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Hochschule Geisenheim University

Group of international Experts in GiESCO vitivinicultural Systems for CoOperation

27–31 July 2025 • Geisenheim (Germany)

Book of Abstracts



iVES Conference Series
vine & wine

GIESCO 2025

INFORMATIONS

This book of abstracts results from a collaboration between the GiESCO 2025 conference (held from 27–31 July 2025 in Geisenheim, Germany) and the International Viticulture and Enology Society (a not-for-profit organization). It is published online with open access on the *IVES Conference Series* platform.

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EDITORIAL

Dear colleagues,

It is with great pleasure and deep appreciation that we welcome you to GiESCO2025, the 23rd International Meeting of the International Cluster of Experts in Vine Management, held from July 27 to 31, 2025, at Hochschule Geisenheim University, in the heart of Germany's iconic Rheingau wine region.

This conference takes place under the slogan: "Above and Below – Towards the Future". It reflects our shared commitment to addressing the complex challenges facing viticulture in the 21st century - from soil health and biodiversity to water management, climate resilience, digitalization, and sustainability. We believe this offers fertile ground for scientific dialogue and interdisciplinary exchange.

The organization of GiESCO2025 has been a collective effort shaped by collaboration, creativity, and friendship. Many colleagues contributed ideas, time, and energy, and we are deeply grateful to all helpers and volunteers. Thanks to their dedication, we have been able to assemble a rich and diverse program. We are especially thankful to:

- The GiESCO Scientific Committee for its guidance and trust in selecting 9 keynotes, 55 oral presentations, 50 flash presentations, and nearly 160 posters;
- International Viticulture and Enology Society (IVES) for enabling a special issue of seven articles through *OENO One*, and for publishing the proceedings on the *IVES Conference Series* platform, thereby securing long-term visibility of your work;
- Our sponsors and donators, whose contributions helped realize the event;
- The host, Hochschule Geisenheim University, for infrastructure and support.

Over the years, GiESCO has become one of the world's leading scientific platforms in viticulture. It is a place where knowledge is exchanged, networks are formed, and new collaborations emerge. The GiESCO2025 program reflects this spirit - not only through its scientific presentations, but also via special features such as the Professional Day, the Young Researcher Award, and Industry Tours to vineyards and wineries in the Rheingau and nearby regions. These elements aim to create a dynamic and enriching conference experience - combining academic excellence with the cultural and practical richness of viticulture.

Naturally, in organizing an event of this scale, a hiccup or two may occur. We kindly ask for your understanding and assure you that behind every detail stands a committed team working to make your participation smooth and rewarding.

Our goal is to foster inspiring scientific exchange, strengthen connections within the community, and encourage future-oriented thinking. Whether this is your first GiESCO or a return visit, we hope you leave Geisenheim with fresh ideas, new contacts, and a renewed sense of purpose.

We wish you a stimulating and memorable time here in the Rheingau - among colleagues, friends, vineyards, and visions for the future.

With warm regards and on behalf of the Organizing Committee of GiESCO2025, Laurent Torregrosa (Chair GiESCO) (Vine-Wine Science & Education Division, Montpellier), Johanna Döring, Susanne Tittmann, Matthias Friedel & Manfred Stoll (Department of General and Organic Viticulture, Geisenheim).

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LECTURE SESSION

KEYNOTE LECTURE

Above and below–research challenges for the future of winegrape production

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INTRODUCTION

Grapevines interact with the climate (aboveground) and the soil (belowground), affecting the characteristics of winegrapes produced. These interactions are impacted by climate change, the erosion of biodiversity, and losses of soil organic matter (SOM). A valuable resource for adaptation to these impacts, however, may exist in the great genetic diversity in rootstocks, varieties, and clones. This presentation addresses the major abiotic impacts of these global changes on winegrape production and identifies avenues for future research.

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KEYNOTE LECTURE

Rootstocks: how the dark side of the vine can enlight the future?

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Keywords: roots, *Vitis*, adaptation, climate change, agroecology

INTRODUCTION

Global challenges, including adaptation to climate change, decrease of the environmental impacts and maintenance of the economical sustainability shape the future of viticulture. These issues are highly complex and there is no chance that a simple and single solution can solve all of them. From the vineyard perspective, there is an urgent need to analyze cropping systems as a whole and to seek for combined levers which can result in more resilient growing conditions. Doing that, the belowground parts of the vines and the interactions between the soil compartment and the aerial parts require a special focus, as they can be central to develop more agroecological and climate smart practices.

Globally the soil functioning relies on its chemical composition, physical structure and conditions (temperature, water and oxygen content) in interactions with the organic matter content and biological activity. Climate change is not only affecting atmospheric conditions, but also the soil compartment with increases in temperature which could be much higher than for air temperature (Schultz, 2025). Whereas the increase in CO_2 concentration, temperature and the modifications of rainfall regimes have a direct impact on soil as a resource, their effects on the biological component are probably also huge. In addition, climate changer endangers the availability of arable land through enhanced erosion and salinization. The consequences on water supply, mineral nutrition and health of grapevines are an important matter of concern, as they are key factors of wine quality. Despite its importance the underground compartment of vineyards is most of the time neglected due to its complexity and to the difficulties to access (Follain et al., 2025; Schultz, 2025). According to the 4 for 1000 initiative, healthy soils, rich in carbon, are also considered as the basement to mitigate climate change and support agricultural production, which underlines the role of soil to a central component of our future (OIV, 2022).

In most vineyards worldwide, rootstocks represent the major biological link between the soil and the aerial parts of the vines, and their functioning results in transferring the soil properties into wines. Despite the fact they are a key factor of terroir, they have largely been neglected in terms of scientific studies and levers of the viticultural system. Difficulties to access to the hidden part of the plant may explain this lack of knowledge (Bernardo et al., 2025). Their potential contribution to tackle current and future challenges of viticulture and new technologies have changed the game. From genomics to modelling studies, through physiology, genetics and microbiology, interests in rootstocks have increased exponentially over the past 20 years. We consider that this new knowledge can be highly valuable to develop environment friendly and sustainable solutions for the future.

In this context, this communication will give an overview of the most recent findings regarding rootstocks properties. Data regarding the genetic determinism of biotic and abiotic stress resistance/tolerance, root system development characterization and modelling, physiological responses to abiotic stresses, interactions with soil microorganisms on one side and with scions on the other side will be presented.

KEYNOTE LECTURE

The problem of the increasing pH in sparkling wines caused by climate change: use of cationic exchange to correct it

Arnau Just-Borràs[1], Pere Pons-Mercadé[1], Jordi Gombau[1], Pol Giménez[1], Glòria Vilomara[2], Marta Conde[2], Antoni Cantos[2], Joan Miquel Canals[1], Fernando Zamora[1]
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Keywords: climate change, sparkling wines, cationic exchange, pH, titratable acidity, potassium

INTRODUCTION

In recent years, the increase in temperature and the changes in rainfall distribution caused by climate change are affecting vine and grape physiology and are consequently impacting wine composition and quality (Schultz, 2000; Jones et al., 2005). As a consequence of global warming, the grape pulp ripens faster, and the pH and sugar concentration become too high and titratable acidity too low (Schultz, 2016). Therefore, grapes reach a very high potential alcoholic degree and pH sooner than usual. This phenomenon causes harvest dates to be earlier and makes it much more difficult to pinpoint proper aromatic and pulp maturity, which leads to unbalanced wines (Zamora, 2014). The increase on the pH is especially problematic in sparkling wines because they need higher acidity to maintain an adequate freshness.

In this new scenario, oenologists are looking for strategies to mitigate these effects. There seems to be only two possibilities: they can harvest when alcoholic degree and pH are at the correct level and accept that the grapes will not have the correct aromatic and phenolic maturity; or they can wait for adequate maturity and accept that the wines will have high ethanol content and pH.

Neither of these choices is conducive to obtain high quality wines and therefore winemakers are obviously concerned about this problem. Since the lack of real grape maturity cannot be compensated for, most winemakers prefer to wait for the correct grape maturity and then later apply procedures to compensate for the disequilibrium of these unbalanced grapes (Zamora, 2014).

Several practices for reducing sugar in grape juice or ethanol in wines have been proposed (Zamora, 2016). More problematic is compensating titratable acidity and pH. The problem of the low titratable acidity of grape juices and wines can be easily solved by adding authorised acids. Nevertheless, all these organic are not efficient enough for lowering the pH. Furthermore, the use of mineral acids is strictly forbidden (OIV, 2021). In fact, there are only two techniques authorised by OIV for reducing pH: electrodialysis and cationic exchange. Both techniques are very effective and are being increasingly used by wineries; however, cation exchange is probably being more widely used due to its lower cost (Lasanta and Gómez, 2012).

Several studies have been reported about the use of cationic exchange in grape juice and wine and its effects on wine composition and quality but only few of them refer to base wines and only one of them have focused on the effect on sparkling wines produced using the traditional method (Just-Borras et al., 2022). Therefore, the aim of this work is to study how applying cationic exchange to the grape juice influences the composition and quality of the base wines and their corresponding sparkling wines.

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KEYNOTE LECTURE

Unleashing the power of artificial intelligence for viticulture and oenology on earth and space

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Keywords: digital viticulture, remote sensing, machine learning, digital oenology, wine for space

INTRODUCTION

Implementing artificial intelligence (AI) in viticulture and enology is a rapidly growing field of research with an essential number of potential practical applications. Yet, most initiatives have concentrated on specific production chain segments rather than encompassing the entire process from the vineyard to the consumer and making this information available back to winegrowers and winemakers for sustainable decision making (Fuentes et al., 2023, Fuentes and Gago, 2022). Since 2014, our Digital Agriculture, Food, and Wine research group (DAFW, 2017) has pioneered integrating digital tools and AI modeling strategies to analyze remotely sensed data for comprehensive vineyard management. Our work spans diverse areas, including assessing plant physiological and water status for optimized irrigation, monitoring seasonal carbon dynamics of grapevines, evaluating canopy architecture, and detecting smoke contamination at various stages, ranging from canopies to berries, final wines, and acceptability by consumers (Fuentes et al., 2021b).

A notable innovation from our group is the development of low-cost digital technologies coupled with AI that can identify key physiological and quality indicators across the plant/canopy (De Bei et al., 2016, Fuentes et al., 2012), berries (Bonada et al., 2013a, Bonada et al., 2013b, Fuentes et al., 2021a, Fuentes et al., 2020b, Fuentes et al., 2010), must (Summerson et al., 2020), and finished wines (Fuentes et al., 2020c, Harris et al., 2023). By leveraging AI modeling, the digital sensors can detect smoke-related compounds to assess levels of smoke taint and various faults *in situ* and throughout the winemaking process that can also be applied for traceability, provenance, and counterfeiting/adulteration detection (Gonzalez Viejo and Fuentes, 2022). Additionally, integrated with AI, low-cost Near Infrared Spectroscopy (NIR) achieves similar targets as the other digital sensors, such as electronic noses (E-nose), while providing valuable assessments of wines through the bottle without needing to open them, including AI modeling of consumer wine appreciation (Harris et al., 2022, Harris et al., 2025).

Our latest research initiatives explore the fascinating intersection of wine and space, investigating how sensory perception and acceptability of wines change in simulated microgravity and immersive space environments, with growing applications to the space tourism industry (Gonzalez Viejo et al., 2024, Viejo et al., 2024). At the forefront of innovation for the wine industry, our group is developing solutions with implications for terrestrial applications and NASA's long-term human exploration missions, including the Artemis program, which aims for the Moon by 2030 and Mars by 2040. The latter is part of the newly awarded Australian Research Council Centre of Excellence in Plants for Space (ARC, 2024).

KEYNOTE LECTURE

Data integration via modeling for adaptation to climate change and efficiency breeding in grapevine

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Keywords: climate change, modeling, data management, grapevine, breeding

INTRODUCTION

Climate can greatly affect grape yield and quality (van Leeuwen et al., 2024). Growing suitable cultivars in a given region and or breed environmental resilient cultivars are essential for maintaining viticulture sustainability, particularly in the face of climate change (Wolkovich et al., 2018). Moreover, as a perennial plant with long productive span of 30–50 years, grapevine may experience cross-lifespan climate change, which can also modify wine quality and challenge viticultural sustainability (Bai et al., 2022b). Using models to integrate available data and knowledge for accurately predicting environment impacts on fruit productivity and quality as well as for designing ideotypes to ameliorate the cultivars represent a huge challenge (Dayer et al., 2022).

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KEYNOTE LECTURE

Climate change is here to stay: adapting vineyards to a warming world

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Keywords: *Vitis*, grapevine, heat stress, drought stress, mitigation

INTRODUCTION

As an industry that thrives more on, but may also be more affected by, vintage variation and regionality than any other agricultural enterprise, grape and wine production is ever more being impacted challenged by climate change. Though the gradual increase of CO_2 in the atmosphere lies at the root of our changing climate, the associated changes in temperature and humidity arguably pose the greatest challenges to grape growers. In many regions, soil moisture is decreasing while rising temperatures are increasing both the plant water demand and the heat stress during the growing season (Green, 2024). Though winter temperatures are on an upward trend as well, the risk of winter freeze and spring frost damage persists. Therefore, grape growers face climate-related production challenges and threats throughout the year. One consequence of the global warming trend is the exploration of grape production in previously unsuitable, or marginally suitable, areas further from the equator and at higher elevations (Fraga et al., 2016; van Leeuwen et al., 2024). This trend is taking advantage of the overall lengthening of the growing season (defined as the frost-free period) and the increase in seasonal heat summation (measured as growing degree days), weighed against the availability of suitable land and other resources and the risks imposed by unseasonable temperature fluctuations. In established grape-growing regions, growers might also consider planting on sites with different slope aspects to exploit mesoclimates with less direct solar exposure. Of course, moving to a new location is not an option for growers in existing vineyards, who instead must adapt by using alternative means to mitigate the perceived adverse effects of climate change.

Successful adaptation and mitigation requires decisions to choose from and implement a set of alternative or complementary choices either when replanting a vineyard or when extending the lifespan of an established vineyard. Replanting choices may include changes in scion or rootstock cultivars, planting density, row direction, trellis design, training system, or potential irrigation need (Naulleau et al., 2021). Once a vineyard has been established, cultivars may be grafted over, the trellis design and training system can be somewhat retrofitted, irrigation can be added (provided water is available) or altered, and additional choices concern vineyard floor or soil management, pruning strategy and seasonal canopy management, crop load management, harvest timing, and how to control emerging or changing pests and diseases. In any case, vineyards are costly to establish and take years to reach a positive return on investment, and then growers must ensure continued vineyard profitability for decades. Such economic considerations paired with market uncertainties and growing labor constraints mean that the aforementioned choices cannot be made by considering climate change in isolation, but must also integrate decisions regarding mechanization and automation (Kurtural and Fidelibus, 2021). This presentation builds on our current knowledge of grapevine biology and recent advances in viticultural practices to discuss possible adaptation strategies that growers may use to mitigate climate change effects.

KEYNOTE LECTURE

Life cycle assessment (LCA) to move towards more environmentally friendly winegrowing

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Keywords: environmental sustainability, viticultural practices, ecodesign, serious game, environmental impacts, climate change

INTRODUCTION

As six on the nine planetary boundaries have already been crossed, putting our safe life on Earth at risk (Rockström et al., 2024) and agriculture is significantly responsible for it (Campbell et al., 2017), viticulture, faces the challenge of reducing its environmental impacts through fundamental changes to its practices. However, the diversity of the environmental impacts of winegrowing activities on the environment is not commonly identified by the production stakeholders or advisors. This makes it difficult for winegrowers to identify the most environmentally friendly practices. When information is available to winegrowers, usually focuses on one single impact: carbon footprint.

Nevertheless, a detailed impact assessment that is as exhaustive as possible is the best way to inform improvement decisions. The Life Cycle Assessment (LCA) method, which is based on life cycle thinking, like are carbon or water footprints, considers the impacts of the entire life cycle of a product. By assessing all phases of the production process, it ensures that local environmental improvements do not result in the shifting of pollutant loads (Jolliet et al., 2010). LCA offers a comprehensive list of environmental impacts. It is standardised (ISO, 2006) and considered by the International Organization for Standardization (ISO) to be the method that should be used for ecodesign (ISO, 2011). It is also the method chosen by the European Union (Pedersen and Remmen, 2022) and France for environmental footprinting of consumer goods.

The LCA methodology has been implemented in the wine industry for two decades, for various purposes such as quantifying the environmental impact of a bottle of wine and identifying the main life cycle phases that contribute the most (Ferrara and De Feo, 2018). For instance, the global warming potential impact of a bottle of wine ranges from 0.6 to 3.5 kg CO_2 (Pinto da Silva and Esteves da Silva, 2022), which is equivalent to the greenhouse gas emissions of 5 to 26 km by car. Viticulture contributes 15–60% to the carbon footprint of a bottle of wine, depending on vineyard, cellar and packaging practices. The glass bottle alone accounts for around half of the carbon footprint of a full bottle of wine (Navarro et al., 2017). LCA is also used to compare the environmental impact of different types of wine (European-Commission, 2021). In the last decade, the research unit GRAPPE has been developing the use of LCA to inform the choice of winegrowing techniques (Renaud-Gentié et al., 2020, Gentil et al., 2020) and to conduct ecodesign (Perrin et al., 2022, Renaud-Gentié and Julien, 2024).


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ORAL SESSION

SCIENTIFIC ORAL

Exploring magnesium defficiency in Welschriesling grapevines: A multi-omics approach to address viticultural challenges

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Keywords: magnesium deficiency, Welschriesling, viticulture, PacBio sequencing, epigenetics

ABSTRACT

Magnesium (Mg) deficiency poses a significant challenge to viticulture, particularly affecting Welschriesling (WR), a key grape variety in Austrian and Central European vineyards. This issue is especially pronounced in regions with light soils and sufficient precipitation, where Mg is easily leached, resulting in reduced photosynthesis, lower sugar content, and consequently, diminished vine health and wine quality. Existing WR clones exhibit limited Mg uptake efficiency, necessitating innovative solutions to identify genotypes that offer a better Mg uptake and metabolism.

Our interdisciplinary study aims to identify WR genotypes with enhanced Mg uptake efficiency and to uncover the genetic and epigenetic mechanisms underlying this trait. Combining cutting-edge bioinformatics, and a comprehensive multi-omics approach, we compared Mg-efficient (Mg+) and Mg-deficient (Mg-) clones across genetic, epigenetic, and transcriptomic levels.

Using PacBio long-read sequencing, we identified small variants with DeepVariant and structural variants with DeBreak, alongside assessing DNA methylation profiles via the IPDsummary tool. Gene expression analysis was performed with Illumina short-read sequencing, and Mg-related candidate genes were identified through weighted gene co-expression network analysis (WGCNA). A pivotal gene located on chromosome 11 potentially involved in Mg uptake efficiency, was among the identified candidates.

These insights lay the foundation for the development of biomarkers to distinguish Mg-efficient clones, enabling more targeted vineyard management strategies and contributing to the sustainability and resilience of viticulture. Furthermore, this research provides valuable insights applicable to other viticulture regions facing similar challenges, enhancing the global sustainability of grape production.

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SCIENTIFIC ORAL

Above and below: soil moisture and soil temperature interact to alter grapevine water relations

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Keywords: *Vitis vinifera*, PIP, soil temperature, aquaporins, roots

ABSTRACT

The combined effect of soil moisture and soil temperature on grapevine physiology is gaining interest in the context of global warming. However, the interaction between these factors and their impact on grapevine water relations remain poorly understood. Grapevines can adapt their root water uptake in response to environmental changes by regulating the expression of root aquaporin genes. Drought and lower rootzone temperatures have been observed to reduce their expression, decrease water uptake, and root hydraulic conductance. Based on data from a field irrigation trial where irrigation induced a localized reduction of 3°C in the soil that lasted for three days, we investigated the interaction of soil moisture and soil temperature on gas exchange, vine water status, whole-plant hydraulic conductance (Kplant), and root aquaporin differential gene expression in potted vines. Due to the important role that aquaporins play in root hydraulic conductance changes in response to the environment, we also analyzed the relative expression of four Vitis vinifera PIP aquaporins (VvPIP1;1, VvPIP2;1, VvPIP2;2, VvPIP2;4N) known for their confirmed presence in grapevine root tips. We hypothesized that warmer root zone temperatures would increase Kplant by upregulating VvPIP gene expression in roots, possibly accelerating the onset of drought stress. We manipulated soil moisture and soil temperature in potted, own-rooted vines by recirculating through a custom-built system either chilled glycol or hot water while controlling the irrigation input. Leaf gas exchange and leaf water potential (predawn and midday Ψleaf) were measured, and Kplant was estimated. Root samples were collected after seven days for RT-qPCR analysis of PIP gene expression. RNA was extracted from actively growing roots following the DEPC-CTAB protocol and used for differential gene expression after performing RT-qPCR. The results showed that the leaf-level responses were dominated by the influence of soil moisture, while aquaporin gene expression in the roots was more sensitive to the effects of soil temperature. Soil moisture and, to a lesser degree, soil temperature were correlated with Ψleaf and Kplant, supporting the hypothesis of a possible interaction between these factors. Cooler root zone temperatures also reduced Kplant, stomatal conductance and the expression of aquaporin genes in the roots.

SCIENTIFIC ORAL

Root water uptake patterns in rootstock-scion interactions influence grape water use strategies in a Mediterranean vineyard

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Keywords: *Vitis vinifera*, isotope, stomatal conductance, fluorescence, water potential

ABSTRACT

Increasing drought is the most important impact of the ongoing climate change in the Mediterranean Basin, and it is predicted to result in productivity decreases and changes in grape quality. Therefore, viticulture in the Mediterranean wine growing regions has the pressing need to adjust to climate change by using more resilient varieties and rootstocks. Rootstocks contribute to the regulation of scion water use and determine resource availability through the development of the root system. However, there is a lack of knowledge on the spatio-temporal patterns in root water uptake, and how rootstocks determine them by interacting with the environment, which prevents efficient knowledge transfer into practice. Indeed, belowground water relations are key for grapevine physiology and thus productivity, but they remain largely undisclosed. To address this knowledge gap, the present work aims at assessing the effects of three well-established rootstocks - 41B Millardet et de Grasset (41B), 140 Ruggeri (140Ru), and 110 Richter (110-R) - on the depth of water uptake and the vine performance of the cultivars Grenache, Cabernet Sauvignon and Marselan (3 varieties x 3 rootstocks in 3 blocks) at an experimental vineyard located in the NE Iberian Peninsula. To evaluate the effects of the scion/rootstock interaction, physiological phenotyping was carried out using techniques such as leaf gas exchange measurements, pressure-chamber-based water potential and airborne sensing using thermal and multispectral cameras. We also employed isotopic techniques (δ2H and δ18O) to infer the depth of root water uptake. In particular, we aimed to estimate the relative contribution of various water sources (soil at different depths) to water uptake, across three different rootstocks. The results indicate that although small physiological differences at the leaf level exist among rootstock-scion combinations, a significant effect of the rootstock is observed in terms of water status, more particularly, in the predawn water potential, which could be related to contrasting root exploration capacities. This highlights the ability of certain rootstocks to explore deeper soil layers. In this work we will discuss the physiological relations in scion/rootstock interaction under the scope of climate change scenarios and the usefulness of isotopic tracers as powerful tools to infer the temporal and spatial origin of water taken up by grapevine roots.

