SC + Venzar 500SC + oil	2.0l + 0.4l	Larger Vol. OSR – two true leaves	Cleavers, crop damage can be seen during rapid / soft growth
		Betasana SC + Efeckt + Debut/Shiro + Venzar 500SC + metamitron + oil	2.5l + 0.4l + 20g + 0.4l + 0.5l	Designed as a two spray programme, second application should be timed 14 days after the first. Should the second application be delayed and the weed size increased, the dose of ethofumesate may be increased to 0.8l/ha and Debut to 30g/ha	
1st pair true leaves fully expanded	From expanded cotyledons (one true leaf maximum)	Betasana SC + Efeckt	2.0l + 0.4l	Wide spectrum on small weeds	Beet must not be under stress
		Betasana SC + Efeckt + Dow Shield 400/ Vivendi 200	1.5l + 0.6l +0.25/0.5l	Mayweed spp, creeping thistle. For vol. potatoes the first application should be made when the potato shoots are between 5-10cm tall, with a follow up 7-14 days later	
	Larger than one true leaf (two true leaves max)	Betanal Tandem + Oil	1.5l/ha + 1.0l/ha	Speedwell + Fat hen	
		Betasana SC + Efeckt	3.0l + 0.6l	Fire engine option for contact and residual activity	Do not let polygonum or mayweed spp. escape beyond two true leaves
4 leaves	4 leaves	CONVISO One	1.0l	Broad spectrum, Weed beet, Polygonums, Brassicas* (*not Clearfield Vol OSR)	Speedwell

FAR Treatments					
Minimum beet crop growth stage	Maximum weed growth stage	Examples of products/actives available see Herbicide restrictions and useful information chart	Rate per hectare	COMMENTS	
No restriction	Emergence -1cm diameter	Betasana SC + Efeckt + metamitron (FAR 1st application)	0.5l + 0.2l + 0.5l	Crop safety broad spectrum	
Cotyledon		Betasana SC* + Efeckt + metamitron + oil (FAR repeat applications)	0.5l + 0.2l + 0.5l +0.5l	Better weed kill in dry conditions	
2 TL		Betasana SC + Efeckt + metamitron g + Dow Shield 400/Vivendi 200	0.5l + 0.2l + 0.5l + 0.125l/0.25l	Wide weed spectrum Vol. potatoes	Most expensive FAR mixture
		Betasana SC + Efeckt + Debut/Shiro + Venzar 500 SC + oil	0.5l + 0.2l + 10g +0.2l + 0.5l	Good choice for brassica weeds and cleavers on heavy soils	

* Helpful in dry and cool weather.

Post-emergence broad-leaved weed control

Product example	Goltix 70 SC / Bettix Flo/ Defiant SC/ Target Flo	Venzar 500SC	Efeckt / Oblix 500/ Ethofol	Betasana SC / Beetup Flo	Dow Shield 400 / Vivendi 200/ Clayton Coccon	Debut*/Shiro/ Kaskad*	Goltix Titan	Tanaris / Topkat	Betanal Tandem/ Powertwin	CONVISO One
	Contact-residual	Residual	Contact-residual	Contact	Foliar translocated	Foliar	Contact-residual	Residual	Contact-residual	Contact-residual
Active ingredient	metamitron	lenacil	ethofumesate	phenmedipham	clopyralid	triflusulfuron-methyl	quinmerac + metamitron	dimethenamid-p + quinmerac	phenmedipham + ethofumesate	Foramsulfuron Thiencarbazone-methyl
Rate of Ai per l or kg	700g	500g	500g	160g	400g/200g	500g	40g + 525g	333g +167g	200g + 190g 200g + 200g	50g + 30g
Annual meadow-grass	S	R	S	R	R	NC	S	MS	S	S
Black bindweed	MR	MS	S	MS	MS	MR	R	R	S	S
Black nightshade	MR	R	MS	NC	R	MS	S	MS	NC	S
Bugloss	S	S	S	S	R	MS	NC	NC	S	MS
Charlock	MS	S	S	S	R	S	NC	MR	S	S
Chickweed, common	S	S	S	S	R	S	S	MS	S	S
Cleavers	R	R	S	NC	R	S	S	S	S	S
Corn marigold	S	MS	NC	MS	S	S	NC	MR	S	NC
Corn spurrey	S	S	S	NC	R	NC	NC	S	NC	NC
Cranesbill	NC	NC	NC	NC	NC	NC	NC	S	NC	S
Creeping thistle	NC	NC	R	NC	S	MS	NC	NC	NC	MR
Dock, seedling	S	NC	R	NC	R	MS	NC	NC	NC	S
Fat-hen	S	S	S	MS	R	MS	MR	MR	S	S
Field pansy	S	S	MS	MS	R	MS	MS	R	S	S
Field penny cress	S	MS	S	NC	R	NC	MS	S	S	S

