

# Feature



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## Biennial beet

Sugar beet is biennial, meaning it takes two years to complete its lifecycle, with flowering and seed production typically in its second year of growth. The plant must undergo vernalisation, which is prolonged exposure to cool temperatures, to trigger stem extension and flower development. Day length, light quality and quantity then dictate seed production, with the main driver being long days. The combined effect of temperature and light sensitivity ensures flowering and seed production normally occurs in the summer months.

## Bolting

Despite being a biennial plant vernalisation and subsequent stem extension and flowering can occur in the first year and this is known as bolting. Vernalisation can start before emergence, when the seed has germinated, as well as affecting the plant post emergence. Conditions for vernalisation require consistently low temperatures of between 3°C and 12°C, with temperatures in the middle of this range having the most affect. Plants must be exposed to these temperatures for prolonged periods and therefore a few cold days will not cause sugar beet to bolt. Bolters are an issue as they lead to a yield reduction of around 11% because the bolted plant relocates sugar from the root to the canopy and shades the surrounding non-bolted plants (Jaggard, 1983). However, the biggest threat is the potential of the bolter to produce hundreds of seeds which if not removed from the field can fall to the ground and lead to weed beet, which is difficult to control in subsequent sugar beet crops.

## How we predict it?

There are many models to predict vernalisation; the BBRO approach avoids overcomplication whilst maintaining the required level of accuracy. BBRO took the bolter

# Physiology Focus

Plant physiology provides the building blocks to growing a healthy crop. By understanding key processes such as germination, leaf development, photosynthesis, root function, nutrition and transpiration we can work to mitigate environmental changes and drive yield improvements.

In the first of a series of bitesize articles, BBRO's Georgina Barratt takes a look at the physiology of sugar beet.



**Fig. 1.** A bolted sugar beet plant

numbers in the main variety trials since 1972 and the early sown bolter trials undertaken since 2000 and the corresponding temperature records to identify the temperature and length of exposure which drives bolting. The result was the total number of hours that temperatures were below 7°C between sowing and the end of June.

## How is bolting assessed in the RL trials?

Early sown bolting trials (ESB) are sown deliberately early and sequentially from the last week of February to the 5th of March (9th March in 2018) with this work separate from the main RL trials. The number of bolters in the ESB

trial are recorded and average number of bolters from the last three years of trials presented in the RL. This data is used to identify varieties which are not suitable for sowing before mid-March and highlighted using a red cross in the RL. In addition to this there is also the normal sown bolter (NSB) figures

RECOMMENDED LIST OF SUGAR BEET VARIETIES								
RZ1 (winter) varieties						Days to	Salvage 100%	
Status: (C) = control variety *						RL1	RL2	
APPROX as sown by the Breeder						BCN		
CRIP YIELDS	MEAN		85% hd					
Adjusted tonnes % of C=100%*	111.1 t/ha	100.0	2.6	102.8	99.8			
Segaryield % of C=100%*	18.1 t/ha			102.8	100.0			
Root yield % of C=100%*	101.4 t/ha			104.3				
Segar content %	18%							
BOLTERS per 100 100 plants/ha	MEAN	96% hd	99.5% hd					
*C= Unavailable for sowing (ECHOIC; Mid March for new (2023) list)								
Early sowing, before 5 March*	2,190h	3,375	4,268	2,600	2,45			
Normal sowing	1,075h	59	55	3	15			
PRE-GAPPING ESTABLISHMENT*								
Control	100%							
DISEASE (1 = high leaf infection 3 = very low leaf infection)†								
Rust	4.3							
Powdery mildew	5.5			(5.0)	5.0			
RL SYSTEM								
Year first listed				2007	2018			
BREEDER/UK GROWING†								
Breeder				KWS	KWS			
UK Agent				SWB	SWB			

Most of control values include BTS 560 which is no longer listed.

- Newly listed varieties (PHL/PSI) have results from three years using appropriate sowing dates.
- Yields based on an average plant population of 180,100 plants/ha in these trials.
- The ratings from normal sowings are applicable for sowing after mid-March.
- Differences in establishment of less than 3.7% should be treated with reserve.
- Observations for rust taken from inoculated trials that are not taken to yield.
- BTS = Belaseed, KWS = KWS UK Ltd, LG = Limagrain UK Ltd, STR = Stratus.

Diagonals indicate figure derived from fewer than 3 years of data

which show the average number of bolters in main RL Trial which is drilled mid-March, enabling a further check of bolting behaviour. Both the ESB and NSB figures are quoted as 'number per hectare based on beet populations of 100,000/ha'.

### Weed beet

Weed beet germinates from seed produced by bolters and at densities as low as 1 plant/m<sup>2</sup> can reduce root yields by 11% (Longden, 1989), therefore preventing or reducing the number of bolters and subsequent weed beet in the crop is beneficial to yield. Weed beet tends to germinate at a different time to the beet that has been drilled and this causes two main issues.

Firstly, if the weed beet germinates before the main crop it competes for water, nutrition and light reducing the yield potential of the plants around it. Secondly, weed beet can encourage pests, such as virus carrying aphids (beet yellows, mild yellowing and chlorosis viruses are not spread by weed beet seeds but do encourage migration

of aphids in to the crop) and beet cyst nematode, and diseases, such as downy mildew and rhizomania. The timings of sprays will be optimised for the main crop, which may be too late to control the pests and diseases which have migrated on to the weed beet. Weed beet can also undergo vernalisation and bolt; the likelihood of this increases when the weed beet germinates before mid-March.

