INTERNATIONAL INSTITUTE OF SUGAR BEET RESEARCH

Advancing Sugar Beet in a Dynamic Environment

80th IIRB CONGRESS

ABSTRACTS OF ORAL PRESENTATIONS

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Oral presentations

Session 1: Advanced agronomy in environmental challenges

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IDENTIFYING AND MITIGATING GREENHOUSE GAS EMISSIONS FROM SUGAR BEET PRODUCTION

Agriculture is under ever increasing pressure to reduce greenhouse gas emissions and sugar beet is no exception. Fertiliser and fuel are the main sources of emissions on farm but there is also a need to understand emissions at a larger scale. How can management of the crop be tailored to ensure maximum carbon uptake and retention following harvest? Whilst fertiliser and fuel can easily be accounted for the carbon dynamics of the crop are more challenging to measure due to environmental variables.

A pair of flux towers have been set up in two neighboring arable fields in the UK to measure CO_2 fluxes. These systems measure at a field scale and operate 24/7. This ensures the data collected can be used to quantify the carbon dynamics of the crop. The two fields have contrasting management practices such as a cover crop compared to stubble and ploughing compared to reduced tillage. The system is left in the following cereal crop to assess if there are any legacy effects from the differing sugar beet management. The project is in its 4th year with data collected from two sugar beet seasons as the flux towers move every two years to stay ahead of the sugar beet rotation. This work complements other ongoing projects aiming to identify emissions from alternative fertilisers and tillage practices in sugar beet. Data will be presented from the two-sugar beet and following cereal crops as well as emissions data from complementary projects.

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Is sugar beet really detrimental to soil organic carbon?

Sugar beet cultivation is generally classified as detrimental to soil organic matter, and losses of soil organic carbon (SOC) are therefore included in greenhouse gas balances. In fact, this categorisation is based on a hardly representative and irretrievable data set from the 1970s. Other than that dataset and previously published data from the long-term trial reported here, no studies on the subject are known to the authors. The present study combined measured SOC contents from the German Agricultural Soil Inventory with values from a long-term crop rotation experiment. The nationwide data set showed lower SOC stocks (-4.6%) for sites with compared to sites without sugar beet cropping. However, re-sampling of sites 10 years later revealed no (further) SOC loss. The long-term field trial revealed no negative effects of sugar beet cultivation on SOC. We concluded that sugar beet cultivation may have had a negative impact on SOC stocks in the past which seems to be no longer the case under current conditions. This might be due to the establishment of a new equilibrium in SOC stocks under long-term sugar beet cultivation. Moreover, the now common practice of cover crop cultivation before sugar beet might partially mitigate the low input of organic matter by sugar beet crop residues.

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NITROGEN-FIXING BACTERIA TO IMPROVE NITROGEN USE EFFICIENCY. DO BIOSTIMULANTS DELIVER WHAT THEY PROMISE?

In recent years, various biostimulants based on nitrogen fixing bacteria have been introduced onto the market. The claim of these products is that they provide significant amounts of nitrogen from the atmosphere, which comes available for crops. The reliability of this mechanism in non-leguminous crops like sugar beet, is uncertain. If these biostimulants turn N_2 into mineral nitrogen, this could be a welcome contribution to improve the nitrogen use efficiency of sugar beet. To investigate this, COBRI institutes conducted several field trials in 2024 with two biostimulants, based on different bacteria strains. These trials were located in Belgium (IRBAB), Denmark (NBR), Germany (IfZ) and the Netherlands (IRS). The effect of the biostimulants was tested at three different nitrogen levels (low, medium and high). Results of these trials will be presented at the IIRB congress.

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ADVISING SUGAR BEET GROWERS ON IRRIGATION IN DIVERSIFIED CONTEXTS

Climate change is increasing the need for irrigation in sugar beet cultivation across more regions in France, prompting the development of new strategies. The aim of this work is to be able to advise farmers on irrigation strategies adapted to these diversified contexts, while considering their specific constraints.

To achieve this, Optirrig (Cheviron, B., *et al*, 2016), a framework based on a crop model (Mailhol, J-C., *et al*, 2018) for multi-objective constrained optimization of irrigation strategies was enhanced for sugar beet through the integration of new formalisms and parameters. The model was calibrated using 8 trials and validated using 31 trials.

A web-tool was developed to perform pairwise comparisons between constrained scenarios described by agricultural variables (e.g., dates, doses, trigger criteria). It addresses practical questions such as: “When should I stop irrigating?”, “Is it beneficial to irrigate sugar beets?”.

This tool relies on reference tables made from simulations generated with Optirrig. These simulated situations were defined thanks to a survey conducted among sugar beet growers in 2023. However, the tool is flexible and allows for the addition of many more scenarios.

This web-tool shows the differences in terms of consumed amounts of water, yields and economic performances over the last ten years between any two selected scenarios.

This oral presentation will show the crop model’s performance results and include a demonstration of the web-tool.