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SCIENTIFIC ORAL

The effects of soil health management practices on soil organic carbon persistence and accrual in vineyards

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Keywords: soil health, regenerative agriculture, soil organic carbon, climate change, agroecology, vineyards

ABSTRACT

Context and purpose of the study – Climate change is already threatening California vineyards, as they grapple with increasing extreme weather events and drier growing seasons. As vineyards adopt soil health management practices to bolster their adaptation to these threats, there is potential for these same practices to contribute to climate change mitigation. In particular, cover crops, reduced/no-tillage, livestock integration, and compost application can all increase soil organic carbon (SOC), which prevents carbon (C) from being released into the atmosphere and accelerating climate change. However, SOC is a dynamic soil property, as SOC is continually undergoing transformations via decomposition, so it's crucial to understand better not just how the total C pool changes in response to soil health management, but also how organic matter is allocated between the mineral-associated carbon (MAOC) and particulate organic carbon (POC) fractions. While MAOC can remain in the soil for decades to centuries, POC has a mean residence time of a few years to decades, thus making MAOC a more stable form of soil C. Thus, our study aims to examine the effects of soil health management practices, adopted alone or in combination, on total SOC, MAOC, and POC concentrations in vineyards.

Material and methods - In summer 2023 and 2024, we collected soil samples at 24 vineyard blocks in Napa County, California, USA. The vineyard blocks reflect a gradient of soil health management practice adoption, with each site utilizing from one to four practices (maybe list out practices here?; unless it's the same as you mentioned in the previous section), so we have an even distribution of six vineyard blocks along each bin within the gradient. Due to their geographic proximity, all vineyard blocks experience similar annual temperatures and precipitation, but there is variation in their soil textures, with sites having either loam, silt loam, or clay loam soils. At each site, we collected bulk soil samples from 0-40 cm, subdivided into 10 cm depth increments, within five vine inter-rows. We used air-dried, 2-mm sieved soil for all SOC, MAOC, and POC measurements. We separated MAOC and POC by physical fractionation (MAOC < 53 µm). We measured the C content within each fraction and analyzed bulk samples for total SOC by combustion using an Elementar Vario MAX Cube CN elemental analyzer.

Results – In the surface soil depths (0-20 cm), we expect that total SOC concentrations will increase with the number of soil health management practices adopted, while the relative allocation of C between MAOC and POC will vary with the kinds of practices utilized. We expect that sites that implement reduced/no-tillage will have a greater proportion of POC, since the lack of cover crop residue incorporation into the soil slows the decomposition of plant material. In contrast, we expect that sites that apply compost and incorporate sheep grazing will have a greater proportion of MAOC due to the provision of more labile C forms for microbial decomposition.

SCIENTIFIC ORAL

Factors influencing cover crop water competition in vineyards and implications for future drought adaptation

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Keywords: cover crops, root growth, soil water dynamics, drought

ABSTRACT

Vineyard water management in Australia is often associated with irrigation in warm and hot climates, but in cooler regions the larger share of the seasonal water demand is met by rainfall. This study investigated opportunities to improve the utilization of this rainfall derived water. It focussed on factors that influence grapevine root distribution, ground cover water use, and possibilities to improve drought resilience without increasing reliance on irrigation. It was undertaken in the context of growing interest in the use of permanent cover crops, and a need to better understand how the benefits can be balanced against competition for water during seasons of low rainfall.

Field sites were established in spring 2019 in three own-rooted Shiraz vineyards in the Orange wine region differing in floor management practice, ground cover plant species, rainfall, soil type and irrigation use. Soil and plant water dynamics were then followed for four years, spanning the final season of the severe 2017-2019 drought and three subsequent seasons of high rainfall associated with consecutive La Niña events. Water use traits of ground cover species were characterized, including leaf gas exchange measurements and transect soil coring combined with next generation sequencing to map relative species differences in root distribution and depth. After adaption for use with southern hemisphere vineyards, simulations were then run with the HGU water balance model to test how variations in floor management practices, total plant available soil water or the relative grapevine share of plant available soil water, could have changed water risk through droughts in the historical climate record.

The results suggest the capacity to reduce water competition and conserve rainfall derived soil water is much less than appreciated with current vineyard designs and management practices. The greater opportunity to increase drought resilience may be in the design of new vineyards and encouraging greater exploration of the available soil volume by the grapevine root systems in the first seasons after planting. The latter through staged introduction of cover crops, and understanding the interactive effects of rainfall and irrigation on root distribution. This presentation will describe the findings supporting these conclusions, and discuss the potential gains in water use efficiency in relation to expected increases in future water demand and drought severity with climate change.

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SPECIAL SCIENTIFIC ORAL

Under-vine cover crops in viticulture: impact of different weed management practices on weed suppression, yield and quality of grapevine cultivar Riesling

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Keywords: cover crops, weed suppression, grapevine, under-vine, herbicide, mechanical tillage

ABSTRACT

The regulation of weeds, particularly in the under-vine area of grapevines, is essential for the maintenance of grape yield and quality. This is achieved primarily through herbicide application or mechanical tillage. However, the use of herbicides is controversial due to potential environmental and human health impacts (VAN BRUGGEN et al. 2021). Mechanical tillage represents an alternative that can be employed in organic vineyards. This method also presents certain disadvantages, especially in regard to soil erosion potential, the risk of damage to the vines, inconsistent efficiency and the associated costs for energy, machinery and labour. Given these challenges, alternative, sustainable approaches to weed management are essential for modern viticulture.

The implementation of cover crops in the under-vine zone has been demonstrated to be an effective method for weed regulation, which simultaneously results in improvements in soil structure and soil temperature (ABAD et al. 2023). However, the impact of this approach on soil moisture levels remains relatively unclear (BAVOUGIAN & READ 2018). In terms of grape vine performance, a reduction in growth and yield has been evidenced (CHOU et al. 2018; CONIBERTI et al. 2018), as well as an increase in root length density at deeper soil layers (FLEISHMAN et al. 2023). A reduction in vigor and deeper roots of grapevine, as well as the impact on soil health, could lead to greater resilience in viticulture.

In order to benefit from the positive aspects of under-vine cover crops, it is essential to select appropriate plant species and establish them effectively. This research project was therefore initiated to address the limited number of studies on under-vine cover crops in European viticulture in non-irrigated vineyards with cool climate conditions. Furthermore, there is a need to explore the impact of different plant species, beyond the potential cost savings offered by perennial cover crops, which also possess ecological advantages.

SCIENTIFIC ORAL

Hormone metabolism regulates fruit maturation in a slow ripening grape genotype

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Keywords: berry softening, hormone regulation, RNA-seq, slow ripening, sugar accumulation

ABSTRACT

Context and purpose of the study: Rising temperatures and prolonged heat accelerate berry sugar accumulation in advance of the accumulation of compounds responsible for aroma, color and mouthfeel. This uncoupling of sugar accumulation from key berry quality constituents often reduces fruit and wine quality. Identification of genetic material with reduced rates of sugar accumulation when grown under warm conditions offers a potential solution. Previous work in our laboratory found that the maturation rate of a grape selection with abnormally slow ripening could be restored with hormone treatments, suggesting that the slow ripening phenotype may be regulated by hormone metabolism. This study aims to identify the candidate genes driving this phenotype by performing a deep transcriptomic analysis and characterizing hormone dynamics.

Material and methods: Over three years, samples were collected weekly for soluble solids, berry weight and firmness in a white-fruited grape selection displaying slow ripening and a full sibling of the selection with normal ripening. The slow ripening selection fruit was treated with 2000 ppm abscisic acid (S-ABA, ProTone, Valent Biosciences) using Tween20 (0.1% v/v) as surfactant. Hormone analyses were conducted on samples at pre-, mid-, and post-veraison stages for both genotypes and ABA-treated and untreated fruit for the slow ripening genotype. Gene expression analysis was performed using RNA-seq on the same samples.

Results: The onset of berry softening in the slow ripening selection was delayed 45 days compared to its normal ripening sibling. Reduced levels of free ABA and higher inactive auxin conjugation were observed in the slow ripening selection, suggesting a blockage of signals in the early ripening phase. ABA treatment accelerated the maturation of the slow ripening selection, and its free ABA levels were similar to those of the normal ripening selection. Differentially expressed genes (DEGs) associated with hormone metabolism, transcription factors, and other ripening-related processes were found when comparing slow vs normal ripening and ABA-treated vs untreated fruit. The data suggested an active disruption of metabolic pathways regulating auxins and ABA cross-signaling, essential to orchestrating the onset of berry maturation in the slow ripening selection. Further studies are needed to identify the genomic regions responsible for the slow ripening trait and evaluate this genotype's use for cultivar improvement.

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SCIENTIFIC ORAL

Effects of grapevine mycorrhizal association on fine root dynamics depend on rootstock genotype

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Keywords: grapevine-AMF associationi, rootstock genotype, minirhizotron, root system dynamics, sustainable viticulture

ABSTRACT

Context and Purpose of the study. Arbuscular mycorrhizal fungi (AMF) symbiosis with grapevines is a key component of vineyard ecosystems. AMF enhance nutrient uptake, water absorption, and resilience to environmental stresses, while also improving soil structure and influencing root system development. However, a better understanding of the impact of AMF on grapevine belowground traits is still needed. This study aimed to investigate the growth response of grapevine fine roots and root morphology to AMF inoculation across key phenological stages over two growing seasons.

Material and Methods. The study was conducted at Cornell vineyards in Lansing, New York in 2021 and 2022. The experiment followed a 2x2 split plot design with five replications (100 vines in total). Two-year old Pinot noir grapevines grafted onto 3309C and 101-14 Mgt rootstocks were the main plots, with sub-plots of vines either inoculated or not with a bioinoculant containing four AMF species. Fine root production and dynamics were monitored at budbreak, veraison and post-harvest using minirhizotron methods. Root morphology, AMF colonization, leaf area and leaf blade nutrient concentration were also evaluated.

Results. Inoculation significantly increased root length colonization (RLC) compared to control plants. Interestingly, the degree of colonization varied between rootstock genotypes, with RLC increasing by 11% and 8.71% in 3309C compared to 101-14 Mgt for inoculated vs. control plants at veraison in 2021 and 2022, respectively. While both inoculated rootstocks showed greater fine root production vs. control plants, overall fine root growth (<1 mm in diameter) was 57% higher in inoculated 3309C than in inoculated 101-14 Mgt over the two growing seasons. Leaf area, root diameter and root length were greater in inoculated vines than in control plants, particularly for 3309C. Significant differences in petiole nutrient concentration were observed between treatments, but only in the first growing season for both root systems. Our results highlight the importance of minirhizotron technology in advancing our understanding of the spatial and temporal development of the grapevine root systems and the effects of AMF association in the field. Gaining insights into the influence of AMF on grapevine root systems and scion genotypes as well as their contribution to vine growth, could lead to new strategies for adapting viticulture to climate change and reducing dependence on agrochemical input.

SCIENTIFIC ORAL

Disentangling the sources of variation in stomatal regulation in field-grown cultivar-rootstock combinations

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Keywords: climate change, adaptation, sustainability, water-use, machine learning

ABSTRACT

The inherent variability of Nature poses challenges for researchers to draw clear conclusions from field experiments. Identifying and assessing adaptations to climate change requires agronomic field trials. These are always complex to interpret, given the numerous and complex interactions between genotypes, environmental conditions, and cultivation practices. The existing diversity of plant material makes the selection of cultivars and rootstocks a feasible lever of adaptation to climate change, and one that is already being adopted by growers. Here, we assessed the main sources of variation in stomatal regulation (gs) across a large cohort of cultivar-rootstock combinations in our completely randomized GreffAdapt vineyard (Cabernet Sauvignon, Grenache, and Syrah each grafted onto 5BB, 1103P, 110R, 140Ru, and SO4). Using the LI-600 porometer/fluorometers we assembled an incredibly large and robust dataset of gs values across the season, comprising over 6000 gs and chlorophyll fluorescence measurements. Our goal was to disentangle sources of variation in gs in order to determine the contribution of plant material. Classical analysis of variance showed that the environment and date of measurement accounted for the overwhelming proportion portion of the variance (~90%), which obscures potential cultivar-rootstock effects over the season. Therefore, we integrated machine learning, spatiotemporal normalization of the gs response, and the use of linear mixed models to disentangle environmental (e.g. VPD, PAR, and leaf temperature), plant material, and vigour-related (e.g. yield and pruning weight) variables. The resulting model demonstrated that cultivar and cultivar-rootstock interactions, taken together, explained over half of the variation in gs. The rootstock by itself had a low contribution to the variation in gs, particularly in Grenache, which exhibited the most conservative stomatal regulation across nearly all rootstocks. The 5BB rootstock promoted high stomatal conductance on both Cab. Sauvignon and Syrah, while 1103P showed a more conservative behavior in Syrah. This study highlights that because of the incredibly high variation due to environment across space and time, field studies cannot rely on just a few measurements taken at a few times. Broader and more comprehensive datasets, paired with state-of-the-art statistical modeling, are likely important for understanding the contribution of specific factors to water-use regulation in vineyards.

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SCIENTIFIC ORAL

Exploring the mechanisms underpinning grapevine susceptibility to esca in a range of *Vitis vinifera* L. cultivars

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Keywords: ecophysiology, grapevine trunk disease, plant-microorganisms interactions, phenotypic diversity, wood properties

ABSTRACT

Grapevine susceptibility to fungal diseases, including the vascular disease esca, is a major threat for wine productivity and vineyard perennity worldwide. The genetic diversity of grapevine cultivars could be a promising tool to mitigate disease impact in a sustainable manner. Our aim was (i) to study the genetic component of esca susceptibility, that has rarely been investigated, and (ii) to identify specific mechanisms and varietal traits underlying esca susceptibility amongst grapevine cultivars using a multi-trait approach of physiopathology and a common garden vineyard.

To describe the genetic component of esca susceptibility, we monitored for seven years esca incidence and severity in 46 cultivars randomly planted in the VitAdapt experimental vineyard (Bordeaux, France). We tested for phylogenetic autocorrelations between epidemiological metrics using cultivar SSR genotyping data. We then explored the relationships between esca incidence and ecophysiological traits monitored on the same plants: flowering date, δ13C in berry juice at maturity, stomatal conductance, N-tester at flowering, and pruning weight. On a subset of cultivars, we also studied the role in the varietal susceptibility of wood anatomical, functional and biochemical traits, microbiome and metabolome.

We first highlighted a broad and temporally consistent gradient of varietal susceptibility, with a mean annual incidence of 0 to 26 % of vines expressing esca foliar symptoms depending on the cultivar. A significant but weak phylogenetic signal was detected for the incidence of symptoms across this panel of cultivars. Then, we revealed a significant negative correlation between esca incidence and δ13C, suggesting that cultivars with high water use efficiency are less prone to express esca. We also identified a positive correlation between stomatal conductance and esca incidence. In addition, the least vigorous cultivars were among the least susceptible. To explore the underlying mechanisms esca susceptibility, we are analysing wood-related traits, as well as comparing the diversity, structure and composition of fungal and bacterial wood communities along the gradient of susceptibility.

SCIENTIFIC ORAL

Early ripening in cool climate viticulture varieties is mainly based on a mutation in 'Pinot precocé noir'

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Keywords: climate change, cool climate viticulture, marker development

ABSTRACT

For a long time, cool climate grapevine breeding has striven for early ripening cultivars to adapt to the former climate conditions. However, due to climate change and with altered growing conditions, many current cultivars are now ripening too early and are suffering from a loss of quality and authenticity. 'Pinot Precoce Noir' (PPN) is an early-ripening clone of 'Pinot Noir' (PN) and the phenological differes phenologically by an about two weeks earlier onset of veraison. We found that the early veraison locus Ver1 on chromosome 16, previously identified in 'Calardis Musqué', originated from PPN. The study aimed to develop a functional SSR marker for early ripening to include this trait in marker assisted selection (MAS) and for parentage analysis.

A set of 72 important international cultivars and others with high relevance for German viticulture were investigated for their allelic status within the Ver1 locus. DNA was extracted from leaves and screened with SSR markers specifically developed for the genomic region of the Ver1. PCR fragment length for this markers was determined using a ABI 3130xl Genetic Analyzer. The functional confirmation was based on data from 12 years of veraison observations (BBCH 85) of these cultivars grown at JKI Geilweilerhof, Siebeldingen, Germany.

A single marker located within the Ver1 locus was found to have a unique fragment length on the functional Pinot-allele for the trait time of ripening. This allowed differentiation between the very early ripening PPN phenotype, the early ripening PN phenotype and the remaining varieties which were found to ripen later.

This characteristic makes the SSR marker a valuable tool to trace individual descendants of the Pinot family back to their respective founders, either the original PN or its earlier ripening PPN mutant. The screening of viticulturally relevant cultivars and the availability of a reliable veraison data set showed up its selective value. The results additionally indicate the high selective pressure of the early ripening phenotype in cool climate breeding in former decades. The marker provides a straightforward method for screening genetic resources and breeding material based on established SSR-based MAS pipelines. By enabling breeders to adapt their cool-climate viticulture breeding programmes to the challenges of climate change, the marker will help to develop climate-adapted and more resilient varieties for quality wine production in a sustainable viticulture.

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SCIENTIFIC ORAL

Genetics of adventitious root formation in grapevines

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Keywords: adventitious roots, rooting ability, molecular breeding

ABSTRACT

Commercial grapevine propagation relies on the ability of dormant wood material to develop adventitious roots. Vitis riparia and V. rupestris, two North American native species, are the progenitors of most commercially available rootstocks due to their resistance to Phylloxera and excellent root-forming capacity. Despite the existence of at least 20 others native Vitis species in North America—many of which possess strong resistance to biotic and abiotic stresses—their use has been limited by either poor rooting ability or insufficient understanding of their rooting potential. To advance our understanding of adventitious root formation across Vitis, we combined whole genome sequencing with rooting data from a diverse panel of 19 Vitis species to characterize North American Vitis' rooting potential, determine its genetic control, and identify associated genes. Using two ordinal scales to assess rooting ability at different stages of callusing, we identified significant genomic regions on chromosomes 2, 5, 10, 12, and 18 through genome-wide association analysis (GWA). Our analyses indicate that rooting capability is a quantitative trait with considerable variation within and between species and is not restricted to any single taxon. Most associations explained only a small proportion of phenotypic variation, suggesting that rooting ability is a complex trait controlled by multiple loci with small effects. Several genes associated with hormone regulation, cell wall modification, and stress response were found to be in linkage disequilibrium with significant genetic variants. Hormone accumulation analysis during callusing in extreme phenotypes confirmed the role of hormone-related genes in the ability of dormant cuttings to form adventitious roots. This research supports the implementation of molecular breeding approaches, including marker-assisted selection and genomic prediction, to accelerate the development of new climate-resilient rootstocks.

SCIENTIFIC ORAL

Biodiversity and genetic profiling of autochthonous grapevine varieties in Armenia: A key to sustainable viticulture

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Keywords: biodiversity, autochthonous grapevine, genetic profiling, Armenia

ABSTRACT

Armenia, as one of the ancient centers of grapevine domestication, harbors a unique repository of genetic diversity in its indigenous and wild grapevine populations, highlighting a key role in the millennia-lasting history of grape cultivation in the Southern Caucasus (Margaryan et al., 2021). Recent genomic studies suggest domestication occurred approximately 11,000 years ago in Western Asia and the Caucasus parallel (Dong et al., 2023). The immense biodiversity of grapevines found in Armenia, despite its relatively small territory, is driven by unique topography, varied climatic conditions, and a rich cultural and historical heritage in vine and wine traditions that spans thousands of years. According to the studies conducted in recent years, Vitis vinifera L. biodiversity of Armenia provides a valuable genetic toolkit for breeding and selecting varieties that are better adapted to abiotic and biotic stresses (Riaz et al., 2020; Margaryan et al., 2023). Moreover, local autochthonous varieties may possess phenotypic traits linked to quality, such as unique flavor profiles and wine characteristics, which could be leveraged to maintain competitiveness in the global wine market while preserving traditional viticulture practices and safeguarding genetic resources.

Until recently, there was very little information available about the precise number of Armenian autochthonous grape varieties, and there was often uncertainty regarding their actual counts due to the presence of synonyms and homonyms. Over the past ten years, alongside the renaissance of the wine industry in the country, large-scale inspections and genetic profiling of Armenian autochthonous grape varieties and wild genotypes have been initiated. This effort focused on the characterization and long-term conservation of vine genetic resources, supported significantly by the German partner, the Institute of Grapevine Breeding (JKI). The conservation and rescue of grapevine genetic diversity in Armenia is critically urgent. Many indigenous varieties are no longer cultivated or exist only as isolated vines, placing them at significant risk of extinction. Last thirty years, the widespread cultivation of a limited number of commercial vines has led to a significant decline in genetic diversity, with only 40-50 out of 400 -450 autochthonous grape varieties currently utilized in wine and brandy production. Numerous minor autochthonous vines, which hold regional importance in specific wine-growing areas, remain underutilized. This under-exploitation was attributed to the lack of comprehensive studies characterizing these neglected varieties, particularly in terms of their oenological and agronomic traits. These challenges underscore the urgent need for the systematic inventory, collection, conservation, and comprehensive characterization of grapevine genetic resources in Armenia. Additionally, a deeper understanding of the genetic diversity and relationships among genotypes is vital for promoting their sustainable use and enhancing the resilience of viticulture. The sustainability of traditional viticulture systems, also in Armenia, faces significant threats from climate change and associated environmental pressures, such as shifting temperature regimes, altered precipitation patterns, and an increased incidence of pests and diseases, which collectively jeopardize grapevine productivity and wine quality (Delrot et al., 2020). In this context, the rich genetic diversity of Vitis vinifera L. of Armenia represents a valuable resource for developing resilient and sustainable viticulture practices.

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SPECIAL SCIENTIFIC ORAL

Estimating grapevine crop coefficients at high-resolution using open-source satellite data

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Keywords: irrigation scheduling, crop coefficient, satellite, spectral unmixing

ABSTRACT

Climate change results in increasing water stress due to co-effects of rising evapotranspiration (ET) and decreased precipitation over the past 65 years (Spinoni et al. 2019). Though mild water deficits can improve fruit and wine quality, severe shortage of water to grapevines negatively influences both grapevine productivity and fruit quality (van Leeuwen et al. 2024). To address these adverse drought effects on grapevines, one direct and effective solution is the application of supplemental irrigation with appropriate schedules (Schlank et al. 2024). For winegrapes, ET-based irrigation scheduling has shown to result in higher yields, bunch numbers, and crop water use efficiency, compared to other methodologies like grower's experience and soil-based measures (Schlank et al. 2024).

The ET method measures evaporation from soil and transpiration from vegetation. Crop evapotranspiration (ETc) can be computed according to derived formula (Allen et al. 1998):

$$ETc = ET0 \times kc$$

ET0 is the 'Reference ET', which represents the rate of evapotranspiration from a reference surface, often a 10 cm tall grass, and can be calculated via the Penman-Monteith model (Allen et al. 1998), with data commonly obtained from automatic weather stations. A key parameter in the ETc computation is the crop coefficient (kc), a dimensionless parameter related to the canopy size and leaf area, and is highly variable during the growing season due to varying canopy structure, fraction of ground covered by vegetation, training system, and pruning level, amongst others (Pereira et al. 2020).

