



KliWiResse

Klima-Widerstandsfähige Rebsorten zur Sicherung des Ertrags

Newsletter #4 (October 2023-March 2024)

UPCOMING EVENTS

May 14th 2024

KliWiResse Project Meeting III, Institut de Biologie Moleculaire des Plantes (IBMP), CNRS, 12 Rue du Général Zimmer, 67084 Strasbourg

<https://www.ibmp.cnrs.fr/>

Project meetings:

30.11.2023: The second project meeting of KliWiResse was held at JKI. All project partners attended the meeting to present and discuss the results from the experimental season 2023. Several new methodologies have been developed that can now be used in the coming growth season. Several large-scale experimental campaigns were discussed and planned, and the necessary exchange of materials and research visit were defined. The coordinator of the sister project Wivitis, Dr. Katja Herzog, was present as well and fields of interaction were discussed. The meeting took place in a working atmosphere and ended with a

tasting of products from the experimental vineyard of the JKI including the newest generations of PiWis, but also European Wild Grapevines.

Scientific achievements:

ScreenSYS In the project part which aims in developing a protocol for production of double haploid grapevine plants from microspores, ScreenSYS so far developed a suitable flower identification procedure to isolate microspores at their optimal developmental stage and established the optimal base culture medium. Medium optimization was continued by testing some of the chemicals available at ScreenSYS which were shown to increase microspore viability in other plant systems or resulted in induction of microspore proliferation, the first critical step to generate multicellular structures from which double haploid plantlets can be generated. Some of the chemicals applied significantly increased the viability of grapevine microspores during cultivation. Additional combinations with plant growth regulators resulted in the first observations of initial, potential cell divisions. As these investigations depend on the availability of fresh flower material, planned next experiments will be performed with the onset of grapevine flowering. Some experiments will be done before with greenhouse-grown material provided by our associated partner WBI.

The second project part relates to the investigation of basic physiological mechanisms determining heat and drought tolerance at the single cell level. For this, ScreenSYS aims in establishing a cell culture model system for grapevine genotypes with different tolerances. To establish a robust system for the intended experiments (e.g. genotype comparisons, effect of heat-induced secondary metabolites on heat tolerance), additional optimizations were done with a cell culture from Hördt which included correlation of cell yield and viability with digestion conditions, cell culture cycle, and optimization of image recording settings and quantitative analyses procedures. The system is now ready to conduct comparative and physiological experiments which will be initiated.

KIT at Karlsruhe, Germany has been analysing the data from the last vegetation season. In addition to the Bachelor thesis by Ruslan Eliseev, the Master thesis by Paula Venzke could be successfully concluded. She could demonstrate the superior heat tolerance of the *sylvestris* genotype Hördt 29 over Riesling by several physiological and molecular parameters. A central finding was that the stomata open under heat stress in both genotypes, which allows to lower leaf temperature. However, while Riesling needs to keep stomata open over a long time, thus, losing a lot of water, Hördt 29 can already shut them after one day, probably due to its more efficient activation of heat-shock genes. This allows Hördt 29 to retain water even under heat stress. Because this genotype has become so important, a high-quality de-novo

genome annotation was launched. During the winter period, when plant material is not available, a new Bachelor student, David Jacob, is working with cell cultures from different grapevines, including Hördt 29. Making use of the genome database GrapeKIT, he could identify a specific version of galactinol synthase, an enzyme responsible for producing the precursor of the sugar raffinose, a powerful antioxidant which is known to be crucial for the tolerance to osmotic stress. He could show that the expression of this gene is induced more vigorously in cells of Hördt 29 as compared to the other grapevine genotypes.