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DROUGHT-SENSITIVE SUGAR BEET MODELLING FOR IDEOTYPING FUTURE HIGH-YIELDING GENOTYPES

Drought stress is among the most critical yield limiting factors in sugar beet cultivation. It is projected to intensify under climate change due to rising temperatures and altered precipitation. Breeding drought-tolerant varieties therefore requires a mechanistic framework to quantify genotype × environment interactions and to support trait-based ideotyping.

We present a data based integration of water status modifiers (transpiration deficit) in multiple relevant processes of a dynamic crop growth model to comprehensively represent drought-sensitivity in sugar beet crops. This enables the integration of past, present, and future climate scenarios.

Significant parameters were found within the processes of storage root–leaf ratio, leaf blade–petiole ratio, specific leaf blade area, rooting depth, and radiation use efficiency (RUE). Final parameterization and subsequent validation across European multi-environment trials demonstrate the ability of the model to reproduce yield responses under varying drought stress conditions.

We present virtual ideotyping and scenario testing with historical and projected climate series to prioritize breeding targets and to inform management under water restriction. Analyses across a data derived parameter range identified high dry matter partitioning to the storage root, rapid canopy (LAI) development and deeper rooting - and their interactions with RUE - as the principal functional levers that buffer yield losses under water limitation.

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BEETADAPT: NEW TECHNOLOGIES FOR HIGH-THROUGHPUT PHENOTYPING AND PHENOMIC SELECTION IN SUGAR BEET BREEDING

Sugar beet breeders are increasingly using digital technologies to get more and highly precise data on phenotypic traits. BeetAdapt explores how unmanned aerial vehicles (UAVs) and edge intelligent algorithms can be used to transform conventional data collection from field trials into data oriented field trialing, allowing relational studies between yield performance and developmental and/or disease parameters over the entire growth season. The project explores the following datasets from field trials: drone flight time series data (RGB and multispectral), long term NIR spectra, root yield, sugar content, and weather data, which together constitute a comprehensive phenomic dataset.

Phenomic selection based on NIR spectra and environmental data enables a high predictive ability for complex traits such as sugar yield. Results of different years indicate that sugar yield and sugar content can be predicted with accuracies of up to 0.93 and 0.97 across entire breeding programs. Different scenarios were tested - predicting untested genotypes in completely new environments or sparse testing of genotypes in environments. The project also harnesses drone imaging to train machine learning models that diagnose diseases like Syndrome Basses Richesses (SBR) in situ. The integration of phenomic selection not only increases plot throughput but also allows breeders to dynamically adapt trial designs to new environments. BeetAdapt aims to accelerate genetic gain and opens new frontiers in sugar beet field trialing and breeding.

Session 2: Current perspectives on weed control and resistance management

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CURRENT DEPLOYMENT AND CHALLENGES OF THE CONVISO® ONE HERBICIDE-BASED WEED MANAGEMENT SYSTEM IN EUROPEAN SUGAR BEET CULTIVATION

Since its first registration in France in 2017, the Conviso® One herbicide has been approved for use in several European countries and by 2026, it has become adopted across many sugar beet growing regions. The system combines the herbicide Conviso® One (foramsulfuron + thiencarbazone-methyl) with ALS-resistant SMART cultivars. This approach offers new opportunities for weed management but also introduces specific requirements and challenges, making it a key topic of discussion within the IIRB Weed Control Study Group.

Compared with conventional weed control strategies, the Conviso® One system offers weed management with potentially fewer applications and a lower treatment index. However, depending on national approvals and practical experience, additional treatments are sometimes required. Conviso® One is effective against certain weed species at more advanced growth stages than conventional herbicides, but some species show reduced sensitivity. The emergence of ALS-resistant weed populations poses a serious risk to the long-term sustainability of the system. To address these challenges, resistance monitoring and diagnostic tools are being developed across different countries. Integrated weed management (IWM) across the arable rotation remains crucial for maintaining the long-term efficacy of the Conviso® One system.

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ACETOLACTATE SYNTHASE (ALS) RESISTANT WEEDS IN SUGAR BEET

With the introduction of thoramsulfuron and thiencarbazone-methyl (Conviso One) as an option for weed control in SMART beet varieties, the appearance of weeds resistant to this chemistry has made an appearance in the sugar beet crop. SMART varieties are an important option for sugar beet growers as they allow fields with high levels of conventional weed beet to be brought back into production so it is essential to preserve the longevity of this chemistry.

ALS resistance in annual broadleaved weed species is considered relatively rare but this is probably related to limited testing. The first incidence of ALS resistance in broadleaved weeds in the UK was identified in the early 2000's in scentless mayweed (*Tripleurospermum inodorum* MATIN), poppy (*Papaver rhoeas* PAPRH) and Common chickweed (*Stellaria media* STEME).

This presentation explains the work carried out by ADAS, BBRO and British Sugar in confirming the presence of ALS resistant poppy (*Papaver rhoeas* PAPRH) weeds in the sugar beet crop, the methods of testing and the importance to sugar beet growers.

Conventional methods of testing relies on the 'pot method' which can take several months from collection of seed to obtaining results, it is also time consuming and costly. A new method being validated by ADAS/BBRO/British Sugar uses molecular testing where leaf samples from weeds that have survived a herbicide application are tested. It is estimated that the turn round time from sampling to results will be 7-10 days.