Compared to other time-consuming, costly, cumbersome and often single-point or small-scale kc measurement methods like lysimeter or flux tower, remote sensing (RS) has high temporal flexibility and broader spatial representativeness by capturing structural, spectral, thermal, or microwave information from land covers (Gautam and Pagay 2020, Gautam et al. 2021). Amongst the mainstream RS platforms including Manned Aircraft System (MAS), Unmanned Aerial Vehicle (UAV), satellites provide low-cost, long-term time-series data with broad spatial coverage, which benefits regional predictive analysis (Gautam and Pagay 2020, Govi et al. 2024). Airborne platforms, by contrast, are more challenging to operate and collect data at such a large scale. Additionally, the similarity between kc and satellite-derived vegetation indices has driven the use of low-cost remote sensing technologies to estimate kc across various spatial and temporal scales (Gautam et al. 2021).

The current limitation of using satellite data is the low resolution of the dataset; typical pixel sizes or ground sampling distances (GSD) are greater than the area occupied by a single grapevine canopy. Furthermore, vineyard inter-rows are often covered by non-vine vegetation such as cover crops or weeds (Gautam and Pagay 2020), which result in a 'mixed' satellite pixel that contain a combination of grapevines, bare soil, weeds, and/or cover crops, all of which add "noise" to the vine spectral signal (Govi et al. 2024). Separation of land cover types to obtain specific VI values can help to improve the accuracy of RS kc predictions (Quintano et al. 2012). To the best of our knowledge, there are no reports on unmixing data of low- to medium-spatial-resolution satellite data for grapevine kc computation. This study aims to fill this gap.

SPECIAL SCIENTIFIC ORAL

Artificial intelligence-driven classification method of grapevine phenology using conventional RGB imaging

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Keywords: grapevine phenology, image classification, growth stages, precision viticulture, deep learning

ABSTRACT

The phenological stage of the grapevine (Vitis vinifera L.) represents a fundamental element in vineyard management, since it determines key practices such as fertilization, irrigation, phytosanitary interventions and optimal harvest time (Mullins et al., 1992). Phenology can be understood as the study of the phenological events, or the stages of plant development that occur during their active lifecycle, in response to climatic conditions. The phenological development of grapevines is mainly influenced by climatic elements, such as temperature, solar radiation, and precipitation, which also influence the production and the quality of grape berries. Temperature is the main forcing element in the phenology of grapevines, in this sense, the projected increases in temperature under future likely climate change scenarios may lead to the advancement of 6 to 25 days for different grapevine varieties in mediterranean climate regions (Reis et al., 2020).

To standardize the description of these stages, several phenological scales have been developed, including the Baggiolini scale, the Eichhorn-Lorenz (E-L) scale, and the extended BBCH scale. The Baggiolini scale, initially used for planning pesticide applications, was limited in scope as it only covered early development stages. In contrast, the E-L scale introduced 47 numerical codes describing 22 phenological stages from winter bud to leaf fall, providing greater detail and flexibility to incorporate sub-stages (Coombe, 1995). The extended BBCH scale increased precision by detailing phenological macro and micro-stages, facilitating its application across multiple crops and standardizing its use internationally (Lorenz et al., 1995).

Despite advances in these descriptive tools, phenological identification traditionally relies on manual observations by an experienced technical person. This method is time-intensive, subjective, and often unable to capture spatial variability within the vineyard, which can lead to suboptimal decisions (Verdugo-Vásquez et al., 2016). In addition, climatic variations, edaphic conditions and agronomic practices can further complicate correct identification (Altimiras et al., 2024).

In this context, emerging technologies, such as computer vision and deep learning, offer a promising solution. These tools provide a possibility to automatize the classification and monitoring of phenological stages by capturing and analysing large-scale images. Algorithms based on convolutional neural networks (CNNs) have proven to be effective for image classification techniques in agriculture, with accuracies exceeding 88% in applications such as grapevine phenological stage identification (Schieck et al., 2023). In addition, these technologies have also been successfully used in the detection of grape bunches under various occlusion conditions (Íñiguez et al., 2024) and in the assessment of diseases such as downy mildew (Hernández et al., 2021). Systems that integrate proximity sensors and IoT platforms are integrating the capacity for continuous and real-time monitoring in vineyards, reducing costs and improving decision making (Mendes et al., 2022).

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SPECIAL SCIENTIFIC ORAL

Development of spectral indices to monitoring non-destructive of ripeness for water stressed grapevine (*Vitis vinifera* L.) using contour map optimization

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Keywords: ripeness, spectral indices, optimization, contour map, water stress, *Vitis vinifera* L.

ABSTRACT

Accurate and non-destructive monitoring of grape ripening is essential for optimising harvest decisions, particularly under water stress conditions. This study aims to evaluate the application of the contour map optimisation method for determining spectral indices to non-destructive monitoring of soluble solids (SS), titratable acidity (TA), and pH for grapevines (cv. Cabernet-Sauvignon) under four levels of water application. Hyperspectral reflectance data (350–2500 nm) were acquired from grape berries during two consecutive growing seasons (2019/20 and 2020/21) to identify optimal wavelength combinations using contour maps. Results indicated that the optimal spectral indices were SI_{SS} = 1600 nm/1412 nm for SS, SI_{TA} = 1617 nm/1415 nm for TA, and SI_{pH} = 694 nm/697 nm for pH. In this case, the linear regression based on SI_{SS}, SI_{TA}, and SI_{pH} presented a coefficient of determination of 0.82, 0.83, and 0.95, respectively. Model validation confirmed the stability of these spectral indices across different irrigation regimes, with an index of agreement of 0.94 for SS, 0.90 for TA, and 0.79 for pH. The results demonstrate that contour map optimisation could increase the robustness of spectral indices, improving their reliability across varying conditions of soil water availability. This methodology provides a viable alternative to destructive ripeness assessment techniques, offering a scalable solution for vineyard management and decision-making in precision viticulture.

SCIENTIFIC ORAL

Qualitative modelling of factors influencing the development of Black rot, for the prediction of damage to bunches

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Keywords: IPSIM-VIGNE-black rot, injury profil simulator, model, disease

ABSTRACT

Vines are one of the most pesticide-intensive crops in France, and reducing their use is a major challenge for both the environment and human health. Vines are subject to several diseases, including black rot (BR). This disease is causing more and more damage in South-Western France, and modeling of this damage has not yet been developed. Developing an Injury Profile Simulator (IPSIM) model appears to be an interesting tool for achieving effective BR management that guarantees vineyard productivity while limiting the dependence of cropping systems on fungicides. Indeed, this approach has proved its effectiveness on other crops such as wheat and sunflower. Based on expert knowledge and literature, we have developed IPSIM-VIGNE-Black rot. This hierarchical qualitative model evaluates the severity of BR attack on bunches of a field for a given year. The BR severity is simulated according to the disease's health history, the winegrower's cultivation practices, and the field's environment. IPSIM-VIGNE-Black rot is a multi-attribute model comprising 46 attributes, including 29 input attributes and 17 aggregate attributes. In terms of the disease's health history, the input attributes are the history of BR contamination at different levels: field, set of fields, and vineyard. The winegrower's cultivation practices are divided into two main parts: the effectiveness of treatments against BR and the effectiveness of prophylactic measures. The effectiveness of treatments is determined by the type of sprayer and products used. Prophylactic measures include all winegrower's cultivation practices that affect the development of BR without treatments. Finally, the field's environment corresponds to the presence of abandoned vines adjacent to the field and the drying characteristics of the field, such as the presence of wind. Model results were compared with independent observations collected in conventional and organic vineyards in South-Western France over 12 years. IPSIM-VIGNE-Black rot showed encouraging predictive quality, with an accuracy of 48%. This model is promising, especially as improvements in its construction are envisaged to increase its accuracy. This model will be integrated into an IPSIM-VIGNE model including the 3 main diseases, powdery and downy mildew, and BR. Eventually, it could be used by the profession as a tool for diagnosing and understanding damages to limit its consequences and the use of pesticides.

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SCIENTIFIC ORAL

Advanced phenology due to climate change is projected to shift precipitation patterns for key cultivar-region combinations in New Zealand

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Keywords: grapevine, rainfall, climate change, modelling, land-use

ABSTRACT

Context of the study: Shifts in grapevine phenology driven by temperature increase due to climate change may result in different rainfall profiles between phenological stages. This may lead to extremes of excess or reduced water input at different phenological stages of the grapevine.

Purpose of the study: To evaluate precipitation for phenological periods under future climate change scenarios for key region-cultivar pairings in New Zealand: Sauvignon blanc- Marlborough, Merlot-Hawke's Bay, and Pinot noir-Central Otago in New Zealand.

Material and methods: Six global circulation models (GCMs) were used to generate daily temperature and rainfall data and averaged across the GCMs for three periods: baseline (1985-2005), mid- (2031-2050) and end-century (2081-2100) using IPPC climate change scenarios RCP4.5 and RCP8.5. The temperature data was used in phenological models simulated budburst to flowering, flowering to veraison, and veraison to target sugar concentration of 200 g/L, and three weeks prior to flowering. Rainfall indices of total precipitation (mm), number of rain days, and rainfall intensity (average precipitation per rain day) were calculated for each phenological phase for each region-cultivar combination.

Results: Rainfall projections increased from budburst to flowering but decreased for the other periods for Sauvignon blanc-Marlborough, and at times was accompanied by increased rainfall intensity due to fewer rain days. However, the total rainfall for the growing season was unchanged.

Merlot in Hawke's Bay exhibited similar trends for phenophase changes in rainfall, but with fewer rain days, rainfall intensity was unchanged.

For Pinot noir in Central Otago, up to 37 mm more rainfall was projected between budburst and flowering compared to baseline, but conversely deficits of up to –20 mm was projected from veraison to target sugar concentrations by the end of the century.

Significance of study: The projected trends have adaptation management implications such as canopy management to manage vine vigour and disease pressure to manage projected increase rainfall between budburst and flowering for Central Otago-Pinot noir or lower risk of escalating disease in Hawkes-Bay Merlot due to no change in rainfall intensity. The projected differences highlight the importance of combining phenological modelling by cultivar and region, demonstrating a diverse range of potential futures for NZ winegrowing.

SCIENTIFIC ORAL

Grapevine root system architecture: empirical insights and first steps towards in silico studies

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Keywords: grapevine rootstocks, 3D digitization, drought resilience, water uptake modeling, CPlantBox

ABSTRACT

Root System Architecture (RSA) is crucial for plant resilience and resource uptake, yet remains underexplored in viticulture. We present key findings from our two-year vineyard establishment trial where we applied a field-to-parameter pipeline to explore the RSA development of young vines (cv. Riesling) grafted on different rootstocks, obtaining high-resolution 3D RSA data. In total, we excavated and digitized 96 root systems from three distinct rootstock genotypes — '101-14', 'SO4', and 'Richter 110' — at four developmental stages: 3, 6, 15, and 18 months post-plantation. Our results demonstrate that rootstock genotype significantly influences major RSA parameters, such as rooting depth, branching patterns, and rooted soil volume. We highlight how 3D representations of root systems provide more profound insights compared to traditional 2D approaches, particularly in understanding how genotypic variations influence potential water uptake capabilities within the 3D soil domain. Additionally, our findings shed light on how spatial rooting patterns are influenced under realistic winegrowing conditions, with a notable limitation of inter-row soil exploitation, potentially induced by soil compaction due to tractor traffic. Looking ahead, we introduce our dynamic grapevine root growth model to simulate genotype-specific RSA development. This model serves as a foundation for future in silico experiments aimed at modeling rootstock suitability under specific climatic and edaphic conditions, including drought stress scenarios. By highlighting existing knowledge gaps, this work sets the stage for advancing RSA research to enhance predictive modeling and implement model-informed modifications to viticultural practices, like intercropping systems, under changing environmental conditions.

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SCIENTIFIC ORAL

Unveiling the impact of seasonal weather and fungicide spraying on vineyard autochthonous yeast populations: implications for Riesling wine quality

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Keywords: weather, fungicides, biodynamic, conventional, autochthonous yeast

ABSTRACT

Fungicide spraying is a common viticultural practice that occurs throughout the growth season that protects developing vines and bunches against diseases caused by fungi or oomycetes. The need for fungicide spraying varies seasonally, due to differences in weather conditions, especially rainfall. This study examined the effects of seasonal weather and fungicide spraying on vineyard autochthonous yeast populations and their impact on Riesling wine quality. Biodynamically and conventionally grown Riesling grapes were hand harvested and processed to obtain juice for conducting uninoculated fermentations spanning seasons 2021-2023. In the first two years, differences in fungal diversity between these treatments were mostly found in the juice, favouring the conventional treatment. In 2023, differences in diversity were greater, potentially linked to nutrient leakage from the berries, highlighting the complex interactions between weather conditions and disease management practices as drivers of differences in fungal diversity, challenging our ability to tease apart their individual effects. Regarding the link between yeast populations and volatile aromatic compound production in wine, biodynamic wines were characterised by different terpenes, which suggested the presence of species with glucosidase-activities. However, no direct link can be drawn between yeast community populations and volatile compound production in these fermentations, due to the presence of relic DNA, which distorts the interpretation of results.

SCIENTIFIC ORAL

Under-vine and between the rows: Investigating sustainable floor management in vineyards

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Keywords: vineyard floor management, soil health, weed control, soil moisture retention, sustainable viticulture

ABSTRACT

Investigating vineyard floor management is essential as these practices directly impact soil health, vine growth, and grape quality. Traditional methods, like tilling or herbicides, control weeds but can harm soil structure and biodiversity, while alternatives like cover cropping and mulching may offer environmental benefits and introduce trade-offs in water and nutrient availability.

In 2019/2020 a vineyard floor management trial was established at the University of Adelaide, Waite Campus, Australia. Mid-row treatments were a mown spontaneous cover crop and a rolled cover crop of oats and peas. In the under-vine area, treatments included herbicide, cultivation and mowing. All treatments were replicated four times. Measurements of vine performance, yield, maturity, soil health, and plant species diversity (between and during the seasons) were recorded during 2021-2024.

Rolling the mid-row vegetation increased pruning weight without any effect on yield. The only significant differences in maturity data were a lower berry weight when the under-vine area was cultivated versus herbicide treated, and the pH being highest when the under-vine was herbicide treated, followed by cultivated then slashed. Phenolics and anthocyanins were higher when the under-vine was cultivated versus herbicide treatment, regardless of mid-row treatment. Differences in percentage ground cover were significant when looking at the various under-vine treatments, with slashing providing the greatest coverage, followed by cultivation then herbicide treatment. Whilst the differences between groups were not large, herbicide in the under-vine area decreased berry weight, total phenolics and anthocyanins, biodiversity, percentage ground cover and biomass. Greater plant diversity and ground cover observed in mown treatments corresponded to a significant improvement in soil water infiltration rates and increased soil organic carbon levels. These findings suggest that diverse plant cover, particularly under-vine, contributes to healthier soil, potentially increasing vineyard resilience amid environmental challenges like drought and limited water access. Understanding the impacts of under-vine and mid-row treatments can help vineyard managers balance these factors, promoting more sustainable and productive viticulture practices.

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SCIENTIFIC ORAL

Hidden costs of wine: quantifying environmental externalities of organic and integrated management

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Keywords: true cost accounting, sustainable viticulture, externalities, monetization of environmental impacts

ABSTRACT

Agriculture is one of the largest contributors to environmental pollution and causing significant impacts on human health, ecosystems, and resource availability. Transitioning to more sustainable agricultural systems is crucial to mitigate these externalities. Organic agriculture is often seen as a key strategy for sustainable food production. However, the insufficient internalization of externalities in food prices can mislead consumers, promoting the demand for products that may be inadequately priced and environmentally unsustainable. Therefore, this study aims to quantify the external costs of organic and integrated viticulture using data from a long-term field trial in Germany. Life Cycle Assessment (LCA) was applied from cradle-to-farm-gate with functional units based on vineyard area (1 hectare) and grape yield (1 kilogram) to include the impact of changes in yield. Environmental impacts were monetized using True Cost Accounting, with factors derived from European Commission's recommendations, and disaggregated across value chain steps to identify key contributors to externalities. The results reveal minor differences in overall externalities between organic and integrated viticulture. External costs per hectare were slightly lower under organic management (612 €/ha with central monetization factors), while costs per kilogram of grapes were higher due to reduced yields. Shifts in the relative contribution of impact categories were observed, with climate change and particulate matter identified as the most significant contributors to external costs. In terms of endpoint areas of protection, damages to human health and ecosystems accounted for a larger share of the total externalities compared to resource depletion. These findings highlight the importance of considering yield variability and multiple environmental impacts when evaluating the sustainability of viticultural practices. While external cost assessment provides valuable insights, its inherent limitations, e.g., valuation-, geographical- and temporal- uncertainty, and the aggregated nature of the data must be carefully considered to ensure their appropriate use in environmental policy and decision-making.

SCIENTIFIC ORAL

Uncovering the influence of vineyard management on fungal community structure and functional diversity within above-ground compartments

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Keywords: mycobiome, grapevine, *Vitis vinifera*, management systems

ABSTRACT

In viticulture, microbial communities – particularly fungi – play a vital role in plant health, disease management, and grape quality. This study, conducted in Geisenheim as part of the InBioDyn long-term trial, explores how different vineyard management systems (integrated, organic, and biodynamic) affect fungal diversity and function in the above-ground plant parts, including bark, leaves, and grapes.

Across management systems, overall fungal species richness has been shown to not differ significantly. The composition of fungal communities, however, significantly varied among the studied management systems. Specifically, the leaf and grape compartments under integrated management showed distinct shifts in fungal community structure when compared to organic and biodynamic approaches, resulting in a higher abundance of mycoparasitic fungi (e.g., Sporobolomyces roseus, Sporobolomyces ellipsoideus, and Rhodotorula glutinis). In contrast, organic and biodynamic systems did not differ significantly in terms of fungal community composition.

These results underscore the critical role of management strategies in shaping fungal community composition and demonstrate how management practices can selectively influence functional components of fungal communities. This study highlights the potential for targeted microbiome management through strategic vineyard practices to enhance sustainability and plant health in viticulture.

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SCIENTIFIC ORAL

Economic comparison of viticultural cultivation systems: evaluating costs across integrated, organic, and biodynamic practices

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Keywords: viticulture, production costs, economic sustainability, management assessment

ABSTRACT

The cost-effectiveness of a winery requires constant cost control in order to ensure competitiveness on the wine market. Primary production is therefore closely linked to the market situation and helps producers to maintain economic viability even in years of weak sales (Dixon & Viticulturist, 2023). The ongoing challenge of increasingly sustainable production therefore requires a compromise to be found between environmental benefits, economic advantages and production costs (Falcone et al., 2016). Management also plays a crucial role, as it affects the economy through resource and energy input and output (Lin et al., 2017). The rising labour and input costs in the past few years (Federal Statistical Office Germany, 2024; Statista, 2024a) are encouraging a conversion of management to greater mechanisation. The cost-benefit ratio resulting from this varies with increasing farm size and the investment risk for the purchase of machinery decreases (Signorini & Ivey, 2023). Operational availability of machines depends on key factors such as accessibility of the vineyards, row orientation and the training system. As a result, the potential cost savings can differ considerably depending on these factors (Strub et al., 2021). Labour costs are regulated by legal wage conditions. Individual investments in mechanisation can create realistic cost savings and at the same time prevent labour shortages (Signorini & Ivey, 2023). The differences between integrated, organic and biodynamic viticulture are generally known. The current data on financial performance is still very limited, however. For agriculture, the results of Crowder & Reganold (2015) out of a global meta-analysis of 55 crops, show a higher profitability of organic farming, despite low yields and without taking subsidies into account.

SPECIAL SCIENTIFIC ORAL

Challenges and opportunities for increasing organic carbon in vineyard soils: perspectives of extension specialists

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Keywords: soil organic carbon sustainability, practices, climate zone, extension perception, vineyard, country

ABSTRACT

Increasing soil organic carbon (SOC) in vineyards enhances soil health with associated benefits for climate change resilience and mitigation. However, adoption of SOC-building management practices remains low and hindered by multifaceted barriers. Extension specialists play a crucial role in overcoming adoption challenges by providing tailored advice and training opportunities to growers. This study used semi-structured interviews with extension specialists in warm and cool regions of France and USA to explore context-specific barriers and opportunities for adoption of SOC-building practices. The Multi-Level Perspective framework was implemented to identify SOC-building practices and factors influencing their adoption from niche to mainstream. The practices to increase SOC identified included cover crops, organic fertilisation, and reduced tillage, with regional variations in implementation across climates. Barriers to the adoption of SOC-building practices were centred around costs of implementation, limited knowledge of the long-term impacts of the practices and the complexity of local adaptations of practices to be effective in specific vineyard conditions (e.g., slope, planting density, water availability). Incentives for adoption could include facilitations between grape growers and livestock farmers, targeted research, improved extension programs, and government support through subsidies or restructuring of the supply and value chain both in France and in the USA. A significant gap in extension capacity was identified for cover crop implementation in the USA's warm and cool areas. Research gaps were identified around pruning residue management, the application of arbuscular mycorrhizal fungi, and the integration of grazing animals into winegrape vineyards more in the USA than in France. Expanding applied research and cost-benefit analysis and the long-term impact of these practices is crucial for improving adoption rates of SOC-building practices in the context of climate change.

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SCIENTIFIC ORAL

Mining belowground and aboveground microbiome data to identify microbial biomarkers of grapevine health and yield

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Keywords: arbuscular mycorrhizal fungi, phyllosphere, root, disease management, sustainable viticulture, grape-associated microorganisms

ABSTRACT

Vineyards are home to a wide diversity of microorganisms that interact with plants and with each other. Some microorganisms are grapevine pathogens, such as the oomycete Plasmopara viticola, which causes grapevine downy mildew (DM). Others have positive effects on vine health through protection against pathogens, resistance to abiotic stress and improved nutrition. These beneficial plant-microbe and microbe-microbe interactions, as well as the conservation of microbial diversity, have gained more attention in recent years because they could represent an alternative to the use of fungicides and fertilizer in viticulture and improve vineyard resilience to multiple stresses including those caused by climate change. In this study, we aimed to (i) identify microbial candidates for the biocontrol of DM and (ii) identify microbial biomarkers of high and stable yields over time. We analyzed the microbiota (i) in leaves and topsoil in seven pairs of vineyard plots with contrasting susceptibility to DM according to long-term epidemiological records collected in the Bordeaux region and (ii) in roots and soil in ten pairs of vineyard plots with contrasting yields according to a long-term yield database collected in the Champagne region. We combined differential abundance analyses, Random Forest algorithm, and Threshold Indicator Taxa Analysis (TITAN), and we identified fungal and bacterial taxa that were significantly more abundant in plots with low susceptibility to DM and in plots with high and stable yields. Our results revealed that several species of basidiomycete yeasts were significantly more abundant in the grapevine phyllosphere of plots with low susceptibility to DM, while taxa belonging to arbuscular mycorrhizal fungi were significantly more abundant in plots with high and stable yields. These results suggest that both the aboveground and belowground microbiomes play a role in the performance of grapevine. The relationships between grapevine performance and the abundance of specific microbial taxa should however be analyzed in controlled experiments to demonstrate the role played by microorganisms. I will present results of in vitro confrontation tests between basidiomycete yeasts and P. viticola to show that mining microbiome data can guide the search for microbial taxa beneficial to grapevine.

