KliWiResse

Klima-Widerstandsfähige Rebsorten zur Sicherung des Ertrags

Newsletter #6 (October 2024-March 2025)

UPCOMING EVENTS

April 16, 2025

KliWiResse Project Meeting V, Joseph Gottlieb Kölreuter Institute of Plant Sciences, Karlsruhe Institute of Technology

www.jkip.kit.edu/botzell/

Project meetings:

24.10.2024: The project partners assembled this time at ScreenSYS in Freiburg, all partners were attending. The meeting lastet for a day, where results from the closed vegetation period were presented, discussed and the experiments for the coming year were agreed and coordinated. After the presentation, the automised high-throughput microscopy platform was demonstrated, by which ScreenSYS screens chemical libraries with respect to their ability to induce embryogenesis. The next meeting is planned in the spring in Karlsruhe at partner KIT-JKIP.

Scientific achievements:

KIT member Manasi Nabar spent two months at the lab of partner IBMP (Thierry Heitz) to perform targeted and non-targeted metabolomics on the samples collected from the heat and drought experimental campaign comparing the sensitive Riesling and the tolerant sylvestris Hördt 29. The non-invasive stress monitoring using the miniPAM system has been completed (Bachelor thesis Vanessa Vrbancic) for heat and drought stress and was complemented by screening of root architecture using the WinRhizo technology (Manasi Nabar). Here, the tolerant sylvestris Hördt 29 turned out to show a relatively small root system, meaning that, here, the resilience resides in the upper part of the plant. Two rootstock varieties were included as well. Selektion Oppenheimer 4 (SO4) turned out to show a good root system that persisted under drought stress. Nevertheless, the photosynthetic parameters were poor. In contrast, Börner showed a poor root system, but performed better in terms of photosynthesis. A comparison of combined heat and drought stress in Riesling versus sylvestris Hördt 29 revealed that the combination of both factors represents a separate quality, and the plant response cannot be derived from adding up the stress components. In some cases (jasmonate response gene JAZ1), the components even acted antagonistic, in other cases (heat-shock protein 20), they added up, while some genes stopped to respond to a stress component, when the other stress component was present. Additional 40 genomes from PiWi varieties, rootstocks, and wild species (Ruslan Eliseev, Sebastian Eggers) have been sequenced and are currently integrated into the GrapeKIT genome database (Sumanth Mutte). The samples from the rootstock study conducted at FibL in September (Manasi Nabar, Michael Riemann) are currently probed for carbon isotope ratios. The study by Elnaz Zareei on the role of nitrogen status on climate resilience (Georg-Forster fellowship) revealed that the outbreak of symptoms of Grapevine Trunk Disease, promoted by drought stress, can be mitigated by increasing the nitrogen supply. Likewise, the mode of action of beneficial microbes on resilience (Islam Khattab, Aria Aghayan) has advanced to dissection of the molecular mechanisms. Here, Islam Khattab and Peter Nick were successful in obtaining a EUCOR Seed Money project to explore plant microbe interactions in climate resilience. Further partners are the University of Basel (Pascale Flury) and the UHA Colmar (Julie Chong).

ScreenSYS. In its challenging efforts to develop a protocol for generating doubled haploid grapevine plants, ScreenSYS benefits from its experience with other plant systems, which are also being studied within the company. In addition to chemical compounds already identified for grapevine and applied as part of a long-duration treatment in the protocol, the company has also discovered other compounds that are effective when applied as short-term pulses. The correct combination of these two treatment types has proven essential for inducing microspore proliferation in

other plant species. Building on this insight, ScreenSYS has begun applying selected compounds to greenhouse-grown grapevine flower material to gain experience and prepare for the upcoming main vegetation period. With the next round of high-quality donor plant material, ScreenSYS is confident that optimal combinations of both chemical groups can be identified—paving the way for the first successful inductions of microspore proliferation in grapevine.

Heat and drought stress damages cells also via the accumulation of reactive oxygen species (ROS). ScreenSYS plans to investigate how heat and drought stress induces ROS accumulation in plant cells and if this relates to genotype-specific resilience. Our focus is on two plant genotypes with contrasting heat tolerance. We are currently establishing a protoplast assay to quantify ROS levels microscopically using a fluorescent dye. To further explore ROS dynamics, we will include various treatments and inhibitors. These additions will help distinguish between endogenous ROS production and external ROS effects. This approach aims to reveal cell-level mechanisms underlying heat and drought resilience.