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Performance of Conviso Smart sugar beet varieties under classical and Conviso One herbicide programmes – smarter beets, better yields?

The Conviso Smart System comprises the Conviso One herbicide (foramsulfuron + thiencarbazone-methyl, both WSSA 2) and ALS-inhibitor resistant, “Smart” sugar beet varieties. Its use has increased rapidly in Germany since 2023, following the renewal of approval to allow the application of 2 x 0.5 L ha^{-1} of Conviso One. Conviso Smart varieties are tested within the established official trial system for variety testing. Since standard sugar beet varieties are fully sensitive to ALS-inhibitors, only classic herbicides are used in these trials. Classic herbicides can cause phytotoxic effects, which do not occur within the Conviso Smart system due to the target-site resistance of the Smart varieties. Our study aimed to quantify the yield impact of phytotoxic effects caused by classic herbicides compared to Conviso One. From 2023 to 2025, a series of 29 field trials was conducted, including 13 Smart varieties registered in Germany or other EU countries. The beets were treated with either Conviso One or a site-specific classic herbicide programme. Two standard varieties were included in the classic treatments. Under classic herbicides, the Conviso Smart varieties showed a yield penalty compared to the standard varieties, but this could be offset in the system with Conviso One (± 0 to +1.96 t sugar ha^{-1}), depending on the active substances and dosages used in the classic herbicide programmes. Interactions between variety and herbicide programme did not occur.

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PARSADA: A FRENCH NATIONAL PLAN TO ANTICIPATE THE HERBICIDE MOLECULES WITHDRAWAL

For last 10 years, many herbicides molecules for field crops have been banned, some of them being essential active substances. Such as the PNRI, PARSADA (Plan Anticipation du Retrait de Substances Actives et Développement d'Alternatives) is a French national program which has the objectives to find non chemical alternatives to the future chemicals potential withdrawal. For the major French crops, the priority has been defined for grass weeding where the situation is particularly problematic (few herbicides available and resistance emergence). This plan is composed of different projects: Gramicible, Gramicombi and PARAD in which ITB has a major contribution. Gramicible for non chemical solutions within crop period, Gramicombi for levers combination at crop system scale, and Parad to get knowledge about weeds eco-physiological characteristics and test robotics solutions. Our institute is currently testing the efficiency of spot/band spraying, mechanical weeding, mixed weeding and false seedling against grass weed. The first results of these experimentations are presented in this oral presentation. In addition to technical results, multi-criteria analyses are conducted to conclude on the economical and environmental impact of these alternatives methods.

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ROBOTIC WEEDING PERFORMANCE: RECENT INSIGHTS FROM THE DIGITAL EXPERIMENTAL FIELD FARMERSPACE

Weeding robots are transforming organic sugar beet production and are moving toward broader adoption in conventional farming. Driven by EU legislation to reduce pesticide use by 50% by 2030, more than 40 models are now commercially available. Traditionally, their performance has been assessed based on weed control efficacy (WCE), crop damage, and herbicide savings. While robots now achieve WCE comparable to chemical methods, challenges remain in crop row detection, minimizing crop damage, in-row hoeing precision, and operating speed, which limit large-scale use.

This study evaluates robotic weeding strategies during the 2024–2025 growing seasons. Field experiments employed high-resolution RGB drone imagery to assess the performance of two commercial robots: Farmdroid-FD20 (FarmDroid ApS, Denmark) and the Farming-GT Series 2024 (Farming Revolution GmbH, Germany). Time-series imagery collected before and after weeding allowed plant-level detection of both weeds and crops, enabling the calculation of weed control efficacy (WCE), weed canopy cover, crop canopy cover, and crop losses. Results indicate that image-based analysis provides an accurate assessment of weeding performance and offers detailed insights into robot-specific strategies, particularly regarding hoeing-unit configuration, navigation timing, and crop growth stage. WCE and weed canopy cover were significantly affected by early navigation timing, specifically when sugar beets reached BBCH stages 10–12, for both systems. This effect appears to be driven by crop losses and reduced competition for weeds. Furthermore, for the Farming-GT robot, deactivation of the spot-spraying unit resulted in approximately 4% higher weed cover compared to the system's standard configuration.

In conclusion, we found that robotic weeding systems with optimized navigation management can achieve weed control efficacy comparable to conventional standards. However, field capacity was not assessed in this study and should be considered in future evaluations. Our findings also highlight the utility of UAV technology as a precise, time-resolved monitoring tool for robotic performance. By enabling optimized weed management while potentially reducing pesticide use, robotic weeding represents a sustainable and efficient alternative for modern agriculture.