SCIENTIFIC ORAL

Reduced fungicide sprayings: a biodiversity boost?

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Keywords: fungus-resistant grape varieties; organic management; arthropods; natural pest control

ABSTRACT

Pesticides are considered one of the main causes for arthropod decline in agriculture which in turn may affect ecosystem services such as natural pest control and soil fertility. Although insecticides are usually most harmful to non-target organisms, also fungicides can have unintended side effects on arthropods. Grapevine typically receives ten fungicide sprayings in three months of growing season in the Palatinate region, Germany. Sprayings contain several plant protection products of varying toxicity towards non-target organisms in both organic and conventional viticulture. However, fungus-resistant grape varieties allow to study substantial reductions in fungicide applications under realistic conditions.

We compared the effects of reduced fungicide applications across 36 vineyards in a 2x2 factorial design, including fungus-resistant and susceptible grape varieties under organic and conventional management. Our sampling included arthropods from the grapevine canopy and the inter-row vegetation as well as soil dwelling arthropods and soil fungal communities. Additionally, we set up camera surveyed sentinel cards to identify predators of the European grapevine moth (Lobesia botrana).

First results indicate that canopy dwelling arthropods were strongly enhanced by reducing fungicide sprayings, particularly predatory arthropods including spiders. However, these effects were less pronounced in the inter-row vegetation and on the soil. Both organic management and fungus-resistant grape varieties influenced arthropod communities, but to different extents depending on the sampled microhabitat.

These preliminary results indicate declining effects of fungicides on non-target arthropods from the grapevine canopy (to which the fungicides are applied) towards the ground. The cultivation of fungus-resistant varieties represents a crucial step in the pursuit of sustainable viticulture.

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SCIENTIFIC ORAL

Impact of technical itineraries on the diversity and the functioning of arbuscular mycorrhizal fungi and associated microorganisms in vineyards soils and grapevine roots

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Keywords: grapevine, microorganism, agroecological practices, soil enzymatic activities

ABSTRACT

Context and purpose: The vine is a holobiont, where the plant interacts positively, negatively, and neutrally with microbes that together form the vine's microbiome. We focused on the belowground portion of this microbiome, particularly on arbuscular mycorrhizal fungi, which are known to be essential for plant growth and health and to influence berry quality. We analyzed the soil and root microbiomes of vines, along with associated soil functions, across a wide range of agricultural practices in the Cognac region, such as grass cover and agroforestry. The purpose of this study is to understand the effects of cultivation practices on the interactions between plants, soils, and microorganisms, and to examine the functions associated with mineral nutrient cycles.

Material and method: Roots, rhizospheric soil, and grapes were sampled from 52 plots selected across the Cognac region. The diversity of total fungi, arbuscular mycorrhizal fungi, bacteria, and nematodes was studied using ITS, LSU, 16S, and 18S markers, respectively. Soils were characterized by analyzing their physicochemical properties and measuring enzymatic activities related to nutrient cycles.

Results: We observed differences in soil enzymatic activities between the studied plots, as well as variations in microbial diversity profiles both between plots and between soils and roots within a given plot. An integrated analysis was carried out to assess the relationships between soil characteristics and activities, microbial diversity, and must properties. This innovative study of the core root microbiome at a regional scale highlights highly specific characteristics depending on pedoclimatic conditions and farming practices."

SCIENTIFIC ORAL

Epigenetic reponses and memories to (a)biotic stresses in grapevine

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Keywords: drought stress, carbon limitation, DNA methylation, esca, plant memory

ABSTRACT

Epigenetics corresponds to the complement of genetic information carried in chromatin beyond the DNA sequence. It includes posttranslational modifications of histones, DNA methylation and small RNAs, all involved in the control of gene expression and transposon mobility. Studies in Arabidopsis, tomato and many other plants, have demonstrated the relevance of epigenetic mechanisms in the control of development, their impact on agronomic traits and on genome stability, as well as their role in the responses of plants to various stresses, and to the memory stresses. However, most epigenetic studies so far were performed on annual plants, whereas epigenetic studies in perennials are still in their infancy. As a woody perennial, grafted and clonally propagated pant, grapevine presents unique features that make it an interesting model for epigenetic studies.

In this context we have investigated the role of epigenetic mechanisms in grapevine berries and plants, focusing on DNA methylation. We have shown tissue specific modifications of DNA methylation during berry development and ripening. Additional works are analyzing the possible roles of DNA methylation in the epigenetic memory of stresses considering both annual and trans annual priming of different stresses, such as drought stress, carbon limitation and the esca disease. To this end we are developing integrative approaches that extend from the analysis of epigenetic landscapes, transcriptomic and metabolic profiles to plant phenotypes.

Our current results indicate that the leaf methylome of grapevine is highly dynamic in response to stresses, and that stress priming influence the response of grapevine to subsequent stresses. In addition, we demonstrate a transannual memory of stresses, even after two years of stress recovery, consistent with a long-term epigenetic memory of stresses. However, this trans annual memory may depend on the type, intensity frequency and length of stresses. Current investigation are focusing on the inheritance through clonal plant propagation of stress induced DNA methylation pattern and of their phenotypical consequences. We expect that these approaches in combination will allow determining the part of the epigenetic information that is inherited from parental plants from the one acquired in a specific environment, and evaluating consequences on grapevine plants.

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SCIENTIFIC ORAL

Investigating the variability of basal crop coefficient across diverse production contexts in commercial vineyards

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Keywords: water balance, viticulture, transpiration, evapotranspiration, sap flow

ABSTRACT

Vine water use is a critical determinant of vineyard management practices, especially in the context of climate change. A common approach to estimate water use involves expressing it as a fraction of grass reference evapotranspiration using a crop coefficient (Kc), often divided into three components for plant transpiration (Kcb), cover crop transpiration (Kcc) and soil evaporation (Ke). A review of the literature reveals that Kcb and a fortiori Kc values obtained under specific experimental conditions often show significant variability and limited transferability to other contexts. Factors such as canopy management, cover crop, fertilization and irrigation practices introduce discrepancies, complicating the validation of Kcb modeling assumptions and underscoring the need for direct Kcb measurements to accurately parameterize water balance models.

Leveraging sap flow measurements collected during Fruition Sciences' consulting activities, this study explores the variability of Kcb values across diverse production conditions. Data were drawn from 119 vineyard blocks with at least three years of measurements, ensuring that the two equipped plants per block exhibited comparable transpiration profiles to minimize plant-specific effects. In total, 844 block-vintage pairs from vineyards in France and California (US) were analyzed. Hourly Kcb time series were calculated using the FAO method and smoothed via a moving average. The variability of key parameters, such as the maximum Kcb value (Kcbmax), growing degree days (GDD, base temperature of 10°C) to reach Kcbmax and the variability of post-Kcbmax Kcb values, was studied across blocks and vintages.

Preliminary findings indicate that the first and third quartiles of Kcbmax across all blocks and years were 0.36 and 0.63, typically occurring between 570 and 1325 GDD. The block-specific and vintage-specific coefficients of variation of Kcbmax respectively ranged from 0.22 to 0.39 and from 0.13 to 0.38 (first and third quartiles). Post-Kcbmax block-specific CVs varied from 0.19 to 0.30. These results are intended to spark a discussion challenging our current practices for Kcbmax estimation and to generate leads for further exploration of this database.

SCIENTIFIC ORAL

Dialing in remote measurements of grapevine water stress by incorporating whole plant physiological responses

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Keywords: grapevine, remote sensing, spectroscopy, water potential, drought

ABSTRACT

Context and purpose of the study - Current remote sensing strategies rely heavily on reflectance data and energy balance modelling using thermal imagery to estimate crop water use and stress. These approaches show great promise for driving precision management decisions but still require work to better understand how detected changes relate to meaningful physiological changes. Under water stress, grapevines exhibit a range of responses involving both biological and physical changes within leaves and canopies. This study aims to improve remote sensing indices to track grapevine stress by integrating both physical and biological effects from leaf to canopy and ultimately up to the vineyard level.

Material and methods – A two treatment drought experiment was conducted over the summer of 2024 within a field site in Davis, California spanning across two wine grape varieties (Cabernet Sauvignon and Chardonnay). Diurnal measurements taken at the site were intended to monitor drought stress within the canopy by looking at gas exchange and water movement within individual vines. Physiological measurements of upper and lower canopy levels were used to identify differences between leaves visible by drone and leaves that are not. LiDAR scans were also taken to monitor temporal changes of the canopy in response to water stress.

Results - This dataset can be used to answer questions about whole plant water stress, changes in leaf angle under water stress, where spectral signals are most useful in identifying plant stress, and if seasonal and diurnal changes impact spectral responses. Whole plant stress is integrated by looking at upper and lower canopy responses and compared to drone measurements as well as IRT wavelet calculations for each vine to determine best methods for spectral measurements of grapevine water stress.

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SCIENTIFIC ORAL

Developmental stage-specific effects of high temperature on aroma accumulation in 'Marselan' grapes from the Helan Mountain region

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Keywords: terroir, heat stress, aroma, norisoprenoids

ABSTRACT

The aroma of wine grapes is influenced by a complex metabolic network, with terroir factors, especially high temperatures, playing a critical role during berry development. This study explores how natural terroir conditions affect aroma accumulation in 'Marselan' grapes and the underlying molecular mechanisms.

We constructed the Marselan Terroir-Temporal Metabolic Network (MTTMN) dataset, which includes climate, soil, and vine growth data from five vineyards, as well as physicochemical, metabolomic, and transcriptomic data from 'Marselan' berries at various developmental stages. A total of 46 sample sets, each with three biological replicates, were collected. Targeted metabolomics (GC-MS, LC-MS) quantified 115 volatile metabolites, 43 aroma precursors, and 11 hormones. Transcriptomic data were generated through next-generation sequencing, yielding 890.5 Gb of clean data.

Cluster tree and t-SNE analyses revealed stage-specific accumulation patterns of genes and metabolites, leading to the reclassification of samples into six key developmental stages. Early stages (flowering, setting, green berry) were found to significantly impact aroma compound accumulation, with metabolites like β-damascenone and linalool being key for wine aroma quality. Co-regulation and TO-GCN analyses constructed a regulatory network of aroma metabolism, in which 6 structural genes and 31 candidate transcription factors associated with norisoprenoids were identified.

We found that vineyards with higher temperatures during the green berry stage had higher norisoprenoid levels. Heat treatments at the green berry and mature stages (38°C day, 30°C night) showed that high temperatures promoted β-damascenone and vitispirane synthesis before veraison, but inhibited accumulation after veraison. Transcriptomic analysis confirmed this stage-specific effect. We identified heat-responsive genes in the norisoprenoid regulatory network and validated two key genes, VvZEP4 and VvTAS1, along with three WRKY transcription factors involved in norisoprenoid regulation under high temperatures.

This study provides insights into the molecular mechanisms regulating aroma metabolism in response to terroir, particularly high temperatures, offering guidance for adaptive viticulture strategies amidst climate change.

SCIENTIFIC ORAL

Water status response of *Vitis vinifera* L. cv Cabernet-Sauvignon during the first years within the long-term VineyardFACE (Free Air Carbon dioxide Enrichment) study

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Keywords: grapevine, climate change, carbon dioxide, water status, gas exchange, transpiration model

ABSTRACT

Understanding the water-use responses of grapevines to increasing atmospheric carbon dioxide concentrations is mandatory when assessing the impact of climate change on viticulture as it is a critical part of the adaptation process. Therefore, besides established field measurements on vine water status modelling efforts are required to understand to what extent adaption will be possible under longer term CO2 emission and water supply scenarios. Previously, at the VineyardFACE (Free Air Carbon dioxide Enrichment) experiment in Geisenheim, Germany, plant physiology measurements, e.g. leaf gas exchange and pre-dawn leaf water potential (Ψpd), were made as Vitis vinifera cv. Cabernet Sauvignon established from planting under ambient CO2 (aCO2) and elevated CO2 (eCO2, aCO2 + 20%) concentrations. In contrast to the majority of previous observations on mature grapevines and other perennial plant species under CO2 enrichment, the young vines of the VineyardFACE experiment showed an increased intrinsic water use efficiency (WUEi) under eCO2, which was mainly associated with an increase in net assimilation (A) rather than a decrease in stomatal conductance (gs).

To determine the impact of this stomatal conduction response to eCO2 on whole vine water use of Cabernet Sauvignon, heat balance sap flow gauges were installed for subsequent seasons (2016/2017) when trunks reached a sufficient diameter. Complementary measurements of leaf gas exchange, pre-dawn leaf water potential (Ψpd), soil water content and recording of weather data were performed. In addition, a vineyard water balance model was used to test the implications of the eCO2 response, and possible explanations. Net assimilation and intrinsic water use efficiency values were higher for Cabernet Sauvignon under eCO2 conditions, as were transpiration rates (E) and stomatal conductance. The results were supported by whole vine transpiration measurements, indicating higher water use of young vines under eCO2. The difference in daily vine water use between the two CO2 treatments was higher on days of high evaporative demand. Furthermore, pre-dawn leaf water potentials were slightly lower under aCO2, suggesting a potentially lower risk of drought stress for young vines under eCO2.

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SPECIAL SCIENTIFIC ORAL

Soil incorporation of new superabsorbent hydrogels to improve vine tolerance to summer stress: physiological validation and vineyard applications

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Keywords: water stress, superabsorbent polymers, soil hydrology, vineyard establishment, water potential, photosynthesis

ABSTRACT

Hydrogels are soil-conditioning materials capable of absorbing substantial amounts of water relative to their weight. Their use in agriculture is expanding rapidly, but their effects on grapevines at transplanting has until now not been explored.

This study compared the localised root-zone application to soil of a potassium polyacrylate hydrogel (SH1) and an organic hydrogel (SH2) at vine transplanting, with an untreated control (C) in two experiments: one on potted vines under semi-controlled conditions and the other in a newly established rainfed vineyard.

Both SH1 and SH2 increased soil field capacity and maximum available water. In the potted vines, they improved water status under drought conditions, delaying the decline of stem Ψ (+ 0.25 MPa on the last day before rewatering) and enhancing leaf gas exchange (+ 9 and + 8 µmol m–2 s–1 for SH1 and SH2, respectively, as compared to C). By the end of the second season after transplanting, SH1 and SH2-treated vines exhibited greater leaf area, higher yield (+ 29 % and + 26 % relative to C, respectively), and a lower leaf-to-fruit ratio, resulting in reduced TSS (–2.0 and –2.2 °Brix respectively) and anthocyanin levels. In the field, shoot growth and final leaf area after two years were higher in SH1- and SH2-treated vines (+ 25 %). SH1 accelerated the transition to a productive stage, while SH2 reduced the number of vines requiring two-nodes pruning.

Our findings indicate that hydrogels are promising tools for vineyard water management. Their incorporation at transplanting could help shorten unproductive stages and accelerate full crop development.

SPECIAL SCIENTIFIC ORAL

Accelerated circadian cycles of photoperiod favor photosynthetic efficiency and growth in grapevine

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Keywords: *Vitis vinifera*, microvine, urban agriculture, radiation and water use efficiency

ABSTRACT

Climate change presents a challenge for agriculture worldwide. Yet, crop productivity is negatively impacted by abiotic hazards such as high temperatures and water deficit. In this context, agricultural production is shifting towards areas either of higher altitude or latitude, to lower crop exposure to such constraints (Muluneh, 2021). Meanwhile, the expansion of urban areas reduces the availability of arable land and represents a threat to food sustainability. To increase the efficiency of agricultural systems, artificial devices in urban area including growth chambers and greenhouses deserve more attention. Light intensity, spectrum and duration are essential factors for plant productivity under indoor growing conditions, to which the circadian rhythm must also be added (Paradiso & Proietti, 2021).

In plants, the photoperiod duration and the circadian rhythms regulate various processes such as stomatal opening and growth (Caluwé et al., 2016). Previous studies indicate that prolonged photoperiods can cause photoinhibition, a negative feedback mechanism that limits photosynthesis and growth to avoid damage to the photosynthetic apparatus when the plant receives more light than it can use (Takahashi & Badger, M., 2011). On the other side, short and frequent photoperiods have been shown to optimize photosynthetic productivity in annual species and microalgae (Zhang et al., 2019). However, little is known about the possible impacts of accelerated circadian cycles on carbon metabolism and growth of perennial crops, such as grapevine. Addressing the impact of circadian rhythm on grapevine functioning is thus necessary to determine the most efficient light conditions under indoor growing systems.

Microvine (Vitis vinifera) is a natural mutant that allows short experiments in fully controlled environment in growth chambers due to its small size, fast juvenile cycle and continuous fruiting (Torregrosa et al., 2019). Moreover, microvine varieties resistant to mildews, recently released from our breeding programs, considerably lower the use of chemicals, which is a pre requisite when working under confined spaces. Lastly, microvine vegetative development and individual berry growth and metabolism were shown to be very similar to grapevine (Luchaire et al., 2017; Torregrosa et al., 2019). Altogether, these properties make the microvine a suitable model for determining how changes in the circadian rhythm could impact the efficiency of grapevine functioning and resource requirements.

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SPECIAL SCIENTIFIC ORAL

Grapevine gas exchange responses to combined variations of leaf water, nitrogen and carbon status – a case of study of fungi tolerant varieties

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Keywords: leaf gas exchanges, water use efficiency, nitrogen and carbon status, high throughput, phenotyping, tolerant varieties

ABSTRACT

In the context of climate change and the need to reduce inputs, optimising photosynthesis and grapevine performance requires a better understanding of the interactions between water status, nitrogen availability, and source-sink relationships. This study investigates the combined effects of leaf water potential (Ψpd), leaf nitrogen content (LN), and leaf-to-fruit ratio (L:F) on the photosynthetic activity of three fungus-tolerant grapevine varieties (ARTABAN, 3159-B, and G5).

The experiment was conducted over two years in an experimental vineyard subjected to different agronomic practices that modified water and nitrogen availability (cover cropping, irrigation, fertilisation) and source-sink balance (winter and summer pruning). High-throughput phenotyping methods, including Near InfraRed Spectrometry (NIRS) and chlorophyll fluorescence, were used to rapidly estimate leaf nitrogen and non-structural carbohydrate contents, as well as photosynthetic activity.

Our results show that, among the monitored variables, Ψpd was the main determinant of photosynthesis, while L:F and LN had a moderate influence. ARTABAN maintained higher photosynthetic activity for a given intensity of water deficit than G5, likely due to its lower L:F. Structural equation modelling revealed causal relationships for the three genotypes between Ψpd and LN, between Ψpd and L:F, between L:F and LN, and lastly between Ψpd and photosynthesis (An). In addition, our results showed that leaf non-structural carbohydrate content was driven by both sink demand and maximum CO2 assimilation rate (Amax), rather than by water or nitrogen availability.

These findings highlight the importance of integrating water management and canopy structure optimisation to maintain carbon assimilation under limiting conditions, thus providing new perspectives for improving vineyard resilience to climate change.

SCIENTIFIC ORAL

Impacts of climate change on cv. Glera buds' fruitfulness – 18 years of monitoring in the Conegliano-Valdobbiadene area, Italy

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Keywords: flower induction, anomaly, MLR, modeling

ABSTRACT

Context and purpose of the study: The vine is generally a very fertile plant when compared to other tree species. However, there are varietal, environmental and cultural effects that can affect bud fruitfulness. Since vine productivity can vary greatly from one year to the next, in the recent climate change scenario this study focused on: i) highlighting the magnitude of fluctuations in bud fruitfulness; ii) determining the influence of the occurrence of extreme weather events and the most significant time windows on fruitfulness; iii) to develop predictive models to support winegrowers.

Material and methods: In ten Glera vineyards in the Valdobbiadene area from 2006 to 2023, field data of buds' fruitfulness were recorded in spring (BBCH 53) on the first 10 buds and expressed as: potential fruitfulness, real fruitfulness, n. blind buds and n. sterile buds. These data were related to 61 indices of climate extremes proposed by the WMO calculated on 18 years' time series of the nearby weather stations on an annual and monthly basis. Since bud fruitfulness, the result of the flower induction process, is influenced by the meteorological trend of two successive years, field fruitfulness data were compared with indices calculated both on the current season and on the previous one.

Results: The intensity and duration of thermal anomalies (summer days, frost days), heat waves and tropical nights, temperature excursions, drought events and excess water and warm winters significantly influenced buds' fruitfulness in an even opposite way in relation to the period in which they occur. Not only does the trend of the previous year significantly affect the degree of fruitfulness but also that of the first months of the season (influencing the last stages of gametogenesis). Not only does the trend of the previous year significantly affected the degree of fruitfulness but also that of the early months of the year (influencing the last stages of gametogenesis). Predictive models have been developed both for a single variable and using Multiple Linear Regressions (MLR) being able to effectively estimate the degree of fruitfulness and the extent of appearance of blind and sterile buds. The results obtained represent an important tool for assessing the impact of climate change on viticulture, understanding which environmental variables are decisive on flower induction and providing support to winegrowers to plan pruning and estimate vineyard yield.

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SCIENTIFIC ORAL

Physiological behavior of the Chasselas grape variety under water deficit: 30 years of experiments in Switzerland

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Keywords: water stress, leaf gas exchange, vessels anatomy, xylem embolism, berry composition

ABSTRACT

In the context of increasingly hot and dry summers, the adoption of innovative irrigation technologies has become essential for maintaining grape production while minimizing water use. Grapevines exposed to water and thermal stress activate adaptive mechanisms that, while protective, negatively impact yield and quality. Intense solar radiation further exacerbates these challenges, impairing the phenolic composition of grapes and causing berry sunburn, which compromises yield and fruit quality. To address these issues, a cooling system was developed to reduce sunburn damage in grape clusters. The system integrates proximal sensors to monitor vineyard microclimatic conditions and an actuator that activates nebulizers when temperatures exceed 35 °C, a critical threshold for maintaining biochemical compound stability and preventing berry damage.

Field trials conducted in 2022–2023 at the University of Bologna's experimental vineyard on Pignoletto white cultivar, investigated two treatments: Defoliation (NO DEF vs. DEF, applied pre-veraison) and Misting (NO FOG vs. FOG). The study assessed their effects on yield, berry necrosis, and secondary metabolites such as flavonols and aroma compounds.

The application of nebulized water in the fruit zone consistently reduced air and berry temperatures during both trial seasons. This cooling effect significantly mitigated sunburn damage, increased cluster weight, and enhanced overall productivity in mist-treated vines. While technological maturity showed no significant differences between the two treatments, misted vines exhibited a trend toward higher acidity during the markedly hot 2023 season.

Flavonol synthesis was unaffected by the cooling effect but was stimulated by increased light exposure, resulting in higher concentrations in defoliated treatments. Preliminary findings also highlight the cooling system's critical role in preserving aroma compounds, vital for grape and wine quality.

In conclusion, the fruit-zone cooling system proves to be a valuable and sustainable strategy to alleviate the adverse effects of summer stresses, particularly by reducing sunburn damage and improving yield and fruit quality in white berry Pignoletto cultivar.