Fool's parsley	S	NC	R	NC	R	S	R	S	NC	S
Forget-me-not	S	MS	S	NC	R	NC	NC	MS	S	S
Fumitory, common	MS	S	S	S	R	S	R	R	S	S
Groundsel	S	S	S	S	R	S	S	MS	S	S
Hempnettle	NC	S	S	S	R	S	NC	S	S	S
Ivy-leaved speedwell	NC	S	S	NC	R	S	NC	MS	S	MS
Knotgrass	S	S	S	MS	R	MS	R	R	S	S
Mayweed spp	S	MS	S	MR	S	S	NC	MR	S	S
Orache, common	S	S	S	S	R	MS	S	MR	S	S
Pale persicaria	MS	MS	S	S	MR	S	NC	MS	S	S
Parsley-piert	NC	NC	NC	NC	R	NC	NC	MS	NC	NC
Poppy, common	S	S	S	S	R	MS	NC	S	NC	S
Red dead nettle	S	S	S	NC	R	S	S	S	S	S
Redshank	MS	MS	S	NC	MR	S	S	MS	S	S
Runch	MR	S	S	NC	R	MS	NC	R	S	S
Scarlet pimpernel	MR	S	S	S	R	S	NC	MR	S	S
Shepherd's-purse	S	S	S	S	R	NC	S	MR	NC	S
Small nettle	S	S	S	NC	R	S	NC	MR	NC	S
Sow thistle	NC	R	NC	NC	S	MS	NC	MS	NC	S
Speedwell field, common	S	S	S	NC	R	S	S	MS	S	MR
Sun spurge	S	NC	S	NC	R	S	NC	NC	NC	NC
Volunteer oilseed rape	NC	S	NC	NC	R	S	NC	R	NC	S*
Volunteer potatoes	NC	NC	NC	NC	R	MS	NC	NC	NC	MR**
White campion	NC	NC	NC	NC	S	NC	NC	NC	NC	NC

*** CONVISO One will not control Clearfield**
**** Will control haulm growth only**

This table includes both label claims and supplementary data provided by manufacturers.
S = Susceptible **MS** = Moderately susceptible **MR** = Moderately resistant **R** = Resistant **NC** = No claim of control
*When used with phenmedipham

Yield effect - One tall weed/m^2 can reduce crop yield by 10%!

Herbicide restrictions and useful information

Restrictions on herbicide actives

Active	Example products*	Restriction
ACCase inhibitor herbicides: Propaquizafop, Cycloxdim, Quizalofop-P-tefuryl, Quizalofop-p-ethyl, Fluazifop-P-butyl, Clethodim)	Centurion Max, Falcon, Fusilade Max, Laser, Panarex, Pilot Ultra, Targa Super, Targa Max, Balistik, Select Prime	Apply only one ACCase inhibitor herbicide to reduce risk of resistance developing. Only use a second (different) ACCase inhibitor to control different weeds at different timings.
Clethodim	Centurion max, Balistik, Select Prime	No spray periods: A 5 day no spray period for any herbicide before clethodim application and a 14 day no spray period for herbicides post clethodim application. For Clethodim stewardship see https://www.upl-ltd.com/uk/product-details/centurion-max
Clopyralid	Dow Shield 400, Vivendi 200	In all cases applications should be completed by end of June.
Ethofumesate	Efeckt, Ethofol, Oblix 500, Oblix MT, Torero, Volcano, Betanal Tandem, Powertwin	A maximum permitted total dose of 1.0 kg/ha of active over a three year period on the same field.
Lenacil	Only applies when using Venzar 500SC. Bear in mind other products containing lenacil when using Venzar 500SC	A maximum total dose of 500g/l lenacil per hectare may only be applied every third year on the same field.