3 Rhizomania & Cercospora leaf spot: Fungicide and genetic resistance mechanisms

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RESISTANCE TO RHIZOMANIA: INTERACTION OF THE RESISTANCE PROTEIN RZ2 WITH THE AVIRULENCE PROTEIN TGB1 AND EVALUATION OF THE RESISTANCE STABILITY

The globally widespread beet necrotic yellow vein virus (BNYVV) causes the economically important disease rhizomania in sugar beet. For decades, control relied solely on the resistance gene Rz1. Since the emergence of Rz1 resistance-breaking populations in several countries, the resistance gene Rz2 and its stability are of great importance. Therefore, the aim is to understand the resistance mechanism in detail. In a transient assay in Nicotiana benthamiana it was shown that the resistance protein Rz2 recognizes the viral protein triple gene block I (TGB1) as corresponding avirulence protein. Recognition leads to a hypersensitive response (HR) with cell death (Wetzel *et al.*, 2021). For better characterisation of the interaction, at first colocalisation of both proteins in the cytoplasm and the nucleus was shown. The cytoplasm seems to be the relevant compartment for recognition. Since no direct interaction could be shown in two independent assays (yeast two-hybrid system, bimolecular fluorescence complementation), proximity labelling was established. With proximity labelling it is aimed to identify a potential host protein that is involved in an indirect interaction as third partner. To evaluate the Rz2 resistance stability, bait plant tests with naturally infected soils from Germany, France and the Netherlands were conducted. Rz1 resistance-breaking was confirmed for several soils, but no substantially elevated ELISA values were observed in the Rz1+Rz2 resistant genotype. Sequencing data will show if mutations in TGB1 are present in the Rz1+Rz2 resistant genotype which would indicate first adaptations of the virus population. Here, the conserved NTPase/helicase motifs V and VI are of particular interest. In *N. benthamiana*, it was shown that these motifs are sufficient for recognition by Rz2 whereas alanine exchange of 4 conserved amino acids in motif V circumvents recognition by Rz2.

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GENOME WIDE ASSOCIATION STUDY OF *CERCOSPORA BETICOLA* FOLLOWING REPEATED EXPOSURE TO DEMETHYLATION INHIBITORS REVEAL COMPLEX FUNGICIDE RESISTANCE MECHANISMS

Fungicide-based management remains critical for Cercospora leaf spot (CLS) management in sugar beet. Demethylation inhibitor (DMI) fungicides are currently the most potent class of fungicides available to sugar beet growers for managing CLS. However, the growing prevalence of DMI insensitivity in *C. beticola*, the causal fungus of CLS, threatens long-term fungicide management. Here, the genetic basis of DMI fungicide resistance in *C. beticola* was investigated by integrating large-scale phenotyping with genome-wide association studies (GWAS). A total of 400 representative isolates collected from a field trial in 2020 before and after fungicide applications were assessed for sensitivity to tetraconazole, prothioconazole, difenoconazole, and mefentrifluconazole using a microplate-based assay. Shifts in the effective concentration that inhibited 50% growth compared to the control (EC50 values) revealed reductions in sensitivity among isolates collected after field exposure. These data confirmed field-level selection pressure and established a robust phenotypic foundation for further genetic studies, and a subset of 94 representative isolates was selected for whole-genome sequencing. Multiple SNPs associated with reduced DMI sensitivity were uncovered by GWAS, including several intergenic loci near genes encoding MFS transporters, Zn2-Cys6 transcription factors, and RTA1-like proteins. Together these findings suggest a complex, polygenic landscape of fungicide resistance involving regulatory and efflux-based mechanisms in addition to target site mutations.

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INVESTIGATING GENETIC DIVERSITY AND DMI RESISTANCE IN FRENCH *CERCOSPORA BETICOLA* POPULATIONS WITH BOTH NEUTRAL AND SELECTED GENETIC MARKERS

An important part of a species' evolutionary capacity relies on the genetic diversity that exists within its populations. The study of neutral genetic markers gives us information on the biological characteristics of the species, while the study of selected markers provides clues to the evolutionary paths taken in response to selection pressure. Cercospora leaf spot, caused by *Cercospora beticola*, is one of the major foliar diseases in sugar beet. In France, favorable climatic conditions for its growth combined with the evolution of fungicide resistance have increased its harmfulness. Here we have investigated both neutral and adaptive genetic diversity of *C. beticola* populations in France using 12 microsatellite markers (Vaghefi *et al*., 2018) and high throughput sequencing approach on a gene involved in fungicide resistance to sterol demethylation inhibitor (DMI), respectively. DMI are a key family to achieve *C. beticola* control. This group acts through inhibition of 14α-demethylase (CYP51) and their extensive use have resulted in the evolution of resistance. A total of 710 isolates collected in northern France in 2019 and 2020 were genotyped with the microsatellite markers. We found a high level of genetic and genotypic diversity and low population genetic structure. Those results points towards large populations sizes, frequent sexual reproduction and high levels of gene flow between populations at the studied scale. In addition, a high throughput sequencing approach has been developed to simultaneously detect and quantify CYP51 mutations involved in DMI resistance in *C. beticola* populations. After validation on a controlled mixture of strains, this method has been used on French populations collected from 2021 to 2025 in commercial and trial fields. We identified 8 mutations, including 7 previously described as involved in DMI resistance. Two of these mutations had both a high occurrence and a high frequency in the populations studied. An original mutation was also detected, but would require further phenotypic validation.