SCIENTIFIC ORAL

An automated cooling system to mitigate thermal and radiative stresses in Pignoletto white grapes

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Keywords: climate change; precision irrigation; sunburn damages; phenolic maturity

ABSTRACT

In the context of increasingly hot and dry summers, the adoption of innovative irrigation technologies has become essential for maintaining grape production while minimizing water use. Grapevines exposed to water and thermal stress activate adaptive mechanisms that, while protective, negatively impact yield and quality. Intense solar radiation further exacerbates these challenges, impairing the phenolic composition of grapes and causing berry sunburn, which compromises yield and fruit quality. To address these issues, a cooling system was developed to reduce sunburn damage in grape clusters. The system integrates proximal sensors to monitor vineyard microclimatic conditions and an actuator that activates nebulizers when temperatures exceed 35 °C, a critical threshold for maintaining biochemical compound stability and preventing berry damage.

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In conclusion, the fruit-zone cooling system proves to be a valuable and sustainable strategy to alleviate the adverse effects of summer stresses, particularly by reducing sunburn damage and improving yield and fruit quality in white berry Pignoletto cultivar.

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SCIENTIFIC ORAL

CropManage online decision support tool for irrigation scheduling of vineyards

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Keywords: evapotranspiration, irrigation scheduling, decision support service, deficit irrigation

ABSTRACT

CropManage (CM) is an online decision support service (DSS) developed by the University of California, Division of Agriculture and Natural Resources for assisting farmers with efficiently managing water and nitrogen fertilizer to match the site-specific needs of their crops. CM also allows growers to maintain records of fertilizer and water applications for each of their fields. Although originally focused on vegetable crops, CM was more recently adapted for vineyards. Irrigation recommendations are based on estimates of crop evapotranspiration requirement where the crop coefficient (Kc) is calculated daily and adjusted for canopy development, irrigation method, and water stress imposed by grower management. Data from soil moisture sensors and flow meters can be automatically uploaded into the online application to allow farmers to compare their practices with recommendations. CropManage estimates of crop ET (ETc) were compared with eddy covariance measurements of actual ET (ETa) in vineyards in coastal California from 2019-2024. In addition, CropManage estimates of ETc were compared with satellite-based measurements of ETa from the OpenET platform (etdata.org). Applied water and soil moisture data were also monitored at the study sites. Mean absolute error and mean bias error of modeled dailycumulative evapotranspiration were computed with respect to the eddy covariance measurements and OpenET collected throughout the growing season. Results indicate that CropManage and OpenET both performed reasonably well for estimating ET for winegrape. Seasonal applied water totals were often less than ETc estimates and ETa measurements indicating that soil moisture storage in the root zone likely contributed to a significant portion of seasonal ETc.

SCIENTIFIC ORAL

Evaluating nature-based solutions for under trellis soil management: effectiveness and impacts on vine performance compared to conventional strategies

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Keywords: under-trellis cover crops, adaptation to climate change, water resources, nutrients, soil health

ABSTRACT

Soil management plays a key role in climate change adaptation. Despite weed-grapevine competition for resources can be reduced through tillage and herbicide use, novel nature-based solutions (NBS) are explored as an alternative and more sustainable viticultural practice. Studies demonstrated that ecosystem services can be achieved with conservation techniques such as native vegetation, planted cover crops and row middle mulching. However, it's still unclear if these benefits can be extended to the under-trellis area through NBS adoption. The goal of this study was to identify under-trellis cover crops (CC) that exhibit reduced water use and limited biomass growth compared to native vegetation, while also effectively covering soil and controlling weeds. Their impacts on physiological and agronomical parameters were also evaluated. Four under-trellis treatments (H–herbicide, NV–native vegetation, GH–G.hederacea, TS–T. subterraneum) were compared in a mature commercial Vitis vinifera cv. Italian Riesling vineyard in Oltrepò Pavese (IT). Treatment implementation started in 2022 while inter-row native vegetation was established from vineyard planting. H was included as a low-competition control (two glyphosate sprays), NV as a high-competition control (repeated mowing) and TS and GH as alternative low-maintenance NBS treatments. Measurements done in the 2024 growing season included seasonal variations of soil coverage (%), above-ground CC biomass (LAI and dry matter/m^2) and soil evapotranspiration rate (ET) using a portable closed chamber. Concurrently, assessing grapevine performance: leaf gas exchange, yield and grape composition at harvest, and canopy growth after leaf fall. Lastly, a preliminary assessment of treatment effects on grapevine root distribution up to 80 cm of depth was done. TS showed a decreasing soil coverage trend while NV peaked. H plot soil was maintained vegetation free, and GH under-trellis soil was consistently fully covered. These trends were associated to different CC ET rates (never higher than ET rate of NV). At veraison, both GH and TS treatments showed improved vine's physiological performance compared to NV (A - µmol/m2 – 10.7 and 10.3 respectively vs 8.1; gs – mol/m2s - 0.26 and 0.25 vs 0.18). Further understanding current results of underground interactions between vines and under-trellis CC, describing roots distribution across soil depth and evaluating the effects on soil water potential is required.

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SCIENTIFIC ORAL

On-farm monitoring of grapevine water and nitrogen status in relation to different soil management practices in Valais, Switzerland

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Keywords: grass cover, water management, nitrogen status, competition

ABSTRACT

In response to increasing societal demands for environmentally-friendly viticulture, winegrowers are adapting their cultivation techniques, particularly by reducing the use of herbicides. One such technique involves the implementation of grass cover in vineyards, which can serve as an effective tool for limiting herbicide usage. However, in the Valais region of Switzerland—where vineyards are often located on steep slopes and face dry pedoclimatic conditions with an average annual rainfall of 580 mm—this practice can be challenging to implement. To investigate the impact of grass cover in vineyards, an on-farm network was established in Valais. This network includes over 90 vineyard plots planted with cv. Pinot noir and cv. Chasselas. Cultivation methods are determined by the individual winegrowers and are representative of common practices in the region. Various soil management techniques are employed across the network, including spontaneous grass cover vs sown cover crops, inter-row cover cropping vs total cover cropping, and bare soil management. The primary goal of this network is to evaluate current practices and derive conclusions on grassing techniques suitable for the conditions of Valais. Over three vintages (2022-2024), several physiological and agronomical parameters were assessed to observe vine behavior, including vine vigor, yield components, mineral nutrition, and must composition (with a focus on yeast assimilable nitrogen). Additionally, the water status of the vines was monitored using two indicators: predawn leaf water potential and delta C13 in must sugars.

Our results indicate that, depending on the specific conditions (including vintages and terroirs), the competition between plant cover and vines for access to water and nutrients (particularly nitrogen content in berries) can be significant. This competition may lead to negative impacts on both the quantity and quality of the harvest. Therefore, the use and intensity of grass cover must be carefully adapted to the soil conditions of each plot to prevent excessive competition.

SCIENTIFIC ORAL

The opportunities offered by the climate change

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Keywords: climate change, sustainability, metaethics, vineyard management, *Terroir*

ABSTRACT

Context and purpose of the study. Based on the results of experiments since 2000 at the Institut Agro Montpellier and at INRAE - Pech Rouge, and on the international experience acquired during scientific missions, a global reflection on the opportunities offered by climate change is proposed. The global change is generally considered as a source of major problems, but besides that, there are also a lot of opportunities.

Material and methods. Experimental vineyards at INRAE – Pech Rouge, domaine de La Valette and domaine du Chapitre at Institut Agro Montpellier. Personal whitness vines as a test at a drought frontier of sustainability. Global data collection during international missions.

Results. The opportunities offered by the climate change can be synthesized as follows:

- the universal nature of the global change concerns the society as a whole and thus requires an useful interest for ethical approach and a redefinition of organic viticulture (see the GiESCO EcoMetaEthical charter);

- the extension of viticulture at higher latitudes in new producing countries can encourage wine discovery and consumption in the world ;

- the search for more temperate situations in terms of altitude or exposure creates conditions for valuing some marginal territories and rural situations ;

- the scale of the change unlocks the path to new cultivation systems : optimisation of management of natural water resources through plant architecture (ie : strong root development under Lyre canopy) and soil maintenance (priority for soil preservation), and control of a qualitative drip irrigation using any kind of 'lost water';

- the conjunction between climate change, environmental protection and changes in consumption unlocks the field of changing grape varieties towards resistant to main parasites and qualitative types;

- changes in wines make it necessary to study their typicality and distinguish between evolutionary (basic equilibrium of the taste) and invariant elements (some aromatic notes expressing the 'terroir signature');

- the opportunity also exists in the development of new technologies (precision viticulture, viticultural agrivoltaics), original pruning methods (Half Pruning Before Harvest, Second Adjusted Pruning in Spring), new productions (extension of table grapes, new types of wines).

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SCIENTIFIC ORAL

Managing alcohol in sparkling wine production: adjusting harvest timing and utilizing grape juice in "liqueur de tirage"

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Keywords: harvest date, sugar loading, secondary fermentation, grape juice as "liqueur de tirage"

ABSTRACT

Context and purpose of the study: Sparkling wine production is majorly impacted by climate change as sugar accumulation and aromatic development in grapes are often decoupled. While advancing the harvest date is a common approach to manage alcohol levels, studies showed that delaying the harvest by one week significantly improved the aroma and sensory characteristics of sparkling wines (Skrab et al., 2024). Using grape juice instead of sucrose in the 'liqueur de tirage' for secondary fermentation offers an alternative strategy, thereby reducing the alcohol increase, allowing greater flexibility selecting the harvest date. The "sugar loading" concept, measuring sugar per berry, provides a valuable tool assessing grape maturity but is rarely applied for sparkling wine production. Our study explored various alcohol management strategies for sparkling wine production by experimenting with different harvest dates and using either sucrose or grape juice as the "liqueur de tirage" for secondary fermentation.

Material and Methods: Riesling grapes from Baden-Württemberg (Germany) were harvested in 2021 on four dates based on sugar loading and other indicators (e.g., berry tasting). Starting one week before phloem blockage (17.6°Brix, H1), harvests progressed weekly (19.4°Brix, H2; 19.8°Brix, H3; 20.4°Brix, H4). Must acidity of early harvests was adjusted to match later dates. Base wines were fermented, bottled, and sensory evaluation took place two months later. Experimental batches of sparkling wines were also prepared via méthode traditionnelle using sucrose (24 g/L) or stored grape juice as "liqueur de tirage". The sparkling wines aged on lees for nine months, were riddled, analyzed and sensory evaluation took place two months later.

Results: For the base wines, the 'aroma intensity' descriptors increased significantly between H1/H2 and H3/H4, with the flavor profile evolving from green apple (H1) to citrus (H2), to peach (H3), and pineapple (H4). This trend was reflected in sparkling wines, where early harvests (H1) showed herbaceous notes and lower preference compared to later harvests. Using grape juice for the prise de mousse reduced alcohol and bitterness in sparkling wines while maintaining the quality of mousseux.

Conclusion: Although limited to one season, this study highlights alternative strategies for sparkling wine production focusing on process adaptations to mitigate the drawbacks of using immature grapes for base wine.

SCIENTIFIC ORAL

Soil, foliar, and juice nitrogen application: influence on fruit and wine for Chardonel grown in Virginia

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Keywords: Chardonel, amino acids, nitrogen, vineyard, fermentation

ABSTRACT

Nitrogen (N) is applied in the vineyard or the winery in wine production systems. The influence of different routes of N application is not well understood. Thus, we evaluated the effects of vineyard-applied soil and foliar N on fruit chemistry, fermentation and wine sensory characteristics in the interspecific hybrid Chardonel, in Virginia, USA. For three years, three levels of soil N and two levels of foliar N were applied. Yeast assimilable nitrogen (YAN) and amino acids, soluble solids, pH, TA, yield, berry weight, cluster weight and pruning weight were determined. Wines were made from all field treatments in 2022, and in 2023, winery N addition was overlaid on the control and high vineyard N levels to compare the effects of vineyard- vs. winery-applied N. Wines were subjected to chemical and sensory evaluation.

Vineyard-applied N led to higher YAN, with great impact of foliar vs. soil N. YAN ranged from 128 to 255 mg/L, 132 to 270 mg/L, and 59 to 175 mg/L in 2021, 2022, and 2023. The most prevalent amino acids were proline, glutamine, alanine and arginine. Growing season had the greatest impact on individual amino acids, followed by soil, then foliar N. No effects on yield, berry weight, pH, or TA, and minimal effects on soluble solids, cluster weight, and pruning weight were observed. For 2022, sensory differences were observed among wines, but differences were not explained by the field treatments alone. Moderate soil N associated with fruit-forward wines, while foliar N did not associate with consistent outcomes. Sensory differences were also observed among the 2023 wines made with vineyard vs. winery N additions at the control and 100mg/L total YAN conditions. At 200 mg/L total YAN the source of N no longer resulted in sensory differences, indicating that lower total YAN wine fermentations may be more influenced by the source of nitrogen. Finally, the residual amino acid profile in wine differed among the field treatments, which could influence wine aging characteristics. Taken together, our findings indicate that while the moderate soil and foliar N applications evaluated in this study may not significantly influence components of yield or primary fruit chemistry, YAN and amino acid profile are affected. Also, sensory differences in wines made from fruit receiving different N treatments in the vineyard and/or winery are detectable by untrained panelists, indicating the potential for N management to influence wine typicity.

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SCIENTIFIC ORAL

Pioneering dynamic AgriVoltaics in viticulture: enhancing grapevine productivity, wine quality and climate protection through agronomical steering in a large-scale field study

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Keywords: climate change, yield, climatic protection, plant modelling, steering policies

ABSTRACT

Context and purpose of the study - Climate change threatens traditional winegrowing regions, with about 90% of areas like southern France at risk by the end of the century due to heatwaves and droughts. To adapt, wine producers must adjust grape varieties, rootstocks, training systems, and vineyard protection. Agrivoltaic systems, which provide shading for vines, offer a potential solution, but permanent shading can reduce berry development and yield. Sun'Agri, in collaboration with INRAE and CA66, developed a dynamic agrivoltaic system with adjustable photovoltaic panels and optimized shading based on the vines' needs, balancing climate protection and productivity. Deployed in southern France, this system has been studied for six years to address both climate protection, productivity and quality challenges.

Material and Methods – In 2018, Marselan, Chardonnay and Grenache Blanc grapevines were planted manually under the dynamic agrivoltaic (DAV) system in Tresserre (South of France). The system covered 4.5 hectares, adjacent to a 3-hectare control field planted mechanically. DAV was divided into two areas to test two shading strategies: full solar tracking and agronomic steering based on plant needs. From 2018 to 2024, microclimate, vigor, phenology, yield components, and berry and wine quality were monitored. Since 2022, shading management has been optimized using a grapevine crop model. In 2022, soil pits were carried out to assess root development under different treatments.

Results – In the first harvest of 2022, yields were lower in the DAV area due to manual planting and soil compaction resulting in a plant vigor decrease. In 2023, a drought year, agronomic steering under DAV provided significant climatic protection and outperformed the control with yields up to +45%. In 2024, another drought year, yields continued to exceed the control by 61% for Chardonnay, 31% for Grenache Blanc and 18% for Marselan. In contrast, the solar tracking area, designed for maximum electricity production, resulted in a yield loss up to 45% compared to the control for both last years. The DAV with agronomical steering also improved berry quality and sensory profile of the wine. As demonstrated by the differences observed in yield and quality, the optimization of shading with agronomic steering policies seems to be a necessity to adapt grapevines to climate change challenges while maintaining vineyard productivity.


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Effects of mulching with municipal solid waste (MSW)-compost on the soil microbiota and decomposition activity in a productive vineyard in Apulia (Italy)

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Keywords: municipal solid waste (MSW)-compost, vineyard, mulching, metabarcoding, teabag index (TBI)

ABSTRACT

Application of municipal solid waste (MSW)-compost as a mulching material in vineyards supports sustainable practices and aligns with both circular economy and zero-waste principles.

Aim of the study was to evaluate the effects in vineyard of MSW-compost mulching on the bacterial soil microbiota structure and decomposition activity.

The experiment was conducted in a 5-years-old vineyard (cv. 'Primitivo') in Salento (Southern Italy). Vineyard implantation consists of rows, vertical shoot positioning with Guyot pruning. Grapevine plants were divided into groups of 6 plants each, subjected to the following treatments (n=3, completely randomized design):

1. Film-black: mulching with traditional black PE film;
2. Film-b/w: mulching with biodegradable film;
3. Compost (8): mulching with MSW-compost, 8 kg plant-1;
4. Compost (15): mulching with MSW-compost, 15 kg plant-1;
5. Compost (22): mulching with MSW-compost, 22 kg plant-1;
6. Control: no mulching.

MSW-compost consisted of a composted mixture of green residues and the organic fraction of municipal solid waste (MSW) produced by a local company.

Metabarcoding was performed on an Illumina Miseq2 machine (paired end sequencing), targeting the V3-V4 region of the 16S rRNA gene, and included both MSW-compost and soil samples collected in March, July and October 2023. QIIME2 and nested plugins were used to analyze the sequence data, inspect alpha and beta diversity, and assign taxonomy.

Soil decomposition activity was assessed by Teabags method on treatments Film-black, Compost (15) and Control.

No significant effects were obtained on both alpha and beta diversity, likely due to a high sample heterogeneity; however, plots showed an impact of the MSW-compost on the soil microbiota structure: compost-treated samples segregated from control in July but notably less in October, indicating a reduction of the effect over time. Some genera contributed more to group stratification, by decreasing in the compost-treated samples: Rubellimicrobium, unidentified genera of the Azospirillaceae family; Candidatus_Alysiosphaera; unidentified genera of Chloroflexi (order Kallotenuales); WD2101 (phylum Planctomycetota); unidentified genera of the Geodermatophilaceae family, and Rhodocytophaga. Pairwise comparisons based on fold change showed significantly increased or decreased taxa.

Teabags index showed that MSW-compost stimulated the soil decomposition activity in the first 3 months after its application.

OPEN ACCESS

FLASH ORAL

DNA-free genome editing confers disease resistance in grapevine varieties

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Keywords: genome editing, protoplasts, sustainability, NGT1, grapevine

ABSTRACT

The grapevine is facing significant challenges due to climate change, as rising temperatures impact its physiological traits and disrupt plant phenology. Additionally, increased virulence in pathogen attacks and pests leads to significant yield loss, requiring widespread application of plant protection products. Traditional agronomic practices offer only partial mitigation, requiring the development of precise and effective intervention strategies. The economic worth of viticulture has prompted continuous efforts in grapevine genetic improvement programs, traditionally involving conventional breeding and clonal selection that, however, are complex and time-consuming. The New Genomic Techniques that exploit genome editing via CRISPR/Cas9 present an avenue for developing tools to mitigate the challenges of viticulture, including fungal diseases.

We report the application of a DNA-free genome editing approach to induce targeted mutations in grapevine susceptibility genes. CRISPR/Cas9 ribonucleoparticles were introduced into protoplasts isolated from embryogenic calli. Through protoplast regeneration, edited grapevine plants of different commercial varieties were obtained. These mutations reduced susceptibility to pathogen attack and confer resistance to pests.

The success of this application for the improvement of target traits establishes a foundation for promoting viticulture sustainability yet preserving the identity of the grapevine cultivars. This advancement aligns with market and legislative demands, paving the way for a resilient and environmentally conscious winegrowing system.

FLASH ORAL

Exploring induced mutagenesis as a tool for grapevine intra-varietal improvement: increased diversity in ripening periods and bunch traits with climate resilience potential

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Keywords: induced mutagenesis, grapevine improvement, climate resilience, intra-varietal diversity

ABSTRACT

The wine industry currently relies on a limited number of grapevine cultivars, comprised of numerous clones with slight differences in their viticultural, oenological, or stress-tolerance traits. To adapt to and mitigate the impacts of rising global temperatures and associated stress pressures, characterising and conserving intra-varietal diversity is crucial for cultivar improvement. Mutagenesis can enhance genetic diversity, offering a means to identify and conserve potentially useful traits. Induced mutagenesis using chemical or physical mutagens is widely employed in plants to introduce genetic variation.

As a relatively young cultivar, Pinotage (a South African-bred red-wine cultivar) has very few registered clones compared to ancient cultivars. To increase the diversity of currently available Pinotage planting materials, an intra-varietal improvement scheme was implemented using gamma irradiation. The treatment was applied to in vitro plantlets of three widely planted Pinotage clones (Pi7B, Pi45R and Pi48I), targeting the meristems of the latent buds, resulting in a collection of ~1400 putatively mutated plants. A subset of 500 individuals (irradiated treatment vines and unirradiated somaclonal controls) was pre-selected and field-planted in 2021. Fruiting began in 2023, enabling detailed analysis of viticultural and oenological characteristics towards selection.

Phenotyping techniques (using OIV descriptors and agronomic measurements) and phenological scoring (using E-L scale), including ripeness monitoring, were employed to perform the initial characterisation of the fruiting putative mutant grapevines. Diverse phenotypes were observed amongst the population, including variation in berry skin colour, flesh colour, seed characteristics and bunch compactness. The bunch architecture traits and compactness were a particular focus given the links with improved ripening and reduced fungal infections of less compact bunches. This population also displayed a wide range of phenological progressions and ripening periods. Variation in the véraison-harvest period has implications for climate resilience, as rising global temperatures advance phenology and ripening, resulting in unbalanced phenolic accumulation and sugar-to-acid ratios, restraining grape and wine quality. Our results on this population will be shared to highlight the potential of gamma irradiation and induced mutagenesis for increasing intra-varietal diversity in grapevine cultivars and clones.

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FLASH ORAL

Transcriptomic analyses of wild *Vitis* species under drought conditions for next-generation breeding of grapevine rootstocks

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Keywords: genetic variability, *Vitis*, drought, transcriptomic, rootstock.

ABSTRACT

Drought is one of the main challenges for viticulture in the context of climate change. Selecting drought-tolerant plant material can be an effective strategy for a sustainable viticulture. The choice of rootstock is a relevant way of adaptation to future environmental conditions as we can improve plant performance without modifying the scion variety and thus the wine composition. For this purpose, breeding new rootstocks is essential since currently used rootstocks have a narrow genetic diversity that could compromise their ability to adapt to new environmental conditions. Thus, exploiting a wider range of wild Vitis species for the innovation of new grapevine rootstock varieties is crucial. The aim of our work was to identify the molecular determinants of root drought responses in a wide range of unexplored wild Vitis species and identify interesting genotypes for rootstock breeding. For this purpose, we characterized the response of cuttings from ten wild Vitis accessions, from three different species (V. acerifolia, V. candicans and V. doaniana) to moderate drought with a focus on root morphological and molecular responses. The plants were submitted to water stress (30% of soil water capacity) for 4 weeks in a greenhouse. RNA sequencing data were generated from roots of all ten accessions and differential gene expression analyses were conducted. The results show a high conservation of core gene expressions responses to drought; interesting genes include a range of MYB transcription factors. In addition, species-specific gene expression patterns were identified. Our results highlight high intra-specific variability in root gene expression profiles in response to drought. These outcomes contribute to decipher the genetic regulation of root drought responses in wild Vitis species.