This chart is a guide and does not override any statements made in manufacturers' technical literature or on product labels.

* May contain more than one active

Active Ingredient	*Voluntary Initiative (VI) / Stewardship*
Quinmerac	*Quinmerac has been detected in drinking water sources - unless care is taken to reduce the risks to water then this is at serious risk of restricted use. Quinmerac is highly mobile so good practice during filling, cleaning out and application to prevent field losses from run-off. Follow VI best practice to protect water- Fill sprayer in a bunded area and clear up any spills immediately. Ensure there is a 6m grass buffer strip next to water courses. Wash sprayer down in the field or in a bunded area. Do not apply when soils are cracked, dry or saturated. Do not apply if heavy rainfall is expected within 48 hours of application or drains are flowing. Maximum dose: 250g quinmerac/ha - lower dose rates reduce the risk of movement to water, when applied in combination with other herbicides can give equivalent control.*
CONVISO One (Thiencarbazone-methyl + formasulfuron)	*Requires a 10-metre aquatic buffer zone* *Mark and record each variety location, thorough cleaning out of the drill is essential when switching between varieties. Plan for bolter removal from every field.* *Thorough cleaning of the tank between Conviso One and conventional sprays is essential.* *Ploughing is recommended following a Conviso Smart sugar beet crop. Monitor groundkeepers that are showing signs of new growth and use a non-ALS-based herbicide to treat them.*

Using Mineral Oils: Vary the dose according to temperatures below

Maximum temperature (°C) on the day of spraying	Dose of oil (l/ha)
Up to 14	1.0
14-18	0.75
18-21	0.5
Above 21	no oil recommended

Adjuvant oils

- *Can improve weed control but can also reduce sensitivity of herbicide products.*
- *Are of most benefit when weeds are large or 'waxy'.*
- *Should always be used as recommended on the label.*
- *Can increase risk of crop damage when beet are under stress.*
- *As temperatures increase, so does the risk of damage.*
- *Current formulations of broad-leaved herbicides are generally well constructed and do not require an adjuvant to improve weed control but these will often have a recommendation for addition of an adjuvant when low doses are used or weeds are likely to be particularly difficult to control.*

Always check product labels to confirm rates or contact your agronomist.

