Deploying Wild Beet Resistance Sources for Breeding **SBR and RTD Tolerant** Sugarbeet Varieties

79th IIRB Congress, 27-28 February 2024, Brussels (B)
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Introduction

Two novel sugarbeet diseases called "Syndrome des Basses Richesses" (SBR) and “Rubbery Taproot Disease” (RTD) are spreading in certain regions of Southern and Eastern Germany, Switzerland and very likely reaching neighboring countries in short term. Both diseases are transmitted by plant hoppers (e.g., *Pentastiridius leporinus* and *Hyalesthes obsoletus*) serving as vectors for two bacterial pathogens. It is currently believed that ‘Candidatus *A. phytopathogenicus*’ is the main causal agent for SBR, while RTD expressing sugarbeet are infected with ‘Candidatus *Phytoplasma solani*’. SBR - infected sugarbeet plants display heavy symptoms including leaf yellowing and necrosis, growing of asymmetric, lancet-shaped leaves, browning of tap root tissue but most importantly loss of sugar content up to 5% (abs.) and yield losses up to 25%. RTD-infected sugarbeet suffer from heavy water losses at late stages of plant development, conversion of stored sucrose to mono-saccharides such as glucose and fructose, and a severe susceptibility to fungal and bacterial secondary infections.

Fig. 1: Exemplary Field trial in Southern Hesse for SBR tolerance in experimental hybrids.

15.0 %	**Sugar Content** (abs)	**16.9 %**	**Sugar Content** (abs)	**13.7 %**
53.8 t/ha	**Root Yield**	**65.8 t/ha**	**Root Yield**	**63.0 t/ha**
8	**SBR Rating**	**2**	**SBR Rating**	**8**

Experimental hybrids are tested under field conditions for tolerance against SBR in different test sites distributed in core regions of SBR occurrence. For SBR, phenotypic variation in KWS elite germplasm is used to provide tolerant varieties. (Pictures: KWS)

Breeding for SBR and RTD Resistance

Currently, there are no chemical or agronomical measures available to control bacterial infections or plant hopper development. Therefore, the diseases need to be brought under control by genetic solutions through introduction of genetic resistance and development of SBR and RTD tolerant or resistant varieties. Field and greenhouse test systems were developed for SBR and RTD and are already routinely used to describe large numbers of breeding lines and experimental hybrids.

To meet market demands in short term, SBR or RTD tolerant sugarbeet varieties are developed using existing phenotypic variation of KWS elite germplasm.

For example, JOSEPHINA KWS combines high sugar yields under SBR pressure with required rhizomania and nematode resistance. To ensure continuing breeding progress novel experimental hybrids are tested regularly for high yields under SBR (Fig. 1). In addition, both, field, and greenhouse tests for SBR and RTD symptom development upon plant hopper infestation were developed (Fig. 2) and are used to screen wild beet accessions as genetic resources for SBR and RTD resistance (Fig. 3).

Fig. 2: SBR and RTD greenhouse test system to screen for tolerance or resistance founders.

A greenhouse phenotyping system has been developed and is applied to screen for founders of SBR and RTD tolerance or resistance, respectively in sugarbeet elite and wild germplasm. Planthoppers (*Pentastiridius leporinus*, left) are collected in infested sugarbeet fields, analysed for presence of pathogens, and directly used for greenhouse infestation. (Pictures: KWS)

Fig. 3: Breeding for SBR and RTD resistant variety components.

SBR susceptible elite parent SBR rating 8 | **SBR resistant wild beet SBR rating 2** | **F1 susceptible x resistant SBR rating 2**

	Phytoplasma Copy Number	Proteobacterium Copy Number
Wild Beet	61165	0
Wild Beet	27530	0
Wild Beet	0	32
Wild Beet	0	113
Elite	11213376	2613
Elite	2876645	360
Elite	12278361	45
Wild Beet	2018329	252
Elite	4234936	11
Elite	2501366	14
Elite	544624	63

Single plants of elite germplasm and wild beet accessions are tested in a green-house test for resistance against SBR and RTD.

Copy numbers of Phytoplasma and Proteobacterium are quantified upon plant infestation with loaded planthoppers (left).

For SBR plants are additionally rated for symptom expression. Potential wild beet sources of resistance are crossed with susceptible elite germ–plasm to equipe sugarbeet elite lines with resistance traits (top).

(Pictures: KWS)

Conclusion/Outlook

Both SBR and RTD are assumed to become a permanent threat for sugarbeet growers with total acreage rather increasing in future. KWS has established dedicated breeding programs for both sugarbeet diseases to meet demand for specialized sugarbeet varieties. Novel genetic resistance sources are identified, introduced in elite germplasm, and combined with market relevant traits. Modern plant breeding methods including fast breeding cycles, advanced phenotyping and genomic data analysis are employed for holistic variety development. KWS is working with highest priority on providing SBR and RTD tolerant sugarbeet varieties in shortest possible time to preserve sugarbeet in SBR and RTD infested regions.

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