FLASH ORAL

Identification of QTLS for sunburn resilience in grapevine berries

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Keywords: climate change, QTL analysis, abiotic stress, grapevine sunburn, cool climate viticulture, MAS

ABSTRACT

Context and purpose of the study – Grape sunburn is an abiotic stress response triggered by high temperatures. In European cool-climate wine-growing regions, heat stress events are intensifying in their frequency, due to climate change. This stresses grape berries, causing browning and shriveling and results in yield losses and diminished wine quality. Traditional management practices, such as defoliation in the cluster zone to reduce fungal pressure, may exacerbate this issue. Developing climate-adapted cultivars with resilience to sunburn could address these trade-offs for the vineyard management. Some fungus-resistant varieties (PIWIs), like Calardis Blanc, were recently identified to shown notable sunburn resilience. Establishment of vineyards with such culivars that combine protection against abiotic and biotic stress, can help to secure yield and wine quality for a future-proof sustainable viticulture. This study identifies two significant QTLs associated with sunburn damage based on field trials to gain knowledge for genetic factors and highlights the potential and challenges of breeding sunburn-resistant grape plants through marker-assisted selection (MAS).

Material and methods – For this study, a biparental F1 mapping population of Calardis Musqué x Villard Blanc (CMxVB), comprised of 150 genotypes, was investigated at the JKI Geilweilerhof in Siebeldingen, Germany. New SSR markers were developed for the genomic regions associated with loci on chromosomes 10 and 11 and incorporated into an existing genetic map. Sunburn assessments were performed from 2019 to 2023, with damage evaluated each year based on the OIV descriptor 404 for "thermal stress", whenever symptoms became evident.

Results – Composite interval mapping (CIM) using the revised genetic map and five years of phenotypic field data on sunburn damage identified two significant QTLs. One was located on the lower arm of chromosome 11, with LODmax values reaching 16.3 and one on chromosome 10, with a LODmax value of 10.29. The highest sunburn resilience in berries was linked to the additive effects of an optimal allelic combination at both loci. The results show the high genetic influence while the ripening stage during the heat event revealed to be of minor importance. The QTL regions were further analyzed for annotated and expressed genes in developing grape berries, providing insights into potential mechanisms underlying sunburn resilience.

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FLASH ORAL

Rootstock selection moderates the effect of rising temperatures through drought tolerance and modulation of stomatal conductance

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Keywords: climate change, Grenache, isohydric, rootstock, temperature, water use efficiency

ABSTRACT

Climate change is increasing crop evapotranspiration and reducing water availability, especially in the Mediterranean area. The use of grapevine rootstocks (Vitis spp.) is a great modulator of drought tolerance and vigor. Despites these being well characterized in some aspects, the performance of the different rootstocks under climate change conditions is largely unexplored. The aim of this study was to test the effect of increased temperature on water use of water use traits of grapevines on different rootstocks.

In this experiment, four rootstocks (420A, FERCAL, 110R and 140Ru) grafted with Grenache were grown with either ambient or elevated (+4oC) temperature under well-watered conditions. The four rootstocks were also characterized under a drought cycle where irrigation was withheld until stomatal closure. Temperature increased net assimilation (A), transpiration (E) and stomatal conductance (gs), with the rootstocks showing different gs rates. Water consumption (E and gs) of 140Ru was not increased under elevated temperature, suggesting a good adaptation of this genotype to these conditions. Rootstock 140R had the lowest anisohydricity (estimated as the difference between Ψ midday stem and Ψ predawn), while 420A had the highest. Rootstock 110R needed greater soil water tension to close their stomata, while 420A closed stomata under the lowest tension of all.

Being 140R and 110R two rootstocks known as drought tolerant, 110R showed the greatest tolerance to drying soils while 140Ru showed a modulation of water consumption desirable under rising temperatures.

FLASH ORAL

Streamlining rootstock selection: new indices for efficiency and stability in viticulture

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Keywords: rootstock efficiency, yield, vine balance, sustainability

ABSTRACT

Grapevine rootstocks play a pivotal role in influencing scion vigor, yield, and fruit quality, making their selection critical for sustainable vineyard management. This study introduces two novel indices, the Rootstock Efficiency Index (REI) and the Rootstock Stability Index (RSI), designed to evaluate rootstock performance by integrating key factors such as vigor, yield, fruit quality, and vine balance. The primary objectives of this study were to develop these indices and validate their applicability using long-term data. Data were collected over a 16-year period from 10 different rootstocks grafted onto 'Moscato Bianco' planted in Piemonte (Italy). Measurements included yield and its components, pruning weight, vine balance, fruit quality and disease incidence (Botrytis and acid rot severity). The REI was developed to assess how efficiently rootstocks support the production of high-quality fruit without negatively impacting vine balance, which is a key indicator of vineyard health and sustainability. The RSI, in contrast, was created to evaluate the year-to-year stability of rootstock performance, highlighting rootstocks that consistently meet desired benchmarks for yield and quality under variable climatic conditions. The analysis reported significant differences in yield, pruning weight, sugar content, and acid content across rootstocks, while disease susceptibility (Botrytis and acid rot) remained consistent. 420A showed lower yields, acid content, and pruning weights compared to other rootstocks, while 157-11 displayed a higher REI, suggesting superior efficiency. However, REI values were more influenced by environmental variation than by inherent rootstock traits, underscoring the impact of climatic and site-specific factors. On the other hand, the RSI identified SO4 and 420A as the most stable rootstocks, with Du Lot and 1103P showing greater variability. Interestingly, stable rootstocks such as SO4 and 420A were associated with lower cumulative yields over 16 years compared to more variable rootstocks, suggesting a trade-off between yield stability and productivity. These findings demonstrate the utility of REI and RSI as tools for characterizing rootstock performance. By establishing desired benchmarks for sugar, acid, and vine balance specific to different grape varieties and growing regions, these indices can guide the selection of rootstocks tailored to the goals of both vineyard efficiency and long-term sustainability.

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FLASH ORAL

How sensory quality of wines can be accessed as a trait in MAS grape vine breeding

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Keywords: MAS, sensory, QTL, monoterpenes, thiols

ABSTRACT

In the context of the global crises of global warming, biodiversity and pollution, current agricultural practices need to be reconsidered. Grape breeding can contribute to making viticulture more sustainable by providing new grape varieties with resistance to pests, thus reducing the use of pesticides and their impact on biodiversity and pollution.

As a traditional product with well-established wine styles, the acceptance of new varieties is strongly dependent on sensory quality. In order to speed up grapevine breeding and make it more efficient, wine sensory quality should be included as a trait for marker-assisted selection (MAS) in a grapevine breeding programme.

In the current multidisciplinary project, two segregating F1 populations of 'Calardis Musqué' x 'Villard Blanc' crosses, including a total of 150 selected individual genotypes, were characterised by a high-density genetic map using a 'genotyping by sequencing' approach. More than 1300 individual wines were vinified over eight vintages and comprehensively characterised by sensory and chemical analysis.

Sensory evaluation revealed a constant set of 'best' and 'worst' rated genotypes, independent of geolocation and vintage. In addition, overall wine quality correlated with the descriptive attributes of 'floral' and 'fruity' nuances of aroma.

Targeted aroma analysis for monoterpenes, C13 norisoprenoids and varietal volatile thiols was correlated with sensory results and linked to genetic information from a high-density genetic map of the population via QTL analysis.

FLASH ORAL

Automated detection of downy mildew in vineyards using explainable deep learning

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Keywords: crop protection, grapevine diseases, artificial intelligence, digital viticulture

ABSTRACT

Traditional methods for identifying downy mildew in commercial vineyards are often labour-intensive, subjective, and time-consuming. Artificial intelligence offers an opportunity to streamline and standardize this process, increasing sampling efficiency and consistency. This study presents an interpretable, automated approach to detect downy mildew symptoms in vineyard conditions. RGB images of grapevine canopies were collected across multiple commercial vineyards using a ground-based mobile phenotyping platform. Image analysis was conducted using a sliding window technique to classify sub-images into zones with and without symptoms. Techniques such as transfer learning, fine-tuning, and data augmentation were used to automate classification, comparing the performance of convolutional neural networks (CNNs) and vision transformers (ViTs). The trained model, integrated into the sliding window system, accurately localized symptomatic areas, with predictions interpreted through explainable artificial intelligence (XAI). The EfficientNetV2S model achieved a classification accuracy of 91% and an F1-score of 0.92 in localizing symptomatic zones. This approach enables reliable and interpretable downy mildew detection under diverse field conditions, representing a significant advancement in precision vineyard protection.

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FLASH ORAL

Evaluating the suitability of hyper- and multispectral imaging to detect endogenic diseases in grapevine

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Keywords: remote sensing, PHENOliner, PHENOquad, disease screening, sensor-based detection, esca, phytoplasm, virus

ABSTRACT

Endogenic diseases often arise from pathogens that exist within the plant tissue, including fungi, bacteria, and viruses, which can remain latent and then emerge under stress conditions or favorable environmental conditions, causing symptoms that weaken vines or can lead to plant death. Early detection enables a proactive approach to disease management, promoting both yield quality and environmental sustainability. Spectral sensors enable objective, non-invasive detection of plant reflectance across the visible light spectrum (400–700 nm) as well as in the near-infrared (700–1000 nm) and short-wave infrared regions (1000–2500 nm).

The suitability of ground-based hyperspectral and multispetrctral analyses for the detection of grapevine phytoplasma diseases Palatinate grapevine yellows (PGY), Bois noir (BN) and Flavescence doree (FD), the virus infection grapevine leafroll disease (GLD), and the fungal Esca disease has been evaluated. Distinction between diseases and nutrient deficiencies was tested for magnesium (Mg) and iron (Fe) deficiency. Sensor data has been acquired over recent years from 2016 - 2018 and 2022 -2023 in the greenhouse as well as in field locations in Germany and Italy.

Disease detection models on hyperspectral data for BN and PGY could be developed under controlled conditions, models were able to classify infected plants correctly with an accuracy of up to 96%. Infected shoots collected in the field showing grapevine yellows disease were analyzed, gaining high classification accuracies of up to 100%, leading to the assumption that both diseases might also be detectable directly in the field, which was tested using a multispectral sensor in 2022-2023. GLD detection was initially tested on various greenhouse plants, achieving identification rates of 83–100% for symptomatic vines and 85–100% for infected vines without symptoms. Field plant acquisition showed comparable classification accuracy. The results also demonstrated the potential of hyperspectral analysis for detecting asymptomatic infections directly in the field, though accuracy varied significantly between experimental years. For Esca disease, field detection was conducted over three consecutive years, with hyperspectral detection models successfully developed based on original field data. The overall classification rate for distigushing the classes FD, BN, Fe, Mg and viroses using a hyperspectral sensor was 90%.

FLASH ORAL

Intra-vineyard spatial variability explored over multiple seasons by sensor-based techniques in the Valpolicella area

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Keywords: vineyard-variability, remote sensors, ground-based sensors, vine vigor, berry quality compounds

ABSTRACT

The identification and management of intra-vineyard variability are key to precision viticulture, and sensors have been proven to be highly efficient tools for detecting these variations. Vineyard variability often manifests as differences in vine vigor, which, in turn, can influence fruit development. However, this variation stems from complex interactions among multiple factors (e.g., topography, soil, water availability, microclimate, and climate), that may vary from season to season. Given the dynamic nature of this system, it is important to define the vine and berry vigor responses and their correlation with sensor-derived data over multiple seasons.

To this end, a vineyard in the Valpolicella viticultural area (north-east Italy) was monitored over three consecutive years (2021–2023) employing various sensor platforms. NDVI was calculated using Sentinel-2 and UAV multispectral images, as well as a handheld NDVI sensor. The UAV orthomosaic was further used to estimate the canopy dimension (2D Canopy). A thermal camera was used to assess the crop water stress (CWSI), and a TDR moisture meter was used to measure soil volumetric water content (VWC). Ground truthing across 11 dispersed blocks included bud fruitfulness, shoot development, yield, and vine-balance traits. Berries were analyzed for their weight, skin thickness, and quality compounds.

The spatial variability of each parameter was assessed for its temporal stability, and the relationships between sensor-derived data and direct vine and berry measurements were established across seasons. Correlation analyses and clustering identified several key, tightly related vigor parameters (e.g., NDVIs, 2D Canopy, shoot length, yield, berry weight, and acidity), which were consistently negatively correlated with the CWSI. The latter maintained positive associations with the pH, TSS, anthocyanins, and polyphenols.

This study explores inter- and intra-annual dynamics linking vine agronomic parameters and berry quality traits to sensor-derived data to enhance the informative potential of the latter and help sensor-assisted vineyard management.

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FLASH ORAL

Simulating berry sunburn in virtual vineyards

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Keywords: virtual plant, functional-structural plant model, sunburn, light, abiotic stress

ABSTRACT

Context and purpose of the study. Berry sunburn in vineyards is a recurring disorder that can cause severe yield loss. As sunburn observations are often associated with heat waves, a link to climate change is likely. Sunburn depends on local heat exposure on the berry surface and its susceptibility to sunburn. Since sunburn only occurs when berries are exposed to direct sunlight, the canopy architecture itself may already protect berries from sunburn. Therefore, this study aimed to provide a model-based analysis of berry sunburn that captures temporal and spatial dynamics in vineyard systems.

Materials and methods. We advanced the functional-structural grapevine model Virtual Riesling for conducting in silico studies on berry sunburn. This temperature-sensitive dynamic architecture model was used to create natural, realistic environments covering a variety of typical light conditions within a virtual canopy. Our simulation study involved several possible future temperature scenarios on differently oriented vineyards. Virtual plant management included vertical shoot positioning, cutting, and leaf removal.

Results. Simulation results confirmed the pivotal role of ambient temperatures in the occurrence of sunburn, but also highlighted the particular importance of the timing of the environmental conditions. When virtual berries were shaded by surrounding leaves during times of high temperatures, they likely did not get sunburned. Azimuthal crossing, i.e., the alignment of sun azimuth and row orientation, takes place at different times in differently orientated vineyards. In the virtual vineyards, this significantly affected the progression of the sunburn over the day. As anticipated, the simulations conducted with increased temperatures led to higher sunburn damages, but only when critical temperatures coincided with low self-protective shading. Consequently, e.g., a vineyard with a northeast-southwest orientation may have greater resistance to sunburn after leaf removal than a vineyard with a north-south orientation.

Our study provided first insights into favorable canopy configurations and a valuable expandable data set for in-depth analysis. The approach allowed us to identify critical periods of sunburn occurrence related to environment and vineyard set-up. This makes it a suitable tool for developing mitigation strategies that focus on the interaction between plant architecture and environmental conditions.

FLASH ORAL

Carbohydrate dynamics in Shiraz to determine seasonal allocation to the perennial and annual parts in respect to climatic challenges

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Keywords: carbohydrate balance, grapevine model, climate variability, biomass allocation

ABSTRACT

The dynamic changes of non-structural carbohydrates (NSC) in grapevines during the growing season is driven by phenological events and environmental factors. The perennial NSC reserves have a significant role at the beginning of growing season for canopy establishment and may also contribute to grape maturation. In addition, increasing extreme weather events may elicit utilisation of some of these reserves. This will impact on the seasonal carbohydrate balance; an understanding of the interactions between the various sinks and sources is therefore more critical for the future. The aim of the study was to provide a collection of NSC data from the various parts of grapevines to determine the accumulation and mobilisation patterns during the growing season as well as for simulating organ biomass and NSC distribution. The study was undertaken on own-rooted 10-year-old Shiraz in a vineyard located in the warm Riverina wine region in New South Wales, Australia. Four vines were destructively harvested from dormancy to shortly after leaf fall in monthly intervals. The various sections of the below ground parts were divided into rootstock and roots, while the above ground parts were separated into the different perennial, vegetative and reproductive organs. The various sections were washed, then oven dried at 70o C and the dry weight recorded. A freeze-dried sub-sample was ground prior to the determination of the NSC for each section. There was a considerable NSC accumulation in the annual organs during the growing season, being most pronounced between fruit-set and harvest. In contrast, the NSC in the perennial organs declined to half from dormancy to bloom, with replenishment observed at harvest. The mobilisation in spring was most pronounced in the roots, while the fruit became the most dominant sink after fruit set, being most pronounced during grape maturation. While shoot stems accumulate dominantly the NSC from mid ripening to leaf-fall, with the perennial organs accumulating further NSC in the post-harvest period. The reproducibility of dry matter and carbohydrate reserves dynamics in the various parts of Shiraz vines using APSIM grapevine model will be reported. The study further clarified that the amounts of NSC allocated to the perennial structure and annual parts during the growing season. This will contribute to the optimization of carbohydrate balance of grapevines and to the changes required for carbohydrate allocation due to climate change.

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FLASH ORAL

VitiProtect–Development and testing of a downy mildew AI forecasting model for Swiss viticulture

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Keywords: downy mildew, artifical intelligence, disesase risk forecast

ABSTRACT

Downy mildew (Plasmopara viticola) is a fungal pathogen that causes a destructive disease in grapevines (Vitis vinifera). The dissemination of the disease exhibits considerable regional variability and is influenced by the prevailing microclimate. To control downy mildew, the use of substantial quantities of plant protection products (PPPs) is needed. The development of reliable forecasting models that can provide early warning of impending infection events is of paramount importance for the targeted application of PPPs. However, the prediction of downy mildew is a highly complex undertaking. Current models, which have been tested and proven effective, are mechanistic in nature and have been applied so far for regional contexts. As is becoming increasingly apparent, these models are not able to quickly take into account the changes caused by climate change and microclimatic conditions. New methods from the field of machine learning can increasingly be used and offer more flexible solutions for the future. Such tools could process environmental changes in real time, incorporate them into the risk forecast, and thus enable more individualized, farm-based risk predictions at the vineyard level.

The VitiProtect project is investigating the potential of machine learning for the prediction of diseases in viticulture, with downy mildew serving as a case study. Over the past two years, data on the phenology of the vines and downy mildew infestation were collected on a weekly basis between May and August on 107 unsprayed plots. In addition, meteorological parameters such as rainfall, humidity, air temperature, leaf wetness, and relative soil moisture were measured hourly at all plots. Following data cleansing, a prototype risk prognosis model for downy mildew is developed with the help of artificial intelligence. Currently, this prototype is tested in the field and will be further improved based on new infection data. Field experiments are carried out to examine whether the new forecasting model can be used to reduce the use of PPPs and thus contribute to achieving the sustainability goals.

FLASH ORAL

Title Extraction-modelling approach demonstrates grapevine rooting patterns varies significantly as a result of contrasting ground management and growing environment in cover cropped vineyards.

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Keywords: cover crop management, soil resource competition, GxMxE interactions, grapevine root system architecture, deep learning model

ABSTRACT

The use of cover crops in viticulture has increased in recent decades as growers seek to reduce herbicide use, improve soil organic matter and biodiversity, and minimize soil-related agronomic issues such as compaction and erosion. However, despite the well-documented benefits of cover cropping, soil resource competition from these plant species growing together with grapevines remains a concern among growers. Competition between grapevines and cover crops for water and nutrients is determined by the interactions between their root systems, and the demand for these resources driven by transpiration, growth and maintenance requirements of the whole plant. Recent research also suggests that grapevine root distribution relative to the distribution of cover crop roots is also an important factor, with interactive effects of rainfall, irrigation and vineyard floor management appearing to modify the relative grapevine share of the soil volume. An improved understanding of the functional implications of varying grapevine rooting patterns would provide growers with more informed strategies to manage grape production in cover-cropped vineyards, where for example such information would allow for better-optimized vineyard establishment where the grapevine root system is allowed to establish its territory before cover crop species are introduced. This current work proposes to address this question with a new approach to characterizing root system architecture (RSA) through a novel combination of in-field measurement and modelling, providing a root system structure that can later be used to model water and nutrient uptake. For the first validation of this method, soil core samples were collected from vineyards with contrasting ground management systems, the roots washed and for scanned image analysis in WinRhizo, and distribution data inputted into a newly developed deep-learning 3D RSA generator to create root system architecture snapshots representative of its growing environment. Some early generative results based on field-collected root parameters collected from commercial vineyards in Orange, NSW, Australia and Marlborough, New Zealand wine regions, from the 3D RSA generator, will be demonstrated in this presentation to showcase some of the capabilities of this RSA generator and the contrasting RSA of grapevines growing in different growing environments.

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FLASH ORAL

Sustainable vineyard management at the regional scale: insights from a Swiss winegrowing region

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Keywords: biodiversity, plant cover, regional-scale model, soil quality, sustainable viticulture

ABSTRACT

Swiss wine producers are faced to high production costs and low-priced wine imports. In response, some winegrowers promote their environmental efforts to justify higher bottle prices while minimizing their environmental impacts. However, these efforts are often limited to individual wineries and lack coordination at the regional scale, undermining the potential benefits of environmentally friendly practices on the agroecosystems.

A regional-scale model of sustainable viticulture is being developed in the Swiss winegrowing region of Yvorne (Vaud), by promoting vineyard biodiversity and sustainable management practices. The main objective of the project is to develop, in collaboration with the winegrowers, a more sustainable viticulture approach that harmonizes biodiversity, soil health, and grape quality, while enhancing the attractiveness of the wines.

At this purpose a catalogue of best practices has been developed in 2022 to promote the adoption of sustainable practices. This catalogue is updated annually based on feedback from winegrowers and the results of their experiences. These guidelines aim to promote biodiversity, enhance soil and water quality, reduce the use of pesticides and optimize the application of plant protection products and fertilizers.

Research activities, tailored to local needs, include optimizing winter cover crops for inter-rows as well as low-competitive cover crops for under-rows, managing invasive species (such as Erigeron sp.), utilizing grape pomace as organic amendment, assessing drought impacts, promoting rare species, and evaluating water pollution risks.

Three years after the beginning of the project, the percentage of the vineyard area treated by herbicides has greatly decreased. Vulnerable species and species of particular interest, such as the plants Calendula arvensis and Orlaya grandiflora or the orthoptera Calliptamus italicus have become more abundant.

Continuous monitoring of experiments in the coming years will enable us to provide effective solutions to winegrowers and support the ongoing adoption of sustainable practices. The creation of a certified label will showcase the efforts made and highlight the reputation of Yvorne wines. Additionally, the insights gained from this project have the potential to position Yvorne as a leading example of sustainable viticulture at a regional scale, offering a model that can be adapted and applied to other winegrowing regions.

FLASH ORAL

Evaluation of biodegradable mulch for weed control with focus on vineyard performance

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Keywords: weed suppression, mulch material, soil parameters, vine growth, renewable resources

ABSTRACT

Context and Purpose of the Study. The use of herbicides and mechanical soil tillage, particularly on steep slopes, poses significant ecological challenges, including soil compaction and erosion. This study evaluates the potential of a sprayable, biodegradable mulch made from renewable resources as an environmentally friendly alternative to herbicide use and mechanical tillage. The research focuses on its effectiveness in weed suppression, its impact on soil parameters, vine growth, yield, grape quality, and its practical applicability in vineyard under-vine management.

Materials and Methods. The field trial tested six mulch treatments, varying in application timing and layer thickness (2.5 and 5.0 kg/m²). Weed suppression was assessed through measurements of dry biomass, weed height, and species diversity. Soil parameters, including volumetric soil moisture content, soil temperature, and nutrient levels, were monitored regularly. Vine growth and yield were evaluated using leaf area index (LAI), yield per vine, and pruning weight. The degradation of mulch material was tracked monthly to determine its persistence on the soil surface.

