Syndrome des Basses Richesses - A Novel Insect Transmitted Disease in Sugarbeet

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Introduction

Climate change has hit sugarbeet farmers in certain regions of Southern and Eastern Germany and Switzerland with full power. Surprisingly, it is not only drought related abiotic stress that has become a major challenge in these regions but also the occurrence of a plant hopper (*Pentastiridius leporinus*) transmitting two bacterial pests to sugarbeet. Plants infected with Candidatus *Arsenophonus phytopathogenicus* or Candidatus *Phytoplasma solanii*, or as it is called "Syndrome des Basses Richesses" (SBR), display severe 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%. SBR was first observed in France in 1991[1] with little attention until a few years ago when planthopper populations spread to major sugarbeet growing areas. Along with declining sugar prices, farmers in SBR infested regions have difficulty keeping sugarbeets as a valuable and profitable part of their crop rotation, which threatens the existence of regional sugar factories.

Setup of SBR Test Systems

KWS has chosen various field locations in the disease core regions in Southern and Eastern Germany to test for yield parameters in presence of *P. leporinus* and SBR infestation (Fig. 1). A greenhouse test system was additionally established to independently examine phenotypic variation and to screen for novel tolerance or resistance founders, respectively, from a broad range of sugarbeet germplasm (Fig. 2). Throughputs of the greenhouse test system are expected to increase once rearing protocols for the plant hopper are available. However, both test systems are already routinely used to describe large numbers of breeding lines and experimental hybrids.

(Pictures: KWS)

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Fig. 1. SBR is widely found in Southern and Eastern Germany as well as Switzerland. The disease vector, plant hopper *Pentastidirius leporinus* (lower panel left), is spreading likely as a result of climate change. Field test systems to select high performing lines (upper panel right) and hybrids (lower panel right) under SBR pressure. Representative test locations were set up in Saxony-Anhalt, Hesse, and Baden-Wurttemberg (left panel).

Breeding for SBR Tolerance

KWS is working together with national sugarbeet research institutions to gather solutions on multiple levels. The governmental funded research project PENTA-Resist aims to identify means to fight the planthopper and to interrupt its reproduction cycle. KWS is also part of research collaborations to screen for novel sources of SBR resistance in broad ranges of germplasm including wild beets. Until such resistance founders are available, variation of SBR symptoms in sugarbeet elite germplasm is further developed. Competitive varieties must combine high performance under SBR pressure with established tolerances namely Rhizomania, Cercospora, Nematode and Yellowing Virus tolerances. Fig. 3 illustrates yield trials of experimental hybrids under presence of SBR symptoms which have, for instance, recently resulted in registration of Rhizomania and Nematode tolerant variety JOSEPHINA KWS that has competitive sugar contents and yields in SBR affected markets.

Fig. 2. A greenhouse phenotyping system has been developed and will be applied to screen for founders of SBR tolerance in sugarbeet elite and wild germplasm. Currently, the test system is limited by planthopper (*Pentastiridius leporinus*) availability (left). Planthoppers are collected in infested sugarbeet fields and directly used for greenhouse infestation.

[1] Gatineau, F., Jacob, N. Vautrin, S., Larrue, J., Lherminier, J., Richard-Molard, M. Boudon-Padieu, E. (2002): Association with the syndrome „Basses Richesses" of sugar beet of a phytoplasma and a bacterium-like organism transmitted by a Pentastiridius sp. Phytopathology 92, 384-392.
[2] Pfitzer, R., Schrameyer, K., Voegele, R.T., Maier, J., Lang, C., Varrelmann M. (2020): Causes and effects of the occurrence of "syndrome des basses richesses" in German sugar beet growing areas. Sugar Industry 145, 234– 244.

SBR Tolerant Wild Beet

Sea beet (*Beta vulgaris* subsp. *maritima*) has been a valuable resource for tolerance or resistance genes for many sugarbeet diseases. The SBR greenhouse test reveals broad variation for SBR symptom development in sea beet accessions (Fig. 4). Favorable alleles are introduced in elite germplasm.

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Fig. 4. Susceptible (left) and tolerant (right) single plants derived from greenhouse screens of sea beet accessions for tolerance against SBR.

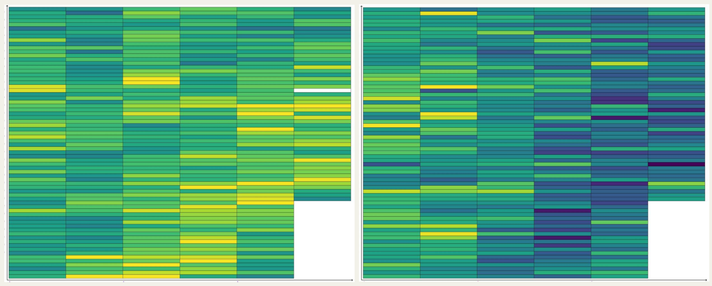

Fig. 3. Selection of high performing and competitive experimental hybrids for variety registration in SBR markets. Example heatmap of sugar content (left panel) and tap root yield (right panel) of sugarbeet experimental hybrids tested under SBR pressure in one location in 2021. The best performing hybrids were selected to enter the official variety registration process. The graph illustrates the field design. Color coding from yellow to purple: Sugar Content, 15% (abs.) - 19% (abs); Root Yield, 600 dt·ha^{-1} - 1000 dt·ha^{-1}.

Conclusion & Outlook

SBR is expected to be an ongoing threat for sugarbeet growers and increase in importance as it continues to expand its range. To cope with the demand for specialized sugarbeet varieties, KWS has established a new breeding program to screen for and make use of novel genetic resistance sources against SBR. Advanced plant breeding methods are employed including fast breeding cycles, advanced phenotyping, genomic data analysis, and holistic variety development. KWS is working with highest priority on providing SBR tolerant sugarbeet varieties in shortest possible time to preserve sugarbeet in affected markets.

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