IBMP at Strasbourg analysed a large comparative experiment between heat-tolerant wild grape Hördt 29 and heat-sensitive cultivated Riesling generated by KIT in summer 2023, is being deeply analysed by IBMP Strasbourg from an hormonal and specialized metabolic standpoint by Dr. Thierry Heitz, Ms. Dennisse Beltran and (visiting from KIT), Ms. Paula Venzke. Early, intermediate, and late timepoints were considered to search for differential adaptation responses in leaves. To our surprise, the abundance of some jasmonate hormonal compounds was found to be reduced in both varieties by heat while two other stress hormones, abscisic and salicylic acids were mostly unaffected by this stress. A similar trend was seen in an independent experiment on isolated leaf discs provided by Mr. Ruslan Eliseev at KIT). A computational metabolomics pipeline was then implemented for the non-targeted analysis by high resolution LC-MS/MS of the comparison between Hördt 29 and Riesling. We were able to identify metabolites belonging to different chemical classes that accumulated differentially in the two varieties either prior to or during heat stress and we followed these changes over time. In the next step central metabolism will be analysed in detail by GC-MS. For the coming season, a new experiment will be conducted at KIT for analysis at IBMP where heat stress will be combined with drought to mimic summer conditions in the vineyard.

JKI at Siebeldingen, Germany has been focusing on establishing and optimising a phenotyping pipeline to study the resilience of grapevine varieties to sunburn, which includes application of combined heat and UV stresses (Dr. Nagarjun Malagol, Dr. Oliver Trapp). In 2023, this pipeline was already applied to screen reference varieties, bi-parental populations, and a set of core selections during the last season (2023). These tests serve as a preliminary dataset, and these genotypes will be re-screened and validated in the upcoming season. In these screenings, *Vitis sylvestris* accessions from the Ketsch peninsula have. In the upcoming season, these populations will be re-analysed for sunburn and promising candidates will already be used in crosses in order to generate segregating bi-parental populations. Efforts are also being made to develop AI-based tools for the quantification of berry sunburn, as manual evaluation is time-consuming and prone to bias. For image acquisition, an automatised robotics system was developed and established, capable of capturing 1800 single berry images per hour and, thus, enabling high throughput. Utilising this system, high-quality images were captured to train an artificial intelligence (AI) based image analysis model, which will be tested and validated in the upcoming season. The AI tools developed at JKI can screen a large number of grapevine germplasm, providing crucial phenotyping data for quantitative trait locus analysis. Consequently, sunburn resilience in the lab and field is analysed through genetic mapping and QTL analysis at JKI. Molecular markers developed in QTL regions can then be used in breeding programs to create novel sunburn-resilient grapevine cultivars.

FiBL at Frick has monitored the performance of different grape cultivars (including traditional and PiWi varieties) at the vineyards of the institute during two heatwaves. Profiling of disease and solar-stress symptoms have been completed, the physiological and oenological analyses are underway. Disease and solar-stress responses were also monitored on pilot farms in the partner cantons of Basel-Landschaft (BL), Jura (JU) and Aargau (AG). Here, analyses of leaf resources and oenological parameters are in progress. In the FiBL experimental fields, considerable cultivar differences in solar-stress resilience could be established. The spectrum ranged from the absence of symptoms, over a few brown spots to more severe responses, such as partial desiccation of the leaf till total necrosis of leaves and apices. Since the genetic approach prepared by KliwiResse will take time, short-term strategies based on changes in agricultural practice were explored. Specifically, the preparation Ferti-Roc (finely ground rock powder containing calcium and silicon) was applied to PiWi and traditional grapevine varieties to assess potential mitigation of stress symptoms. In fact, treated plants showed improvement in oenological parameters and assimilable nitrogen, more nitrogen, phosphorous, and potassium in the petioles, and, hence, improved accumulation of key macro-nutrients. The on-farm trials with Ferti-Roc in the cantons of BL, AG, and JU were evaluated by carbon isotope analysis in the grape sugars as read out for integrated water stress. These preliminary results show that despite the three heat waves in the season of 2023, the PiWi varieties did not exhibit severe water-stress symptoms, while Riesling was confirmed as most stressed variety. Assimilable nitrogen was below 80 mg/L in all those varieties with exception of one which ensures a good fermentation kinetics. Thus, Ferti-Roc can be recommended as efficient mitigation strategy. For the coming season, new cuttings have been prepared to measure additional metabolic parameters extending the data set from the previous season.