Herbicide restrictions and useful information

Broad-leaved weed control products

Product	Formulation	Max No. Apps.	Max Ind. Dose l or kg ha/yr	Max Total Dose l or kg ha/yr	LERAP	Water Volume l/ha	Spray Quality	Active	g ai/ l or kg	Active	g ai/ l or kg
Betanal Tandem	SC	3	1.5	4.0	-	80-100	Fine	phenmedipham	200	ethofumesate	190
Betasana SC, Beetup Flo	SC	NS	3.0	6.0	B	80-100	Fine	phenmedipham	160		
Bettix Flo/Defiant SC/Target Flo	SC	NS	3.0	5.0	-	80-200	Fine	metamitron	700		
Conviso One	OD	1	1.0	1.0	-	150-300	Fine/medium	foramsulfuron	50	thiencarba-zone-methyl	30
Debut/Shiro/Kaskad	WG	4	*30g	-	B	80-150	Fine	triflusulfuron-methyl	500		
Dow Shield 400	SL	NS	0.5	0.75	-	200-250/80-100	Medium	clopyralid	400		
Efeckt/Oblix 500 (Pre-em)	SC	NS	2.0	2.0		200-400	Fine	ethofumesate	500		
Efeckt /Oblix 500 (Post-em)		NS	0.6	1.2		80-100	Fine	ethofumesate	500		
Glotron 700 SC	SC	NS	2.O	5.0		80-200	Fine/Medium	metamitron	700		
Goltix 70 SC	SC	NS	2.0	5.0	-	80-100	Fine	metamitron	700		
Goltix Titan (Pre-em)	SC	1	3.0	3.0	-	80-200	Medium	quinmerac	40	metamitron	525
Goltix Titan (Post-em)		3	1.0	3.0	-	80-200	Medium	quinmerac	40	metamitron	525
Goltix Titan (Post-em ONLY)	SC	3	2.0	6.0	-	80-200	Medium	quinmerac	40	metamitron	525
Powertwin	SC	3	1.3	3.9	-	80-100	Fine	phenmedipham	200	ethofumesate	190
Safari Lite WSB	WG	2	*280g	-	B	80-150	Fine	triflusulfuron-methyl	54	lenacil	714
Tanaris/Topkat	SE	NS	0.6	1.5	B	150-300	Medium	dimethenamid-P	333	quinmerac	167
Torero/Oblix MT/Volcano	SC	NS	2.0	6.0	-	80-100	Fine	metamitron	350	ethofumesate	150
Venzar 500SC	SC	NS	0.4	1.0	B	200	Medium	lenacil	500		
Vivendi 200	SL	NS	1.0	1.5	-	80-100	Medium	clopyralid	200		

SC=Suspension concentrate **WG**=Water dispersible granules **SL**=Soluble concentrate **NS**=Not specified **SE**=Suspo-emulsion **OD**= oil dispersal
* = **WG** rate in grams

Grass weed control products

Product	Formulation	Max No. Apps	Max Ind. Dose l or kg ha/yr	Active	g ai l or kg	Harvest Interval	Water Volume l/ha	Spray Quality
Centurion Max /Balistick/Select Prime	EC	1	1.0	clethodim	120	56 days	Min 200	Fine/Medium
Conviso One	OD	1	1.0	Foramsulfuron + thien-carbazone-methyl	50+30	-	150-300	Fine/Medium
Falcon	EC	1	1.5	propaquizafop	100	60 days	100 - 200	Fine/Medium
Fusilade Max	EC	1	3.0	fluazifop-P-butyl	125	56 days	80 - 500	Fine/Medium
Laser	EC	1	2.25	cycloxydim	200	56 days	100-330	Fine/Medium
Panarex/Rango	EC	1	2.25	quizalofop-P-tefuryl	40	60 days	Min 200	Medium/Coarse
Pilot Ultra/Targa Super	SC	1	2.5	quizalofop-p-ethyl	50	60 days	100 - 400	Fine/Medium
Targa Max	EC	1	1.25	quizalofop-p-ethyl	100	60 days	100 - 400	Fine/Medium
A lower water volume of 100l/ha may be used to control barley cover crops in sugar beet when used as part of a broad leaved weed control low dose/low volume programme								
EC = Emulsifiable concentrate SC= Suspension concentrate OD= Oil dispersion								

The information is based on manufacturers' current recommendations and from British Beet Research Organisation sponsored work.

Pest Control

Pest Control - Insecticidal seed treatments and granules

Product	TARGET					
	Springtails	Symphylids	Millipedes	Pygmy Beetle	Free-living Nematodes	Aphid vectors /Virus yellows
Force ST	*	*	*	*		None
Nemguard-DE					*	

*Efficacy

SLUGS

Defra suggest the use of pesticides containing ferric phosphate, though BBRO are unable to comment on its efficacy. (Metaldehyde no longer available.)