Weed beet that has bolted can produce over 1,500 seeds per plant and these can remain viable in the soil for over 10 years. The BBRO Reference book has details on how best to control weed beet in the crop which in brief includes: tractor hoeing, hand pulling, weed wiping and cutting as well as delaying drilling to encourage a flush of weed beet which can then be controlled using a non-selective herbicide pre drilling and delayed cultivations, as after harvest, the seed can be eaten by birds and mammals. However, the best approach to controlling or eliminating weed beet is to prevent bolting.



Fig. 3. Weed beet in a sugar beet crop

### Management practices to preventing bolting

- **Variety selection and timing of drilling** – establishing a good canopy early is linked to greater crop yield potential so early drilling can be preferable but it is important to select varieties suitable for early sowing (before mid-March). As already outlined, the RL provides data on the levels of bolting observed in each variety. The most important information to note is the red cross in the bolting section. Varieties with a red cross are not suitable for sowing before mid-March.
- **Drilling** – Vernalisation can start before the beet emerge, therefore pay close attention to soil temperature at drilling depth and aim to drill to moisture.
- **Think about field location** – north or south of the beet growing area, by the sea or inland, sheltered by woods or buildings, sloping topography and orientation of field can also affect the temperatures experienced by beet, and hence vernalisation.
- **Conviso varieties** – if weed beet is already an issue in the crop than Conviso varieties and chemistry can help to break the cycle by enabling selective herbicide application to eliminate weed beet. These varieties are not resistant to bolting, so should be managed like conventional varieties when it comes to vernalisation risk.

Overall bolting and subsequent weed beet can reduce yield but by thinking about the risk of vernalisation and adapting management practices, especially variety selection, the problem can be overcome.

Fig. 2. The bolting information on the RL which consists of a red cross if not suitable for sowing before mid-March alongside the early sown bolter (ESB) and normal sown bolter (NSB) values which are the number of bolters per hectare based on beet populations of 100,000/ha.

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ES 2021 (Based on trials from 2017-2019)

Conviso VMS	BT15526	Conviso	BT15519	Elberta VMS	Yorkshire VMS	BT15510	Adrena VMS	Conviso VMS	Elberta VMS	Lignaria	Santa VMS	Lignaria	BT15490	Conviso	Adrena	Elberta	BT15519	Conviso VMS	Elberta VMS	Yorkshire VMS								
RQ	RQ	R	PR1	PR1	PR3	PR3	PR2	PR1	PR1	PR2	PR1	PR1	PR1	PR2	PR2	PR2	FS1	PS1	PS1	PS1								
BCN												BCN					4798	455	455	455								
99.1	99.4	99.7	100.1	100.0	99.8	100.0	100.1	100.7	100.0	100.3	100.4	100.4	100.1	100.5	100.3	100.6	101.4	101.5	101.7	101.7								
99.1	99.1	99.7	100.2	100.0	100.2	100.0	100.1	100.8	100.5	100.3	100.3	100.2	100.2	100.0	100.0	100.0	101.3	101.5	101.7	101.7								
Check varieties for early drilling suitability										15	105	103.8	100.8	101.1	97.1	100.3	101.3	97.4	102.4	100.6	100.6							
7	7	5	5	6	7	35	5	3	6	3	3	3	3	3	3	3	26	17	9	9								
2,255	1,790	4,098	8,494	3,468	1,872	4,466	2,901	1,260	2,083	3,290	1,667	4,016	1,573	2,034	1,871	1,716	8,279	1,964	2,720	2,720								
7	5	50	5	6	7	35	5	3	6	3	3	3	3	3	3	3	26	17	9	9								
Early sown bolter trials (ESB)										102.2	100.6	100.6	101.1	100.9	102.4	100.8	102.3	100.6	100.7	101.3	101.2	102.3	100.2	100.6				
Normal sown RL trials (NSB)										77	83	(56)	(14)	(17)	(28)	(41)	(36)	(43)	(51)	(55)	(44)	(30)	(44)	(37)				
(58)	(53)	(25)	(42)	(42)	(37)	(48)	(36)	(59)	(51)	(48)	(28)	(40)	(28)	(51)	(37)	(42)	(46)	(44)	(34)	(34)								
2016	2017	2017	2020	2009	2018	2018	2019	2020	2020	2019	2020	2020	2019	2019	2019	2019	2018	2020	2019									
KWS	ITS	STR	ITS	KWS	KWS	ITS	KWS	KWS	KWS	SV	KWS	SV	ITS	SV	SV	SV	KWS	KWS	KWS									
KWS	LO	STR	LO	KWS	KWS	LO	KWS	KWS	KWS	SV	KWS	SV	LO	SV	SV	SV	KWS	KWS	KWS									

approximately 2 lbs breeders' seed. Thereafter commercial seed should be used in RL trials. (See supplementary table)

Differences in adjusted tonnes of less than 2.8% should be treated with reserve.

in mixed seasons.

in mixed seasons.

Powdery mildew data taken from main series using 2018 & 2019 trials not taken to yield.

in Sugar Beet UK Ltd, SV = SEVender-love UK Ltd

### References

Jaggard, K., Wickens, R., Webb, D., & Scott, R. (1983). Effects of sowing date on plant establishment and bolting and the influence of these factors on yields of sugar beet. *The Journal of Agricultural Science*, 101(1), 147-161.

Longden, P.C. (1989). Effects of increasing weed-beet density on sugar-beet yield and quality. *Annals of Applied Biology*, 114: 527-532.