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HIGH RESISTANCE IS NOT ABSOLUTE: LESSONS FROM *CERCOSPORA BETICOLA* EPIDEMICS IN AUSTRIAN SUGAR BEET

In 2024, it was observed for the first time across Austria that sugar beet varieties with high resistance (CR 2) to *Cercospora beticola* exhibited a similar disease level under infection pressure as moderately susceptible varieties (CR 4). This observation prompted a detailed analysis of Austrian fungicide trial data from the past seven years. The objective was to determine which factors influenced disease occurrence, which had the strongest effect on the epidemic development of *C. beticola*, and to what extent recommendations for future control strategies could be derived.

The analysis revealed that in the extreme infestation year 2024, the prevailing weather conditions in combination with early canopy closure were causal for the early primary infection and the rapid disease progression. With the introduction of highly resistant varieties (CR 2) in 2021, the average yield level increased by about 50%. The yield gap between CR 2 and CR 4 varieties proved to be greater than that between CR 4 and CR 6. This yield advantage was largely attributable to the absence of *C. beticola*. However, under the disease pressure of 2024, both the overall yield level of CR 2 varieties and the yield differences between resistance groups declined markedly. At the same time, the relative yield benefit of fungicide applications became smaller as overall yield levels increased. However, when highly resistant varieties were infected, the benefit of fungicide treatments increased again.

It can therefore be concluded that sugar beet varieties with high *C. beticola* resistance play a central role in yield stability in Austria, but its effectiveness can only be sustained in combination with a highly effective fungicide strategy.

Session 4: Virus Yellows: Breeding, disease control and agronomic tools

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VARIETY TOLERANCE, THE KEY TO UNLOCKING IPM STRATEGIES FOR VIRUS YELLOWS

The virus yellows disease complex continues to be the most significant threat to sugar beet production in the United Kingdom, as well as to many other countries in Northern Europe. Vectored by aphids, these viruses are transmitted into the sugar beet each spring and can cause up to 50% yield loss. Since the removal of neonicotinoid seed treatments, there has been a significant effort made in developing varieties which are tolerant to one, or ideally all viruses in the disease complex (e.g. beet chlorosis virus, beet mild yellowing virus and beet yellows virus).

BBRO has supported this breeding target through delivering its annual programme of inoculated experiments, including rigorously assessing current and future varieties under uniform and total infestation. Using these data, BBRO now delivers a ranking system for industry which classifies varieties with a virus yellows tolerance claim with a score which relates to their relative yield loss to each virus. This information will give farmers more understanding of the possible performance of each variety under VY infection, allowing for more informed variety selections and realtime IPM decisions.

Giving growers this vital tool will set expectations for yields for such varieties and encourage the use of wider IPM techniques ultimately reducing reliance on chemical insecticides, leading to a more sustainable strategy in the fight against VY.

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BREEDING SUGAR BEET FOR TOLERANCE TO MIXED YELLOWING VIRUSES

Yellowing viruses represent a major threat to the Western European sugar beet sector, causing significant yield losses and quality reductions. United Beet Seeds has conducted extensive screening of their germplasm collections to identify tolerance against various yellowing viruses affecting sugar beet crops. Through comprehensive evaluation methods including visual field assessments, drone-based scoring systems, and molecular analyses of viral load quantification, we have identified tolerant and resistant genotypes across all major yellowing virus species. Additionally, we have identified quantitative trait loci (QTL) regions associated with resistance to the different viruses, providing valuable genetic markers for breeding programs.

Under natural field conditions, mixed infections involving multiple yellowing viruses are frequently observed in sugar beet crops. To better understand the complex dynamics and impact of these co-infections, United Beet Seeds and Groupe Florimond Desprez have initiated collaborative research investigating potential synergistic and competitive interactions between viruses in sugar beet plants. Our research program includes mixed infection scenarios, providing crucial insights into how different virus combinations affect plant performance.

These comprehensive screening efforts have successfully identified sugar beet genotypes with demonstrated tolerance under mixed infection conditions.

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PNRI-C: DEVELOPING STRATEGIES TO MANAGE BEET YELLOWS DISEASE

The Consolidated National Research and Innovation Plan (PNRI-C), launched in 2024 as a follow-up to the PNRI (2021–2024), aims to further develop solutions to control beet yellows disease. This viral disease, caused by four distinct viruses, is transmitted by the aphid *Myzus persicae*. In this new program, the network of pilot experimental farms located across the French sugar beet production area is maintained to continue assessing the field efficacy of potential control strategies. To date, companion plants represent the most effective solution after conventional foliar aphicides, with approximately 30% reduction in aphid populations and yellows symptoms. Chemical mediators, including allomones and pheromones acting on aphid behavior, as well as biocontrol products, are also being tested, although results still need to be consolidated. Releases of lacewings (*Chrysopidae*) have shown promising effects, but remain costly and logistically challenging to implement on a large scale, despite significant progress in mechanised release techniques over the past two years. Our work shows that no single solution is sufficient to manage beet yellows disease, and that effective management will rely on a rational combination of several available tools. Reducing viral reservoirs and vector aphids is also identified as a key prophylactic strategy to limit virus transmission between cropping seasons in a given area. This involves the destruction of overwintering beets (volunteers in cereals, harvest remnants) and host plants such as phacelia, which has been identified as carrying beet yellows viruses. At the end of the program, the aim is to provide growers with operational and economically viable protection strategies to sustainably mitigate the impact of beet yellows disease.