Results. Thicker mulch layers demonstrated superior weed suppression, particularly with later applications. Treatments involving thicker, early-applied mulch achieved the lowest weed biomass values in May and October 2024. Mulch-treated soils retained higher moisture levels compared to mechanically tilled soils. Grape quality, yield, and ripening remained unaffected by the treatments. Thicker mulch layers exhibited greater long-term stability, with later applications further enhancing material retention on the soil surface.

OPEN ACCESS

FLASH ORAL

Growers' attitudes towards organic certification: the case of Central Otago, New Zealand

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Keywords: organic viticulture, qualitative

ABSTRACT

New Zealand viticulture has long been characterised by sustainable grape growing practices as promoted by Sustainable Winegrowing New Zealand (SWNZ) as well as by Organic Viticulture. Central Otago has hereby achieved the highest proportion of Organic Certification with 30% of vineyard area under organic production compared to 4% in Marlborough, NZ's biggest viticulture area. While this success has positively shaped the quality perception of Central Otago wine as well as contributed towards lowering inputs in the vineyard systems, the uptake of Organic Certification has slowed down. A deeper understanding of enablers and barriers for organic certification and management is therefore pivotal to further increase the organic grape production and to support growers in their decision making. This extensive qualitative study interviewed 39 key informants from 29 companies that represent 80% of planted area under conventional, organic and transitional management in Central Otago. The results uncover enablers and barriers across natural, social, human and physical capitals in this region. Particularly the limited suitability of soil characteristics, lack of knowledge or practical experience, negative peer pressure, and doubts about organic practices delivering environmental sustainability were highlighted by the growers and are amongst the factors that certifiers and regional grower organisations may need to address to achieve an increase in Organic Certification. Given the diverse growing and production conditions of Central Otago, the recommendations derived from this study may translate to other viticulture areas that experience similar challenges and opportunities and can therefore support the uptake of organic vineyard management or other sustainable practices.

FLASH ORAL

Integrated sustainability assessment in viticulture: An indicator-based approach applied to organic vineyards

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Keywords: sustainability assessment, indicators, organic viticulture

ABSTRACT

Over the past two decades, sustainable vineyard management practices have become increasingly important as the wine industry is facing critical challenges, including climate change, biodiversity loss, and soil degradation. In this context, developing reliable and robust methods to evaluate the sustainability of viticulture systems is essential for guiding the adoption of more effective and environmentally responsible strategies. This study examines the use of indicators to assess the impact of vineyard management practices on biodiversity and soil health in Franciacorta, a renowned Italian wine region celebrated for its high-quality sparkling wines. A systematic review of the scientific literature was conducted to identify key areas of impact associated with vineyard management. Relevant indicators were selected, calculated, and normalized to evaluate the effectiveness of the practices implemented. The analysis focused on factors such as organic carbon content, water retention capacity, soil compaction, erosion rates, microbial diversity, and the abundance of soil fauna. Practices such as cover cropping, composting, and soil tillage were assessed for their contributions to these indicators. The collected data were processed using normalization techniques to ensure comparability across diverse metrics and to facilitate a comprehensive visualization of the cumulative effects of these practices through intuitive models. The results highlight that sustainable practices, such as cover cropping and the application of organic amendments, significantly enhance biodiversity and improve soil quality. Furthermore, the integration of these indicators into a cohesive framework offers a practical tool for evaluating vineyard sustainability, supporting informed decision-making, and balancing productivity with environmental stewardship. This methodology provides a structured foundation for assessing sustainability in viticulture and contributes to the development of practices that better align with ecological and agronomic objectives. Additionally, sustainable viticulture has the potential to emphasize the benefits of natural capital, enhancing ecosystem processes such as nutrient cycling, pest regulation, and water retention, ultimately fostering long-term resilience and productivity in agricultural systems.

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FLASH ORAL

Carbon footprint as a function of inter-annual climate variability in Uruguayan viticulture production systems

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Keywords: carbon footprint, Tannat, Albariño, vineyard management, subhumid climate

ABSTRACT

Climate change, driven by greenhouse gas (GHG) emissions, is one of humanity's most significant environmental challenges. To mitigate this, all GHG-contributing human activities including viticulture, require careful assessment to understand and reduce their environmental impact. The objective of this work was to evaluate, for the first time in Uruguay, the carbon footprint (CF) of one hectare of Tannat and Albariño vineyards over four growing seasons (GS) and to analyze its interannual variation. The analysis followed guidelines from the Life project Adviclim (Adoir, 2020), and was conducted using OpenLCA® software and the Agribalyse® database, incorporating direct GHG emissions from nitrogen fertilization. We analyzed both direct (DE) and indirect emissions (IE) associated with 10 production activities, including fertilizer application, canopy management, harvesting, pest and disease management, plot maintenance, soil management, trellis maintenance, plant maintenance, winter pruning, and transport in an evaluation plot from a commercial vineyard under Uruguay's Sustainable Viticulture Program. Across the 2020-21 to 2023-24 GS, the average CF in Tannat was 1705 kg CO□ eq. ha□¹ yr□¹, with DE and IE accounting for 70% and 30% of emissions, respectively. Albariño had a CF 14 % lower than Tannat, with the same distribution between DE and IE. The total coefficient of variation across the GS was 18% and 25%, with DE fluctuating by 22% and 15% and IE by 23% and 50 % in Tannat and Albariño, respectively. Among production activities, pest and disease management emerged as the main CF contributor (39% in Tannat and 41% in Albariño), followed by fertilizer application (30%) in Tannat and Soil management in Albariño (24%). Notably, CF from disease management decreased by up to 39% under drier conditions (e. g., 2023 GS) in Tannat, whereas CF from fertilizer application was unaffected by climate variability. Identifying and quantifying GHG emissions is the first step in climate change mitigation, providing a foundation for adjusting production systems toward environmental sustainability. Uruguay is advancing environmental and social awareness of viticulture through its sustainable viticulture program and certification. This study's findings establish a baseline for future climate change mitigation efforts in viticulture.

FLASH ORAL

Pests and biodiversity management on a climate change scenario: a practical case

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Keywords: pests, biodiversity, *e*-dna, extension services

ABSTRACT

The weather anomalies comparing the 1971-2000 time frame and the last years has showned a dramatic scenario when, in some months, average temperature in above 3ºC and the reduction in precipitation in more than 30%.

In Peninsula de Setubal wine region, Portugal, farmers always have feared downey mildew. However, with this change on climate, diseases started to be less frequent and problems and concerns with pests have increased. Besides the new dynamics on frequent pests, new ones have appeared producing unexpected damages and creating new difficulties on how to control them. More over, the remove and ban of active substances led farmers to more difficulties to stop their progression. AVIPE has been testing and implementing trials to alternatives to chemical insecticides but results have been weak.

To better understand the presence and relation between insects, AVIPE has performed a e-dna analysis for 2 years to assess the importance of production methods, organic or integrated pest management (IPM), distances to ecological corridors and presence of insects on ground or on leaves. Besides the accountability by species, it was possible to have a better pictures with insects' orders and their functional groups.

Resulst have showned less insects on organic plot than in IPM, more insects on leaves on the ground than on the vine and similiar number according to distance below or above 100m to the ecological corridors.

This study will continue in the coming years and they will be supported by c-dna analysis.

Such results should make us discussed the dynamics of insects and agricutural practices but always involve farmers for better and quicker dissemination and transfer.

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FLASH ORAL

Measures to promote biodiversity in viticulture–how do socio-economic factors influence implementation?

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Keywords: biodiversity measures, funding, socioeconomy, AmBiTo, contribution margin accounting

ABSTRACT

Context and purpose. In Germany, vineyards are typically intensively managed monocultural systems shaped by low structural variability. However, vineyards can have a high conservation value for biodiversity and associated ecosystem services. In cooperation with Fair and Green e.V. (FNG) and Hochschule Geisenheim University (HGU), strategies are developed to help winegrowers enhance biodiversity in vineyards through the 'AmBiTo' project. In this context, researchers of the HGU explore socio-economic factors that influence the implementation of biodiversity measures. This comprises analyzing potential advantages and challenges of implementing biodiversity strategies including the availability of funding opportunities, financial incentives, and the economic viability. The economic viability is examined by contribution margin accounting helping to identify cost-effective solutions that align with both environmental sustainability and economic goals. This analysis forms the basis for deriving recommendations for appropriate funding measures.

Materials and methods. For socio-economic research, qualitative interviews (N=24), focus groups (N=23) and a quantitative online survey (N=500) were conducted. All methods focused on gathering information about operational conditions, motivations for implementing biodiversity measures, and reasons for not implementing them. They also explored factors influencing current and future decisions to adopt these measures.

Results. The preliminary findings indicate that the majority of winegrowers recognize the implementation of biodiversity measures as a way to establish a more sustainable and resilient foundation for production. They expect advantages such as improved soil health and enhanced ecosystem services which could support long-term vineyard productivity. However, climate change was identified as a major challenge. Winegrowers expressed concerns about the increasing frequency of droughts and a potential risk of increased competition for water. Other challenges identified were perceived high efforts and costs as well as concerns about insufficient funding availability and a general gap between sums of funding received. These findings underscore the need for targeted funding and support mechanisms to address the barriers identified and facilitate the broader adoption of biodiversity measures in vineyard management.

FLASH ORAL

Effects of management and seed mixture on species composition of vineyard inter-row vegetation, soil characteristics and grape berry traits

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Keywords: AmBiTo, berry traits, biodiversity measures, interrow-vegetation, soil characteristics

ABSTRACT

Context and purpose. Viticulture has exerted a profound influence on the landscape and biodiversity of numerous countries for centuries. In recent decades, viticultural landscapes have undergone strong alterations. In regions with flat terrain, the intensity of management practices has generally increased, leading to adverse effects on landscape aesthetics and biodiversity. However, a range of measures can be employed to halt and reverse these negative trends, thereby enhancing the value of vineyards for biodiversity conservation and associated ecosystem services. The AmBiTo project is developing strategies to promote biodiversity in vineyards.

Materials and methods. Vineyard inter-row vegetation plays a critical role in maintaining biodiversity, soil health and grapevine productivity. We investigated the effects of different management practices and seed mixtures on species composition of inter-row vegetation, soil characteristics, and grape berry traits. Three management regimes (mowing, mulching and rolling) combined with three seed mixtures (combinations of different native wildflowers and grasses) and greening by spontaneous species were evaluated over three growing seasons in ten experimental vineyards in the regions Rheingau and Rheinhessen, Germany.

Results. Our results demonstrated that species composition of the inter-row vegetation was significantly influenced by the selected management practice and seed mixture. Furthermore, the soil organic matter and nutrient content, as well as grape berry traits, were also affected by vegetation management and seed mixture. Our findings highlight that tailored vegetation management strategies and seed mixtures have the potential to enhance vineyard biodiversity and sustainability, as well as grape quality.

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FLASH ORAL

Terracing in steep slope viticulture and its potential to promote biodiversity in vineyard ecosystems

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Keywords: steep slope viticulture, vineyard terracing, vineyard abandonment, cultural landscape

ABSTRACT

Viticulture on steep slopes has shaped exceptionally species-rich cultural landscapes in Germany. However, the area under vines has declined sharply in recent decades due to insufficient profitability. Vineyard terracing could be a solution to reduce further abandonment and maintain economic viability.

However, little is known about the effects of abandonment and changes in vineyard management on biodiversity. Over a three-year period, we investigated the effects of vineyard management types (vertically oriented vs. terraced), as compared to vineyard abandonment, local conditions and the surrounding landscape on plant, Orthoptera, wild bee and spider diversity at 45 study sites along the Upper Middle Rhine Valley (UMRV) in Germany.

The small-structured landscape of the UMRV supported high species diversity, high numbers of threatened species and diverse species communities across vineyard management types and fallows. Species responses were group and taxon specific and were driven by different management intensities, local vegetation structures and landscape structure. In short, plant and Orthoptera diversity benefited from terraced vineyards with nutrient-poor and extensively managed terraces. Wild bee diversity was determined by their specific nesting needs and was particularly favoured by the woody structures of the fallows, while spiders benefited from high landscape complexity.

In summary, heterogeneous landscapes, including actively managed and abandoned vineyards and natural elements providing complementary resources, were critical to meeting the many specific needs. However, active vineyard management is essential to maintain the characteristic flora and fauna of steep slope viticultural landscapes. Terraced vineyards, especially when revegetated with regional seed mixes, have a high biodiversity potential and can help to combine economically viable steep-slope viticulture with nature conservation objectives in a land-sharing approach.

FLASH ORAL

Monitoring the establishment of a synthetic microbial community with a potential biocontrol activity against grapevine downy mildew using a microfluidic qPCR chip

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Keywords: grapevine, downy mildew, microfluidics, synthetic community, biocontrol

ABSTRACT

Grapevine downy mildew, caused by the oomycete Plasmopara viticola, is responsible for significant economic losses each year and for a large proportion of the fungicides used in viticulture. In order to limit the use of these chemical pesticides, which are incompatible with the development of sustainable viticulture, biocontrol solutions based on cultivated simplified communities of microorganisms (SimComs) are gradually emerging.

In the present study, we designed several SimComs for the control of downy mildew, using a collection of microorganisms isolated from grapevine leaves by a culturomic approach. The SimComs are composed of bacteria, yeasts and filamentous fungi, described to have either a biocontrol activity against plant pathogens or abundant on grapevine leaves. We tested the hypothesis that including abundant species in the SimComs would help the microbial community colonize the leaves.

A quantitative PCR microfluidic chip (Fluidigm Biomark) was developed to monitor the establishment of SinComs on grapevine leaves. Larger number of reaction are allowed by microfluidic PCR compared to classical qPCR, resulting in quicker and cheaper price per sample. It also has the advantage of providing absolute abundance data compared to metabarcoding approaches that only estimate the relative abundance of microbial taxa.

So far, specific primers for 34 microbial taxa (out of the 42 selected for inclusion in the SimComs) have been designed in single-copy housekeeping genes. We are currently sequencing the genomes of the remaining microbial taxa to complete the primer design. We applied the microfluidic chip to DNA samples extracted from grapevine leaf discs inoculated with SimComs and were able to detect most of the inoculated microorganisms, including some microbial taxa that significantly reduced the intensity of downy mildew symptoms under laboratory conditions.

The microfluidic chip was then applied to environmental DNA collected in vineyard from spore sensor, in order to detect and quantify the targeted protective microorganisms. By doing so, we were able to detect the presence of several microorganisms, including some microbial taxa with proven biocontrol activity against plant pathogens such as A. pullulans and E. nigrum.

These preliminary results shed light on the potential of microfluidic chips as a new molecular diagnostic tool to monitor specific microbial communities present naturally or artificially after Simcom inoculation in the field. Grapevine downy mildew, caused by the oomycete Plasmopara viticola, is responsible for significant economic losses each year and for a large proportion of the fungicides used in viticulture. In order to limit the use of these chemical pesticides, which are incompatible with the development of sustainable viticulture, biocontrol solutions based on cultivated simplified communities of microorganisms (SimComs) are gradually emerging.

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FLASH ORAL

Influence of cultivar and its drought tolerance on soil microbiome

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Keywords: soil microbiome, metagenomics, ITS, 16S, Callet, Merlot

ABSTRACT

Soil microbiome play a crucial role in plant health and resilience, particularly under abiotic stress conditions such as drought. It is essential to know the influence of grapevine genotype on the composition of this microbiome and to investigate this relationship with plant physiology and adaptation to its environment. This study examines the physiological performance under drought conditions in the field of two grapevine genotypes, 'Callet' and 'Merlot', grafted onto the same rootstock (R110), along with their associated soil microbiome. 'Callet' is a local cultivar known for its superior drought tolerance compared to 'Merlot', a widely distributed cultivar. Physiological parameters measured included stem water potential, net photosynthesis, stomatal conductance, and intrinsic water use efficiency. Using 16S rRNA and ITS, microbial diversity was analyzed to assess alpha diversity, beta diversity, and differential abundance of taxa. Statistical analyses, including PERMANOVA and diversity indices (Pielou's evenness and Faith's phylogenetic diversity), were employed to assess community composition and response trends. Physiological results corroborated that under drought conditions and without significant differences in soil water content, 'Callet' plants exhibited better water status and higher photosynthetic rates than 'Merlot' plants. Results also showed that bacterial communities were mainly influenced by genotype, with significant differences observed between 'Callet' and 'Merlot' grafted onto R110, regardless of water availability. In contrast, fungal communities were affected by the interaction between genotype and drought stress, indicating a more complex response. Furthermore, a significant correlation was found between physiological traits and abundance of some fungal species. For example, an unidentified species of the Herpotrichiellaceae family increases its abundance in drought-affected plants, significantly correlating negatively with photosynthesis and conductance and positively with water use efficiency. Taken together, these results suggest that microbiome composition is driven by shoot genotype and its physiological response to water availability.

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FLASH ORAL

Effect of cytokinin and auxin application on double cropping performance in *Vitis vinifera*: preliminary findings

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Keywords: dormant bud, bud forcing, grapevine, yield, fruit composition

ABSTRACT

Double cropping is a novel technique, driven by the extension of the growing season caused by global warming. Previous field studies have shown that feasibility of double cropping in Vitis vinifera cultivars grown in a temperate climate relies on bud forcing efficiency. Key factors include a prompt unlocking of the apical dormant buds which should also have reached sufficient fruitfulness. While it can be assumed that bud dormancy release and subsequent shoot development are influenced by hormonal balance and correlative inhibition, this study hypothesized that foliar applications of exogenous cytokinin (CK) and auxin (NAA) could modulate these processes, potentially affecting bud forcing dynamics and shoot fruitfulness. Forcing treatments consisted of trimming primary shoots at the eighth node and removing all lateral shoots, whereas main leaves and inflorescence developed until the trimming cut were retained. Five treatments were tested: unforced control (UC), control + cytokinin (CCK), Forcing (FR), forcing + cytokinin (FCK), forcing + auxin application (FNAA).

Results showed that among the forcing treatments, FCK achieved the highest bud forcing success rate (106%), expressed as the ratio between forced to primary shoots, followed by F (94%) and FNAA (21%). Primary yield was similar across all treatments (2.74 kg), whereas total yield (primary + forced crop) was highest in FCK (out of a total of 4.78 kg, 2.02 kg were forced grapes), followed by FR (3.62 kg with 1.09 kg of forced grapes) and with no forced crop in FNAA (2.68 kg). Single leaf assimilation (A) rates, measured on 5th to 8th node, were higher in forced leaves (10.9 in FR and 11.2 µmol/m2/s in FCK vines) than primary leaves, which ranged from 6.3 in FNAA to 7.9 in UC, and to 8.3 µmol/m2/s in CCK vines. The harvest of the forced crop was delayed by 47 days compared to the primary crop. Despite cooler late season conditions, temperatures remained adequate for the maturation of forced grapes. They exhibited higher total soluble solids (22.0 in FR and 21.4 °Brix in FCK vines) compared to their primary grapes (18.1 and 19.8 °Brix, respectively) coupled with a significantly higher titratable acidity (10.0 in FR and 11.1 g/L in FCK vines) than primary grapes (4.9 g/L, as average). The study indicates that in Vitis vinifera, exogenous CK and NAA can respectively enhance or impair dormant bud forcing, with CK promoting the feasibility of double cropping in the same vine under temperate climates.

FLASH ORAL

Role of VvNCED1 in β-damascenone and abscisic acid biosynthesis: new insights into aroma development in grapes

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Keywords: β-damascenone, abscisic acid, grape, 9-cis-epoxycarotenoid dioxygenase, stress response

ABSTRACT

β-Damascenone is a key norisoprenoid in grape (Vitis vinifera L.) that imparts floral and fruity aromas to both fruits and wines. It is derived from carotenoid metabolism, with neoxanthin as a substrate. While its biosynthesis and regulation are not fully understood, abscisic acid (ABA), another metabolite of this pathway, plays a vital role in fruit ripening and stress responses, including drought and cold tolerance. This study investigates the role of grapevine 9-cis-epoxycarotenoid dioxygenase 1 (VvNCED1) in the biosynthesis of ABA and β-damascenone, and its involvement in stress responses.

We analyzed the transcriptome and aroma metabolome of Cabernet Sauvignon grapes across developmental stages. The results show that aroma metabolism is stage-dependent, with norisoprenoid accumulation beginning as grapes start to veraison. VvNCED1 expression positively correlated with β-damascenone levels. Overexpression of VvNCED1 promoted ABA accumulation, while exogenous ABA treatment upregulated genes involved in neoxanthin synthesis (VvNXS, Neoxanthin synthase) and cleavage (VvNCED1), leading to increased β-damascenone levels. These findings suggest that ABA mediates the promotion of β-damascenone through VvNCED1. Additionally, drought stress induced by PEG6000 increased ABA levels in grapevine adventitious roots, supporting the role of ABA in stress responses.

Moreover, we propose another mechanism by which VvNCED1 facilitates β-damascenone biosynthesis: VvNCED1 cleaves 9'-cis-neoxanthin into C25-allenic-apo-aldehydes, which are further cleaved by carotenoid cleavage dioxygenase 1 (VvCCD1) into grasshopper ketones, a precursor to β-damascenone. This was partially confirmed by in vitro protein expression experiments.

Based on these results, we propose a cooperative model for VvNCED1 and VvCCD1 in β-damascenone biosynthesis, where VvNCED1 generates precursors for both ABA and β-damascenone. These findings provide new insights into the relationship between aroma compound accumulation, berry ripening, and stress responses, with implications for improving grape aroma through deficit irrigation techniques.

OPEN ACCESS

FLASH ORAL

A sundial vineyard: impact of row density and orientation on cv. Cabernet-Sauvignon physiology and grape composition, insights to face a climate change scenario

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Keywords: row orientation, row density, phenolics, aromas

ABSTRACT

An experimental vineyard with a radial array was planted in 2018, to provide valuable information on the relationship between orientation and planting density on plant physiology and cluster microclimate, and the consequent impacts on grape secondary metabolites, including aromas and polyphenols. This project will allow us to find the best combination between these factors in order to improve water use, and grape quality in our current climate scenario in the Maipo Valley, and give us insights into facing the challenges of climate change.

The vineyard has a radial layout with rows of 15 plants every 6°, starting with a row distance of 50cm and ending with 200cm, planted with Cabernet-Sauvignon cv. (https://www.youtube.com/watch?v=QWFFAvTjy6c&t=79s). During the 2023-2024 season, evaluations of water potential, stomatal conductance, and cluster microclimate were made, measuring light in the cluster's zone with a 1-meter photosynthetically active radiation (PPF) bar and cluster temperature with an infrared radiometer (IRT) three hours before and after the zenith. Also, leaf chlorophyll concentration was assessed on both sides of each row.

Also, PPF and IRT were measured continuously in the central plant (8th) of the rows between 180° and 342°. Simultaneously, a weather station was placed in the center of the vineyard so daily curves of environmental conditions and within the cluster zone were recorded including PPF outside the canopy.

All bunches were analyzed, for which whole plants were harvested and the incidence and severity of berry dehydration were evaluated. Additionally, analyses of acids, aromas and polyphenols were carried out in the grapes.