Pest Control - Insecticides

Example Products	Max. No Apps.	Max ind Dose	Max Total Dose l or kg ha/yr	Min App Interval (Days)	Active	g ai l or kg	HI	LERAP/ Aquatic buffer zone	Target	Comments
Affinto	1	0.14kg/ha	0.14kg/ha	NS	flonicamid	500g/ kg	60 days	-	Black bean aphid, peach potato aphid	
Cythrin 500 EC	2	50ml/ha	100ml/ha	10	cypermethrin	500g/l	14 days	18m ◆	Caterpillar, cut-worm	◆ Horizontal boom sprayers must be fitted with three star drift reduction technology for all uses. Min 600l/ha.
Decis Forte	NS	75ml/ha	75ml/ha	NS	deltamethrin	100g/l	30 days	7m non reducible	Flea beetle	For the control of flea beetle, apply at the first signs of damage. Avoid spraying within 5m of the field boundary. Min 200l/ha.
Decis Protech	NS	500ml/ha	500ml/ha	NS	deltamethrin	15g/l	30 days	7m non reducible	Flea beetle	For the control of flea beetle, apply at the first signs of damage. Avoid spraying within 5m of the field boundary. 200l/ha.
Hallmark Zeon Stealth/Warrior	2-4 ■	75ml/ha	150ml/ha	7	lambda cyhalothrin	100 g/l	56 days	B	Flea beetle, mangold fly, cutworm.	200l/ha volume. ■ Up to 4 doses if rate reduced.
Insyst	1	250g/ha	250g/ha	28	acetamiprid	200g/l	28 days	B	Peach potato aphid	Up to 12 true leaves, threshold for treatment is 1 green wingless aphid per 4 plants. From 12 - 16 true leaves the threshold increases to 1 green wingless aphid per plant.
Kendo/Kung Fu Kusti/Ninja	2-4 ■	150ml/ha	300ml/ha	7	lambda cyhalothrin	50gl	56 days	B	Flea beetle, mangold fly, cutworm	200l/ha volume. ■ Up to 4 doses if rate reduced.
Teppeki	1	140g/ha	NS	21	flonicamid	500g/ kg	60 days	-	Black bean aphid, peach potato aphid	Spray upon reaching threshold of 1 wingless green aphid per 4 plants. Applications at 6-8 true leaf stage, generally May-June. Min 200l/ha.

The information is based on manufacturers' current recommendations and from British Beet Research Organisation sponsored work.

Only use approved products, always read the label and comply with the instructions

Disease control

- An aid to the choice of fungicide products approved for use on the UK sugar beet crop following the principles of 'Good Agricultural Practice'.
- This chart is a guide and does not override any statements in manufacturers' technical literature or on product labels.

Product	Max No. Apps	Max Ind. Dose l or kg ha/yr	Max Total Dose l or kg ha/yr	Active (sulphur)	Active (triazole)	g ai l or kg	Active (strobilurin)	g ai l or kg	Active (SDHI)	g ai l or kg		Water Volume l/ha	Spray Quality
Angle, Priori Gold	2	1	NS		difenoconazole	125	azoxystrobin	125			35	200-400	Medium
Caligula	1	1.2	1.2		prothioconazole	125			fluopyram	125	7	200-300	Medium
Impact	1	0.5	0.5		flutriafol	125					28	Min 200	Medium
Kumulus DF, SOLFA	2	10	NS	sulphur							End Aug	Min 250	Medium
Microthiol Special	2	10	NS	sulphur		800					End Sept	200-600	Medium
Revystar XE	2	1.0	NS		mefentrifluconazole	100			fluxapyroxad	47.5	28	150-400	Medium
Thiopron (be aware of buffer zone restrictions)	2	9.7	NS	sulphur		825					NS	200-600	Medium
Twist	2	0.25	NS				Trifloxystrobin			500	21	min 200	Medium

IMPORTANT: Check health and safety requirements carefully and use appropriate PPE and follow guidance for use. Product requirements differ.