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VIRBICON: INTEGRATED APPROACHES TO UNDERSTAND AND MITIGATE VIRUS YELLOWS IN SUGAR BEET CULTIVATION IN BELGIUM

Virus yellows represent a growing threat to sugar beet cultivation in Belgium. This project investigates virus prevalence, virulence, and transmission efficiency of *Myzus persicae*, as well as identification of risk factors. Virus prevalence appears to be influenced by landscape structure including early sowing dates, soil nutrient, and surrounding crop composition. Regarding virulence, a high-throughput sequencing and qPCR analyses revealed genetic diversity for BMYV, BYV, and BChV, with BChV being the most variable. Mixed infections increased symptom severity and virus accumulation, confirmed via hyperspectral imaging and virus quantification. Biological control strategies are explored, including the use of aphid-killing bacterial strains. Preliminary results show significantly reduced aphid populations and disrupted feeding behavior, suggesting potential for virus transmission suppression. The above findings provide crucial insights for sustainable control of virus yellows in sugar beets.

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THE EFFECT OF SEED TREATMENTS ON FOLIAR INSECT PESTS IN YOUNG SUGAR BEET PLANTS

Aphids (*Myzus persicae* and *Aphis fabae*), beet leaf miners (*Pegomya betae*), flea beetles (*Chaetocnema* spp), thrips (Thrips spp) and plant bugs (*Lygus rugulipennis*) are examples of important foliar insect pests in sugar beet in Europe. These pests damage foliage and reduce plant growth, while aphids also transmit yellowing viruses (BYV, BMYV, BChV), potentially causing yield losses of up to 50%. Currently, control of beet leaf miners, flea beetles, and thrips relies on pyrethroid sprays, which negatively affect beneficial insects. Aphids are managed with systemic insecticides such as flonicamid, but their efficacy is limited to a few days during early growth stages.

Between 2022 and 2025, ring trials were conducted across Europe to evaluate new insecticide seed treatments targeting soil pests. The most important data from 2022 and 2023 were presented at the 79th IIRB congress in Brussels in 2024. However, foliar pests were also observed in these trials, and additional aphid-specific trials were carried out in Belgium, UK and the Netherlands.

Results indicate that certain seed treatments can suppress foliar pests effectively up to the fourth leaf stage. This presentation will highlight key findings and discuss the implications for integrated pest management strategies in sugar beet cultivation.

This research is part of the IIRB project group ‘Soil Insect Pests’, a collaboration between sugar beet research institutes and breeding companies.

Session 5: Beet weevils & Cicades I

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SEARCH FOR ALTERNATIVE CONTROL SOLUTIONS AGAINST THE BEET WEEVIL, *LIXUS JUNCII*

The beet weevil *Lixus juncii* Boheman is a major pest affecting French beet production (sugar beet, vegetable beet and seed beet). The UBELIX research project, co-funded by the French Ministry of Agriculture and Food Sovereignty from 2022 to 2025, aimed to find alternative control solutions for this insect. The main focus of this project was the use of service plants.

Work carried out in UBELIX showed that certain varieties are more attacked by *L. juncii* than others, both in terms of egg-laying punctures on the stems and larval galleries in the beet roots. In relation with these observations of infestations, the differentiated expression of certain metabolites potentially linked to plant defence was observed. The morphology of the beetroots may also play a role in the levels of attack observed, with larger diameter stems generally having more egg-laying holes.

In relation to plant morphology, trials have shown that a trap beetroot with greater vegetative development than the beetroot to be protected (e.g. a fodder beetroot trap to protect a sugar beetroot) attracted more female weevils during spring egg-laying. However, the objective that has not yet been achieved in the project is to maintain egg-laying pressure on trap plants without the weevil then migrating to the beet to be protected. Trials combining different approaches (push-pull) to achieve this objective have been initiated but have not yet led to the development of an operational control strategy against this pest.

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Decoding the sugar beet weevil: molecular resources for RNAi-based pest control

The sugar beet weevil (*Asproparthenis punctiventris*) is considered one of the most important early season pests of sugar beet in Central and Eastern Europe. A promising alternative to conventional insecticides involves RNA interference (RNAi), a conserved gene-silencing mechanism found in eukaryotes. RNAi-based strategies have already proven to be successful in controlling pests such as the Colorado potato beetle. Moreover, RNAi enables species-specific pest control, thereby minimizing off-target effects and environmental impact. However, the development of RNAi-based products requires the generation of comprehensive genomic and transcriptomic data for both the target and non-target organisms. To bridge this gap, DNA and RNA were extracted individually from 32 adult sugar beet weevils collected in Lower Austria. High-fidelity sequencing combined with Hi-C data was used to generate the first reference genome of A. punctiventris. The assembled genome spans 2.26 Gbp with a scaffold N50 size of 115.5 Mbp. This high-quality reference sequence is used to construct a genome-guided transcriptome, with the objective of enabling the identification of RNAi target genes. The transcriptomes of *A. punctiventris* individuals are to be compared with selected and non-target organisms (e.g. ladybird beetles, ground beetles) to rule out potential off-target effects of RNAi constructs. These molecular resources offer valuable insights into the biology of the sugar beet weevil and co-occurring species and provide a foundation for further RNAi-based developments for effective pest management.