Interactions

1. KIT-ScreenSYS: Leaf material from the core set of genotypes as well as inflorescences for the double haploidisation will be transferred starting from April.

2. KIT-JKI: Canes from the core selection were delivered to KIT for rooting preparing the next experimental campaign on heat and drought stress starting in April

3. KIT-IBMP: Data from metabolomics and jasmonate profiles collected at IBMP from the experimental material sampled at KIT during the experimental campaign 2023 were analysed and shared with KIT.

4. FiBL-KIT-JKI: Material from the FiBL PiWi collection has been sent to the partners and is included in the studies on heat stress and sunburn. Sampling of leaf material from the FiBL rootstock collection for carbon isotope analysis has been organised. Peter Nick participated in the Schweizer Bioweintagung in Olten March 13, organised by FiBL

5. WBI- ScreenSYS: Material provision by WBI for floral buds in the right stage for somatic embryogenesis for the next season has been organised.

7. JKI-IBMP: Metabolic profiling at IBMP of the material used for phenotyping at JKI has been organised

Website:

The KliWiResse website is currently complemented with a section on the progress achieved by the partners, this is integrated into the section research.

Newsletter:

Newsletter #5 is planned for September 2024.

Outputs:

JKI

- 11.01.2024 – Nagarjun Malagol et al., “Mapping and characterization of a new resistance to downy mildew in an East Asian grapevine genetic resource”, Annual Vitigen3 Meeting, San Diego, California, USA
- 14.01.2024 – Nagarjun Malagol et al., “Developing a SCNN model for downy mildew disease quantification and identifying a novel resistance locus in an East Asian Vitis species”, Plant and Animal Genome Conference, San Diego, California, USA
- 23.02.2024 – Oliver Trapp und Reinhard Töpfer, “Quo vadis Calardis? – Neue Rebsorten des Geilweilerhofs”, Badischer Rebveredlertag, Rust, Germany
- 02.03.2024 – Trapp, Oliver, “Die Rebenzüchtung und PIWI-Sorten des Geilweilerhofs”, PIWI-Präsentation für Nahe-Winzer, Wallhausen, Germany
- 03.-04.03.2024 – Eurovino Messe, Karlsruhe, discussions with Federal Minister of Agriculture, Cem Özdemir

IBMP

- 14.05.2024 – Project Meeting at the IBMP in Strasbourg
- 16.-19.02.2024 – participation with Dominique Levitte (FiBL) at the 31ème Salon des Vins des Vignerons Indépendants - Strasbourg
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KIT

- 28.10.2023 – Public talk in frame of the Samstagsuni at the University of Freiburg “Weinrebe und Menschen – wie es war, wie es sein wird“, around 300 people attended.

- 06.12.2023 – Presentation of Kliwiresse by Peter Nick in frame of the Interdisciplinary Studies Sustainability at the University of Freiburg (together with René Fuchs, WBI)
- 31.01.2024 – Public Roundtable Discussion at KIT on Plant Science and Sustainability
- 13.03.2024 - Public talk on the project at the Bioweinbautagung in Olten (together with FiBL)
- 13.03.2024 – Second event of Weinbau und Klimawandel – Zusammen schaffen wir das in Olten (together with FiBL) with winegrowers and nurseries from Switzerland, France, and South Germany.

FiBL

- 15.-16.02.2024 – presentation of project at BioFACH in Nürnberg by Dominique Levitte
- 16.-19.02.2024 – presentation of Kliwiresse by Dominique Levitte at two days at the 31ème Salon des Vins des Vignerons Indépendants – Strasbourg (together with Thierry Heitz, IBMP)
- 13.03.2024 - Organised the Bioweinbautagung in Olten and the second event Weinbau und Klimawandel – Zusammen schaffen wir das.

Surveys: The questionnaire for winegrowers developed in cooperation between KIT, FiBL, and Weincampus Neustadt was used for a third poll organised by FiBL in frame of the Bioweintagung in Olten.