CHECK LIST

- Correct application water volumes and nozzle selection are important
- High water volumes are better for the treatment of dense crops
- Lower water volumes other than stated on the product label may not be supported by the product manufacturer
- Always read the label and seek advice from a qualified advisor

Fungicide Restrictions

NS =Not stated

Example products	Restriction
Angle	These products contain an active from the QoI cross resistance group. Apply preventatively rather than curatively. Use an ICM strategy incorporating other methods of control, including fungicides with a different mode of action.
Caligula	Note stewardship conditions No stem vegetables for 1 year, no beet tops fed to livestock

The information is based on manufacturers' current recommendations and from British Beet Research Organisation sponsored work.

Product Example	Powdery Mildew	Rust	Ramularia	Cercospora *
Angle/ Priori Gold	✓	✓	✓	✓
Caligula	✓	✓	✓	✓
Impact	✗	✗	✓	✓
Revystar XE	✓	✓	✓	✓
Sulphur (e.g. Kumulus, Microthiol, Thiopron)	✓	✗	✗	✗
Twist	✗	✓	✗	✗

* Potential decrease in efficacy of some products, if resistant strains are present

Rust

When:	July onwards.
Symptoms:	Small orange/brown pustules on leaf surface, later defoliation occurs after frost.
Risk:	Damp conditions and temperatures between 15-22°C. Low resistance variety.
Severity:	Up to 10-14% yield reductions.
Advice:	Treat as soon as disease appears, this is usually mid August to September but can be earlier.

Powdery Mildew

When:	July to early autumn.
Symptoms:	Grey mould on crop, starting on outer leaves.
Risk:	Mild winters, dry and warm conditions. Low resistance variety.
Severity:	One of the most yield damaging foliar disease in sugar beet, in the UK. Early infections can reduce yields by up to 20%.
Advice:	Apply first foliar spray at the end of July/early August as soon as disease infection is seen.

Cercospora leaf spot

When:	Mid July to October
Symptoms:	Circular spots 3-5mm in diameter with necrotic, tan-grey coloured centres and reddish-brown boarder. Spots coalesce, leading to severe defoliation.
Risk:	Warm wet weather, with temperatures above 25°C.
Severity:	With warmer summers, the risk of cercospora in the UK is increasing, especially following rainfall which creates a combination of warm temperature and high humidity in the canopy.
Advice:	Limited efficacy of some fungicides due to developing resistance.

Stemphylium

When:	July to September
Symptoms:	Disease starts with small, discrete, irregular yellow spots (0.5-2 mm across). The spots begin to die from the centre forming brown spots 1-3 mm across. Heavily infested leaves die and more yellow spots appear on new leaves. Progressive leaf loss follows in August to September with subsequent yield loss.
Risk:	Wet summers (high humidity) and other stress factors (e.g. BCN or low pH).
Severity:	22% to 42% yield loss shown in Dutch trials
Advice:	Send leaf samples to the Plant Clinic for identification. If stemphylium is confirmed in your crop, assess the extent of the disease.

Ramularia

When:	Mid to late autumn.
Symptoms:	Angular leaf spots with central silvery cells and sometimes a dark outer margin on older leaves. Spots are larger than those of cercospora.
Risk:	Cooler (17-20°C) and wet conditions.
Severity:	Usually very low.
Advice:	Current fungicide programmes used in the UK are providing adequate control.

Contact us

British Beet Research Organisation,
Centrum
Norwich Research Park,
Colney Lane, Norwich,
NR4 7UG

General enquiries	**info@bbro.co.uk**	**01603 672169**
Dr Vicky Foster	vicky.foster@bbro.co.uk	07966 961504
Prof Mark Stevens	mark.stevens@bbro.co.uk	07712 822194
Ches Broom	francesca.broom@bbro.co.uk	07710 285689
Plant Clinic	plantclinic@bbro.co.uk	

BBRO@BBRO_Beet

www.bbro.co.uk

www.uksugarbeet.co.uk

BASIS

1st Feb 2024 to 31th May 2024 2 points CP/135213/2324/g
1st June 2024 to 31st January 2025 2 points CP/135357/2425/g

NRoSO:

1st March 2024 to 31st January 2025 2 points NO502594f