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Why Sugar Beet RTD persists in Serbia: the newly revealed Sunflower–Wheat lifecycle of *Reptalus quinquecostatus*

Adults of *Reptalus quinquecostatus* (sensu Holzinger *et al.* 2003) are broadly polyphagous, occurring in Serbia on trees, weeds, and different crops, but their nymphal host plants remain unknown. Outbreaks of '*Candidatus* Phytoplasma solani' (CaPsol, 16SrXII-A) diseases such as RTD in sugar beet raise questions about the origin of the abundant adult planthopper populations across affected crops. A three-year survey in Serbia (2023–2025) combining field monitoring, emergence cages, and molecular tools, showed that *R. quinquecostatus* completes its nymphal development in sunflower–wheat rotations. Third-instar nymphs were found on sunflower roots in September, fifth-instar nymphs on wheat roots the following May, and the first adults emerged from wheat in June before dispersing to other crops. Oviposition on sunflower and successful emergence from wheat were repeatedly confirmed. CaPsol-infected nymphs on sunflower and adults from wheat indicate that *R. quinquecostatus* populations completing their life cycle in sunflower–wheat rotations are key drivers of sugar beet RTD. While a crop rotation–based lifecycle has been documented in Serbia for *Reptalus panzeri* (maize–wheat), and adults of both planthopper vectors of CaPsol often occur in sympatry across crops, this study provides the first evidence of such a lifecycle for *R. quinquecostatus*. These findings add complexity to epidemiology of RTD in sugar beet and emphasize the difficulty of managing CaPsol diseases when vectors persist within core crop rotations dominated by sunflower, maize, and wheat.

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DISTRIBUTION AND DYNAMICS OF CIXIID VECTORS TRANSMITTING PHLOEM-RESTRICTED PATHOGENS IN AUSTRIAN SUGAR BEETS

Syndrome Basses Richesses (SBR) and Rubbery Taproot Disease (RTD) threaten sugar beet production through infection by ‘*Candidatus* Arsenophonus phytopathogenicus’ and ‘*Candidatus* Phytoplasma solani’ related strain 16SrXII-A and -P. Their epidemiology in Austria remains poorly defined. We monitored cixiid populations from 2023 through 2025 at multiple sites across the main growing regions, combining morphological identification with molecular analyses to characterize species diversity and pathogen carriage. Symptomatic plants were analyzed for pathogen load and quality parameters, such as glucose content.

Reptalus spp. dominated cixiid populations across all monitoring sites, with *R. artemisiae* being consistently the most abundant species. Molecular assays confirmed its capacity to transmit both ‘*Ca.* Arsenophonus phytopathogenicus’ and ‘*Ca.* Phytoplasma solani’. Infection rates in *R. artemisiae* ranged from 1.6-6.2%, markedly lower than those recorded for *Pentastiridius leporinus* (8-28%). Prevalence of cixiid populations varied substantially among fields and seasons, reflecting local environmental conditions and vector population dynamics.

The widespread occurrence of *R. artemisiae* in the Pannonian plain, together with its ability to vector multiple phloem-restricted bacteria, mirrors disease patterns described in Serbia. Co-occurrence of ‘*Ca.* A. phytopathogenicus’ and ‘*Ca.* P. solani’ (16SrXII-A and -P) and their transmission by both *R. artemisiae* and *P. leporinus*, complicate outbreak prediction and management. These findings highlight the need for proactive vector surveillance and integrated disease monitoring to safeguard sugar beet production in Central Europe.

Session 6: Cicades II & SBR Complex

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DIRECTED SEQUENCING OF PLANT SPECIFIC DNA IDENTIFIES THE DIETARY HISTORY OF *PENTASTIRIDIUS LEPORINUS*

Pentastiridius leporinus (Hemiptera: *Cixiidae*) is the main vector of an emerging and fast spreading sugar beet known as , the syndrome 'basses richesses' (SBR) disease in Central Europe. This disease is caused by the γ-3-proteobacterium '*Candidatus* Arsenophonus phytopathogenicus' and the phytoplasma '*Candidatus* Phytoplasma solani' which are exclusively transmitted by planthoppers. The disease can lead to a significant loss of sugar content and yield. Monitoring of this insect vector is important for managing SBR disease. *P. leporinus* has a univoltine life cycle in Central Europe. It has adapted to sugar beet and cereals including winter wheat (*Triticum aestivum*) and barley (*Hordeum vulgare*) in crop rotations. The host shift from reed grass (*Phragmites australis*) to sugar beet enabled the spread of this insect vector and SBR disease. However, the other source plants of *P. leporinus* are unknown. In this study, the source plants were identified in the adult *P. leporinus* collected from sugar beet fields at early-season flight. For this, DNA was extracted from the insects and plant genes (trnF and ITS) were amplified by PCR and sequenced. The results showed that various source plants including *Convolvulus arvensis*, *Urtica dioica*, *Lolium perenne* and *Prunella vulgaris* has been visited by the insect vector prior to its immigrating to sugar beet fields. This study indicated application of gut content analysis to identify the wild plants and both pathogens in *P. leporinus* and to examine seasonal changes in host shifts by this insect vector.