IBMP. The 2023 heat-stress time-course Riesling-Hördt comparison, analyzed for hormone, central and specialized metabolism using multi-platform LC- and GC-MS, generated a map of shared changes, and a few heat-affected, variety-specific metabolites or unidentified markers. With this information, a one time-point heat stress experiment was conducted in 2024 by Manasi Nabar at KIT to assess robustness of responses, along with a second, pilot experiment exploring the effects of combining heat and drought. The new material has been transferred to IBMP for extraction by D. Beltran and M. Nabar before comparative targeted and non-targeted analyses. The outcome should guide the planning for 2025 season on additional varieties of interest.

JKI. Significant progress has been made this year in our efforts to understand and enhance sunburn resilience in grapevines. At the JKI in Siebeldingen, the phenotyping pipeline developed to assess varietal responses to sunburn stress has been successfully optimized and established. A re-analysis of last year's screening of Vitis vinifera ssp. sylvestris genotypes confirmed previously observed differences, highlighting the promising potential of these accessions in future resilience breeding strategies. A major breakthrough has been the development of an advanced AI-based image analysis system capable of quantifying berry sunburn with over 97% accuracy. This high-throughput tool can process and analyze up to 1,200 berries per hour, dramatically accelerating phenotyping capabilities. To further validate our Convolutional Neural Network (CNN) model, we collected a new dataset comprising post-sunburn test images from 50 diverse grapevine varieties. Preliminary validation indicates the model is performing exceptionally well on new data, showing strong accuracy and generalizability marking a crucial step toward robust deployment.

In 2023, we screened the 'Augster Weiss' × Hö29 population and observed that the majority of individuals displayed a high degree of sunburn resilience. We now performed SSR marker testing to identify hermaphrodite (HF) individuals, as some part of the progeny were male and non-fruiting. The most promising hermaphrodite individual showing strong resilience was backcrossed with 'Optima' to generate a new biparental population. The cross was successful, and we received approximately 400 seeds from this cross. In parallel, we have completed genotyping of the F1 population derived from a cross between Morio Muskat and the sunburn resilient parent 'Calardis Blanc'. We utilized rhAmpSeq-based markers to construct a high-resolution genetic map of this population. This map will serve as the foundation for identifying genomic loci associated with sunburn resilience, further bridging phenotypic performance with underlying genetic factors.

FibL. The data for 2024 show high disease pressure by Downy Mildew, symptoms were found on all investigated varieties, not only on leaves, but also on berries. Yield losses ranged at 20-40%. Exceptions were Bronner and Solaris. Other Piwi varieties performed better, but even there, resistance remained incomplete. Powdery Mildew was instead not relevant. The effect of the FertiRoc was, as expected, less evident in 2024 compared to the years before, because stress by high temperatures, intense solar radiation, and drought was not an issue in the year 2024. Nevertheless, FertiRoc again produced higher assimilated nitrogen in the must. In an experimental set with Riesling-Sylvaner on the vineyard of wine grower Adrian Hartmann wine from FertiRoc treated versus control grapes was generated. The chemical analysis oft he wine is still ahead.

Interactions

1. KIT-ScreenSYS: Grapevine suspension cells were transferred for protoplast experiments

2. KIT-FibL: Genotypes from the FibL PiWi collection were included into the leaf-disc assay for heat tolerance at KIT and also high-quality DNA was extracted and is currently processed for genome sequencing and integration into the GrapeKIT database.

3. KIT-IBMP: During a 2-months research visit, Manasi Nabar (KIT) has been introduced into the technology for metabolomics developed at the IBMP and analysed the result from the heat, drought and combined heat-drought stress experiments.

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.

5. WBI- ScreenSYS: Material provision by WBI for floral buds.

6. JKI-KIT: Sunburn screening for berries for crossing of *sylvestris* Hördt 29 with Tigvoasa showed good results. Hermaphroditic individuals could be identified and have successfully been back-crossed into Optima for mapping factors for sunburn resilience.

Website:

The KliWiResse website has been complemented with a bilingual repository on climate resilience for commercial varieties, PiWis, rootstocks and sylvestris genotypes, which will be extended in the coming months. The site has got more than 8700 visitors so far.

Dissemination activities

KIT-FiBL

- 14.03.2025 – Presentation of Kliwiresse at the Fachberatertagung „Ökologischer Weinbau“ in St. Ulrich followed by a third round of « Wein - Klima - zusammen schaffen wir das » mainly with winegrowers from South Germany, Switzerland and France

FiBL

- 27.11.2024: OpenDay FiBL
- 24.03.2025: Visit by the Centre de formation professionnel agricole Rouffach at FiBL

JKI

- 09.-10.2025 Eurovino 2025 in Karlsruhe. The project KLIWIRESSE was presented to Federal Minister of Agriculture Cem Özdemir, and stakeholders from research and practice.