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IMAGE-BASED AUTOMATED IDENTIFICATION OF SBR AND STOLBUR-TRANSMITTING PLANTHOPPERS ON STICKY TRAPS

Accurate identification and classification of insect vectors are critical for managing plant diseases such as Syndrome 'basses richesses' (SBR) and Stolbur in sugar beet fields. Traditional methods used to distinguish closely related planthopper species, including *Pentastiridius leporinus*, *Hyalesthes obsoletus*, and *Reptalus* spp., belonging to the *Cixiidae* family, rely on morphological evaluation by expert or molecular assays.

These methods, however, are time-intensive, infrastructure-demanding, and low-throughput. Leveraging recent advancements in artificial intelligence, particularly deep learning, we developed two convolutional neural network models to address these challenges and automatically identify planthopper species from imaging data. Both models were finetuned from a model with the inception v3 architecture that had been pretrained on the ImageNet dataset.

The first model trained on more than 45,000 images distinguishes between the Cixiid family and other insect orders appearing in sugar beet fields, achieving an overall accuracy of 89% on the test set. The second model trained on more than 1500 images focuses on intra-family classification, differentiating *P. leporinus*, *H. obsoletus*, and *Reptalus* spp., with a remarkable overall accuracy of 99% on the test set. Interestingly, based on class activation maps, these models successfully identified critical morphological features, including wing structure, pronotum aspect, and tarsus configuration, to make accurate predictions. Furthermore, molecular analyses including PCR and sequencing of the cytochrome oxidase gene were conducted to confirm that all insect classes were correctly labelled prior to model training. Results of the molecular analysis showed 100% labelling accuracy, thus increasing confidence in the model.

The potential of artificial intelligence methods for high-throughput, accurate insect identification is demonstrated in this work, which will help agricultural systems monitor and manage vectors more quickly and precisely.

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Identification of infestation patterns in the SBR-RTD disease complex: the base for resistance breeding and agronomic control measures

'Syndrome des Basses Richesses' (SBR) and 'Rubbery Taproot Disease' (RTD) form a sugarbeet disease complex that is spreading in specific regions of Western and South-East European countries. Certain species of glass-winged planthopper are associated as vectors for two phloem-limited pathogens causing both plant diseases.

Understanding the impact of the initial infection-timepoint and duration of planthopper exposure on disease severity and yield reduction are crucial for development of plant protection strategies for the SBR-RTD disease complex, specific knowledge, however, is rather limited.

For both, agronomic control strategies and the development of tolerant varieties, a standardized method is required to quantify disease severity and to evaluate yield losses. This is important to reliably determine and compare the tolerance of genotypes across locations and years, as well as to determine the effectiveness of agronomic control measures.

In 2024 and 2025, different methodical trials in a randomized design were conducted at the KWS Breeding Station Seligenstadt, Germany. Periodical opening and closing of net covers allowed planthopper exposure in different, defined periods and thus the investigation of respective yield effects. Combined with daily planthopper monitoring data, the given results can give important indications about the infestation-loss-ratio. The trials may provide a method to quantify disease severity, improve the knowledge for genetic disease tolerance screening as well as the evaluation of agronomic control measures.

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AGRONOMIC PATHWAYS TO MITIGATE SYNDROME DES BASSES RICHESSES (SBR): INTEGRATING CULTURAL PRACTICES AND VECTOR CONTROL FOR YIELD STABILIZATION

The SBR complex is caused by two pathogens, *Ca.* Arsenophonus phytopathogenicus (ARSEPH) and *Ca.* Phytoplasma solani (PHYPSO), which are mainly transmitted by a vector the planthopper *Pentastiridius leporinus*. Severe symptoms (chlorosis, wilting, rubbery taproots) lead to yield losses up to 70%. SBR is an existential threat to sugar beet production in affected areas. Growers urgently need a control strategy compatible with current farming practices. Due to the mobility and long activity period of the vector a novel on-farm trial concept was developed, based on coordinated, farmer-led strip trials. It balances practical feasibility with experimental reliability. As the subplots must be sufficiently large not all treatments can be tested at once. Using an incomplete block design, two treatments and the untreated control were tested at each trial site. We tested different insecticides, biostimulants, fertilizers and repellents individually and in combination to improve yields and control planthopper activity. In so-called model regions, all farmers in a defined area participated in the large-scale project. They adjusted their crop rotations from winter cereals to summer crops after beets to reduce the planthopper population. In addition, they followed a universal treatment regime during the growing year, which included insecticides, biostimulants and foliar fertilizers. Our findings and experiences in the projects underscore that it is possible to stabilize yields through a targeted combination of spray applications and crop rotation measures. Integrated strategies in the trial and model regions' integrated strategy led to considerably higher yield increases than individual products.