Differences were observed in the amount of PPF intercepted in the cluster area, (angle $p < 0.01$; density $p < 0.05$), cluster temperature (angle $p < 0.01$; density ns), and chlorophyll concentration (angle $p < 0.01$; density $p < 0.01$). Stomatal conductance showed significant differences due to density (p-value < 0.01), being higher in the densest zone. In contrast, no differences were found in the xylem water potential at solar noon, with values between -0.76MPa and -0.88 MPa. Relevant to say is that the radiation expected due to latitude modeling did not match our results, mainly because the canopy growth and vigor depended on the orientation, increasing the importance of actual measurements of cluster microclimate.

FLASH ORAL

Relationships between vine isohydricity and changes of fruit growth and metabolism during water deficit

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Keywords: fruit growth, fruit metabolism, isohydric, water deficit, water potential

ABSTRACT

The frequency of water deficits is increasing in many grape-growing regions due to climate change. Grapevine varieties differ in stomatal behavior and their ability to regulate water potential, as well as differ in changes to fruit metabolites and quality during water deficits. However, it remains unclear whether stomatal behavior and water potential regulation, often described as the degree of plant isohydricity, has any relationships with changes to fruit growth and metabolism. This study was conducted on four varieties (`Cabernet Franc`, `Semillon`, `Grenache`, and `Riesling`) subjected to both short-term, severe water deficit and long-term, moderate water deficit. Water deficits were applied at both pre-veraison and post-veraison. Stomatal conductance and leaf gas exchanges were tracked using LI-600 and LI-6800 systems, respectively, and pre-dawn and mid-day stem water potentials were tracked using a Scholander-type pressure chamber. Fruit samples were taken during water deficits and primary metabolites (sugars, acids) and hormone (abscisic acid) levels were analyzed using HPLC-RID-DAD and HPLC-QTOF. The results indicate that `Cabernet Franc` and `Riesling` are more resistant to changes in fruit growth, sugar levels, and abscisic acid levels compared to `Semillon` and `Grenache` during both short- and long-term water deficit, especially at the pre-veraison stage. `Cabernet Franc` and `Riesling` exhibited a greater ability to maintain stomatal conductances, pre-dawn water potentials, and mid-day water potentials as compared to `Semillon` and `Grenache`. Lower stomatal conductances and water potentials coincided with earlier and larger increases in fructose in fruit for `Semillon` and `Grenache`. A relationship between fruit abscisic acid and sugar levels was found at pre-veraison, but not post-veraison. Common metrics of describing isohydricity, including stomatal conductance responses to pre-dawn water potentials and the slopes of the relationship between pre-dawn and mid-day water potentials, did not allow for a clear classification of the varieties based on the isohydricity level. The results of this study show that there is a relationship between variety-specific water relations and fruit growth and metabolism, but the common metrics used to describe isohydricity alone are not helpful for predicting changes to fruit during water deficits.

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FLASH ORAL

Digitization for automation–A frost management case study

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Keywords: precision viticulture, sustainable viticulture, automation

ABSTRACT

The need to mitigate the yield impact of Spring frosts in vineyards remains a significant challenge around the world. A warming climate is being offset by changes in phenology, in this case budbreak timing. In 2024 alone, cold temperature impacts have been highlighted across a range of countries, including Australia, Germany, France, Austria, France and Canada. Accurately predicting the areas of a vineyard most vulnerable to frost requires site-specific knowledge, historic and real-time sensor data. A smart weather forecast is also needed which distinguishes between cold temperature events when mitigating actions will be more or less effective. Are we anticipating a radiative frost or an advective frost? What effect will leaf wetness have? How wet is the ground to start with and how will this affect local temperature changes? How is the forecast performing against measurements in the vineyard? Frost management is just one of many examples where the importance of vineyard digitization and automation are emphasized. Effective deployment of resources is important both in terms of economics and environmental protection and requires the integration of data from multiple sources to support decision-making. Ultimately, autonomous management systems rely upon a precision approach based on timely and accurate data and comprehensive mapping. Such data-driven solutions depend on heterogeneous information from a wide range of systems, requiring a strong degree of integration and standardisation. Our paper addresses how we are tackling this challenge of data fragmentation and interoperability in the vineyard, summarising learning from our Frost Management and VISTA (Vineyard Information System for Technology and Automation) collaborative projects. Having established much of the infra-structure, we will present results at the conference from our Spring 2025 intensive in southern England, generating actionable insights for growers.

FLASH ORAL

The importance of rural extension and advisory services to achieve a sustainable viticulture in a climate change scenario

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Keywords: extension services, climate change

ABSTRACT

A healthy and dynamic agricultural sector is an important foundation of rural development, generating strong bonds to other economic sectors. The success of sustainable rural development depends on developing and implementing comprehensive strategies for dealing with climate change, drought, territorial desertification and natural disasters. Improving access to information, education, extension services and learning resources, will lead to a strong and more resilient rural community. Climate change and European Green Deal are some of the main challenges for the viticulture sector, yet these could be considered an opportunity to implemente new practices to achieve a more sustainable activity. The rural extension and advisory services play a huge role in supporting farmers to achieve all the demands. Through a face-to-face presence in the field, but also with the help of digitalization, precision farming, AI and data analyses, it's possible to create methodologies enabling farmers to deal with the new demands. In Portugal, and in the Peninsula de Setubal's region, the viticulture sector is characterized by farmers with more than 60 years old, small to medium areas and a low educational degree. This situation leads to more difficulties in the implementation of an effective consultancy. So, to have a higher impact, the solution was the creation of living-labs/ demo-farms. It's considered crucial to enable farmers to see "in loco" the implementation of new technologies and practices. Topics like soil management through the implementation of cover crops but also look at the margins and ecological corridors, water management by understanding differences between varieties adapting it to farmers' goals, biodiversity study by metagenomic and e-dna analysis and agronomic practices to mitigate sunburn are some of the activities that AVIPE has been working on.

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FLASH ORAL

Innovative water status monitoring of white grape varieties with on-plant sensors

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Keywords: on-plant sensor, stem water potential, water stress

ABSTRACT

Context and Purpose. Climate change presents significant challenges to agricultural sustainability, particularly through the increasing frequency of drought and water scarcity. Effective water management is essential for optimizing crop yields while minimizing resource consumption. This study investigates the efficacy of two innovative sensors for on-plant water measurement in two white grape varieties, comparing their readings to stem water potential (SWP) values. While previous research has demonstrated the effectiveness of these sensors in various woody species, literature specifically addressing their performance in white grape varieties remains limited.

Materials and Methods. During the 2024 growing season, we tested the leaf vapor condensation sensor FylloClip® and the stem water potential microtensiometer FloraPulse®. These sensors were installed on two white grape varieties, Sauvignon Blanc (Vitis vinifera L.) and Chardonnay (Vitis vinifera L.), in a research vineyard located in Kaltern (Bolzano, Northern Italy). Two sensors of each type were mounted on two plants of each variety, and eight SWP measurement sessions were conducted using a Scholander bomb during critical phases of water stress.

Results. The season began with above-average rainfall, resulting in robust leaf development and limited fine root formation. However, a significant increase in temperature, coupled with a lack of rainfall from July onwards, led to pronounced water stress by August. The correlation between the FloraPulse® sensor data and SWP measurements was strong (R2=0,968) and statistically significant, despite one outlier on August 20 due to cloudy conditions affecting SWP accuracy. Notably, the two grape varieties exhibited distinct responses to water stress, reflective of their differing isohydric and anisohydric behaviors, with Sauvignon Blanc and Chardonnay, respectively. Although the FylloClip sensor provided valuable specific information, its correlation with SWP values was less robust.

These findings indicate the considerable potential of microtensiometer technology to enhance irrigation practices, reduce water consumption, and mitigate physiological disorders, such as berry shrivel, in white grape varieties. This research highlights the importance of innovative monitoring tools in promoting sustainable viticultural practices in the face of climate change challenges.

FLASH ORAL

Effect of vineyard nitrogen management on Souviginer gris wine sensory quality and aromatic compounds

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Keywords: fungus-resistant grape (FRG), nitrogen management, Souvignier gris, wine aroma and quality

ABSTRACT

Fungus-Resistant Grape (FRG) varieties represent a promising approach to address the challenges of climate change and sustainability in viticulture. Despite the growing availability of FRG wines on the market, detailed information on their characteristics is still scarce, as these varieties remain novel. One such variety, Souvignier Gris, is gaining popularity among winegrowers in Switzerland, Germany, and France. Notably, Souvignier Gris has been reported to produce must with low yeast assimilable nitrogen (YAN). To date, little is known about the connection between vineyard management practices, must nitrogen levels, and the implications for wine quality of this variety. This study aims to address this gap and provide vineyard managers with both short- and long-term strategies to optimize must nitrogen status with the goal of improving wine sensory characteristics.

The experiment evaluated the effects of five field treatments (undervine tillage, organic fertilizer, nitrogen-fixing cover crop, foliar fertilization, and a control) and four cellar treatments (0, 30, 90, and 180 g/hl of complex yeast nutrient additions) on YAN, volatile compounds, thiol content, and wine sensory attributes. Analytical methods included WineScan, volatile compound analysis, and sensory evaluation. Preliminary results indicate that foliar fertilization application and nitrogen-fixing cover crops significantly increased YAN compared to the control, leading to distinct aromatic profiles. While the nitrogen-fixing cover crop had an influence on common vigor markers with higher yield and lower sugar accumulation, foliar fertilization increased must YAN without affecting yield. As expected, nitrogen addition to fermentation had a shortening effect on fermentation time and reduced residual sugar levels. Consequently, fermentation was most efficient when YAN in must was increased in the vineyard, while also having the beneficial effect on increasing thiol content. Higher YAN values positively influenced aroma intensity and attributes exotic fruit, ripe fruit and vegetal. This study provides valuable insights into how vineyard management can directly influence wine aroma and overall quality.

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FLASH ORAL

Mapping aromatic profiles of Chardonnay and Sangiovese wines in grafting combination with new rootstocks

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Keywords: new rootstocks, wine quality, aromatic volatile compounds, aromatic precursors, climate change adaptation

ABSTRACT

Rootstocks play a key role in the adaptation of grapevine to environmental conditions, affecting phenology, vigor, yield and grape quality. Thus, the choice of the grafting combination become crucial in maintaining qualitative standards of wine under changing climate. Several studies assessed the effect of rootstocks on grape and wine quality in terms of sugar/alcohol content, acidity and phenolic compounds, but the effect of rootstocks on aromatic volatile compounds is nowadays poorly investigated. The aim of this work is to characterize the aromatic profile of white and red wines under different grafting combinations.

The study was conducted in 2022 in vineyards of Chardonnay, located in Franciacorta, and Sangiovese, located in Montalcino. In both fields, 3 different grafting combinations were compared, including rootstock SO4 and two recently released rootstocks, M1 and M4. During harvest, about 50kg of grapes from each grafting combination were collected to obtain separate experimental wines, using the same oenological protocol. A chemical characterization of the resulting wines was carried out, detecting technological and phenolic parameters, a total of 150 aromatic volatile compounds and over 50 aroma precursors. Aromatic compounds and precursors were quantified using HS-SPME GC-MS, except for thiols and glycosylated precursors measured with online SPE HPLC-MS/MS. Finally, the sensory profile of experimental wines was evaluated through a technical tasting, performed by a panel of 10 tasters. Obtained data were analyzed using a multivariate approach.

The odor detection threshold exceeded for 31 and 29 aromatic volatile compounds in Chardonnay and Sangiovese wines, respectively. Two principal components were identified using PCA: the first one discriminating for varieties (58%), and the second one for rootstocks (16%). Main aroma compounds contributing to PC2 were Ethil Eptanoate and ß-Damascenone, higher for Sangiovese/M1, as well as Isobutyl Acetate, higher for Chardonnay/M4. Significant differences between rootstocks were found on sensory profiles of both varieties. Links between chemical and sensory profiles were highlighted by RDA. Generally, terpene precursors were higher in wines obtained in grafting combination with SO4, whereas thiol and norisoprenoid precursors with M4.

FLASH ORAL

Environmental and yearly influences on four Sicilian grape clones under climate change challenges

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Keywords: indigenous varieties, clones, climatic adaptions, biodiversity, water stress

ABSTRACT

By the end of this century, up to 90% of traditional viticulture regions in the Mediterranean, including Sicily, are projected to face extinction due to escalating climate challenges such as severe droughts, heatwaves, and unseasonal rains. Islands like Sicily are particularly vulnerable, with climate shifts threatening grape composition, plant physiology, and enological quality. Urgent adaptation strategies, including cultivating heat- and drought-resistant grape varieties, particularly indigenous types, are critical.

This study investigated the influence of environmental and vintage factors on four grape clones; Perricone (RS-7), Nero d'Avola (RS-84), Catarratto (RS-60), and Grillo (RS-297) in three Sicilian vineyards located in the west (W), central (C), and southeast (SE) regions over two growing seasons (2023 and 2024). To understand the influence of the environmental and vintage factors on the four clones, a set of physiological (stem water potential, leaf area and composition) quantitative (total yield, berry, bunch and pruning wood weight), and qualitative traits (TA, TSS, pH) were measured.

Overall, clones exhibited contrasting responses across sites and years. Most clones showed greater vigor and yield in 2023 than in 2024 ($p>0.05$), except Nero d'Avola, which yielded more in 2024 (2.9 kg/plant vs. 1.4 kg/plant in 2023). Stem water stress varied significantly between clones in both years, with site SE exhibiting greater susceptibility to water stress compared to sites C and W in 2024. Notably, Grillo displayed higher stem water potential (-1.5 MPa at site C vs. -1.1 MPa at site SE). In terms of maturation, site C clones exhibited the lowest TSS in 2023, whereas in 2024, site C recorded the highest TSS.

These findings underscore the significant impact of environmental and vintage factors on grapevine physiology, productivity, and wine quality. Finally, our results highlight the importance of site-specific adaptation strategies and the potential resilience of indigenous grape varieties in mitigating climate change challenges.

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FLASH ORAL

Closing the carbon loop: evaluating the potential of grapevine-derived biochar as a soil conditioner in warm climate vineyards

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Keywords: climate change, carbon sequestration, soil health, microbiome, soil moisture

ABSTRACT

Significant increases in anthropogenic carbon dioxide (CO2) emissions due to combustion of fossil fuels and intensive land management practices that release CO2 into the atmosphere have resulted in higher air temperatures due to the greenhouse effect. Agriculture offers tremendous potential to mitigate the negative impacts of climate change and global warming due to the CO2 sequestering ability of crops via photosynthesis, which ultimately build soil organic carbon (SOC) through root sequestration of carbon and decomposition of plant litter (Woolf et al. 2007). Another avenue to increase SOC is through the conversion of plant biomass, particularly woody biomass, into a recalcitrant carbon product known as biological charcoal (aka "biochar"). This conversion is typically done through pyrolysis, an anaerobic combustion, of lignocellulosic feedstock(s). Sequestering biochar into the soil can result in a negative carbon balance and reduce CO2 emissions by 12-84 % compared to using it as a fuel source (Lehmann 2007). As the wine industry seeks to meet their environmental, social and governance (ESG) targets, the use of biochar in vineyards as a carbon insetting tool could be a powerful tool in the viticulturist's toolkit, particularly with the potential benefits offered by biochar for vineyards.

Several studies have reported on the use of biochar in vineyards located primarily in Europe, but also, to a lesser extent, in USA. In an early trial of biochar conducted in a Valais, Switzerland Pinot noir vineyard, top-soil application of biochar at 8 t ha-1, with and without compost, impacted neither grapevine vegetative and reproductive performance nor fruit composition (Schmidt et al. 2014). Similarly, a long term (4-year) study in Italy found no impact of biochar on grape composition, however, there was a significant and consistent increase in yield, by as much as 66%, compared to controls (Genesio et al. 2015). Biochars made with vineyard prunings as feedstock, as done in the current trial, had a positive impact on several soil physical parameters including bulk density (decreased), aggregate stability (increased), and plant available water (PAW; increased, but only at high soil matric potentials > -30 kPa) (Burrell et al. 2016). Oddly, the same study evaluated biochars made at two pyrolysis temperatures – 400 °C and 525 °C – and did not find differences in any of the aforementioned soil parameters despite the 525 °C biochar having higher porosity. Nevertheless, the study highlights the potential of using biochar to increase soil moisture retention, which would be advantageous in low rainfall seasons. Due to its highly porous structure, biochar could also provide habitats and niches for soil microorganisms including bacteria, fungi and Archaea (Li et al. 2018). The effect of biochar on soil microbial processes have not been reported in vineyards; in other cropping systems, addition of biochar to soil increased microbial abundance, which was favoured by less lignocellulosic feedstocks (Gul et al. 2015).

FLASH ORAL

Impact of innovative canopy management techniques on grape and wine quality under mediterranean summer conditions

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Keywords: heat stress, shading, rippening, delay

ABSTRACT

The recent effects on temperature and rainfall caused by global warming pose a serious threat to the wine industry worldwide, mainly in terms of a loss of quality in the wines produced. The main effects on grape quality include an imbalance between the sugars and organic acids accumulated in the berries, which leads to a deficient winemaking process and lower-quality wines. To mitigate these effects on grape quality, a study was carried out to evaluate new vineyard management techniques on white berries compared to traditional models. During the 2024 summer season, this study was conducted with plants of 'Prensal Blanc' and 'Giró Ros' cultivars at commercial vineyard Bodega Son Juliana, located in one of the main wine-growing regions of Mallorca. Two leaf cover management treatments were applied: the first being a winery control called leaf thinning (L), and the second, called leaf thinning and shading (L+S), in which where the vine shoots were released to shade the bunches of grapes. During the grape ripening months, temperature and radiation conditions were monitored at the bunch level, in addition to tracking the main grape quality parameters (sugar content and acidity). At harvest, yield, disease impact, and berry quality were analyzed for each variety-treatment combination. The remaining material was used to vinify the grapes with commercial yeast. Once finished, the wines were bottled, wine samples were sent for analysis, and a tasting was conducted. The results from the monitoring during the ripening months showed that the L+S treatment delayed sugar accumulation and acid degradation by 1 to 2 weeks in both varieties, thus delaying the harvest date. The final grape quality results showed that the application of the treatment had positive effects in preventing acid degradation and regulating the must's pH. The wines resulting from the winemaking process showed positive effects from the L+S treatment compared to the S treatment, with more balanced wines, as well as better ratings in the tasting.

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FLASH ORAL

Short-term canopy strategies to enhance grapevine adaptation to climate change

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Keywords: viticulture, temperature, photosynthesis, heatwave, wine

ABSTRACT

Context and purpose of the study. Viticulture faces significant challenges due to climate change, with increased frequency of extreme weather events impacting grapevine growth, grape quality, and wine production. These issues, once confined to warmer regions of southern Europe, now affect cooler areas like Northern Italy, where there is an increasing frequency of storms, heavy rainfall, and heatwaves which can lead to ripening arrest and quantiqualitative losses. This issue affects both red and white grape varieties, with the latter particularly vulnerable due to reduced acidity levels, crucial for aromatic and sparkling wine production. To address the impact of high day and nighttime temperatures in the summer (from July until harvest), the present study was aimed at testing different short-term adaptation solutions including the use of shading nets and the spraying of particle films such as kaolin and zeolite, the first reducing overall incoming solar radiation and the latter increasing albedo while reducing the temperature of leaves and fruits.

Materials and Methods. The experiment was conducted in an organic vineyard of Vitis vinifera cv. Glera, cultivated for Prosecco wine production in Norther-East Italy. From pre-véraison (early July) until harvest, a complete randomized block design was applied with the following three treatments plus an untreated control: shading net (black 40%), kaolin and zeolite applied on both canopy sides of three adjacent vine rows per block. Throughout the experimental period, continuous monitoring of berry temperature and canopy microclimate, as well as physiological and morphological measurements, were carried out at regular intervals. At grape maturity, various cluster/berry morphometric parameters, yield variables and berry composition qualitative analyses were assessed to determine whether the treatments had significantly affected the chemical properties of grapes, must, and base wine.

Results. Treated vines exhibited sustained stomatal conductance compared to the control. This improved physiological activity in treated plants aligns with the average temperature data recorded by sensors on canopies and berries. Berry and canopy temperatures in the control plants were consistently higher than those of the treated plants. The treatments also had a significant effect on berry characteristics evaluated at harvest. Notable changes in acidity, calcium, copper content, and berry weight were obtained, suggesting the potential applicability of these short-term adaptation techniques not only for fostering vine adaptation to heatwaves in the field but also for preserving and in some cases improving berry chemical characteristics and wine quality.

FLASH ORAL

Exploring the potential of agrivoltaics in German vineyards: A GIS-based assessment

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Keywords: agrivoltaics, GIS-based assessment, renewable energy integration, viticulture, spatial analysis

ABSTRACT

The growing demand for renewable energy and sustainable agricultural practices has highlighted the potential of agrivoltaics (Agri-PV) as a promising solution, particularly in the context of German viticulture. The integration of photovoltaic systems in vineyards offers benefits, including optimized land use and resilience to weather extremes.

This study investigates the spatial potential for deploying Agri-PV systems over vineyards, with the objective of balancing renewable energy generation with agricultural productivity. To achieve this, a Geographic Information System (GIS)-based approach was employed, integrating geospatial datasets with over 24,000 data points to assess both energy generation potential and compatibility with ongoing agricultural activities. Key exclusion criteria, such as protected areas and unsuitable terrains, were applied to refine the analysis. A multi-criteria evaluation framework prioritized areas based on energy production potential, land use compatibility and proximity to infrastructure.

Preliminary results show significant opportunities for Agri-PV deployment in southern and southwestern Germany. The findings underscore the role of GIS tools in strategic planning for dual land use, showing that suitability varies across German wine regions. The approach identified several high-potential locations, which could serve as focal points for further feasibility studies and pilot projects. Nevertheless, the expansion of renewable energy in Germany often faces challenges related to the underutilization of existing infrastructure. Limited accessibility due to the lack of grid connection points in rural areas and the fragmented agricultural structure, characterized by small and scattered vineyard plots, complicates large-scale Agri-PV integration.

The results provide stakeholders with key data for sustainable Agri-PV implementation. This study underlines the high potential of GIS tools and geodatasets in addressing spatial and infrastructural challenges for renewable energy development. Limitations in data availability, such as incomplete grid information, affect the accuracy of site selection. To mitigate this, the approach utilizes community-driven map material from local stakeholders.

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FLASH ORAL

Agrovoltaic on vineyards: preliminary resuls on seasonal and diurnal whole-canopy gas exchange

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Keywords: dual land use, light interception, photosynthesis, transpiration, cluster temperature

ABSTRACT

Context and purpose of the study. Albeit standing as a fashionable research topic dual use of land as viti-voltaic still lacks of fundamental knowledge about whole canopy grapevine response to altered microclimate under panels vs open field conditions.

Material and methods. Solar panels (SP) were mounted at pre-veraison on half of four adjacent, 50 m long grapevine rows. Panels were mounted 3.13 m from the ground and were 109.2 cm wide. Half of the row was the open-field control (OF). Data were taken in the two central rows planted with Malvasia di Candia aromatica and Cabernet Sauvignon cultivars. Rows were 35° NE-SW oriented and panels were left horizontal from veraison until harvest. Whole canopy gas exchange was continuously measured from DOY 221 (9 August) until DOY 272 (29 September), whereas direct and diffuse total radiation were monitored with a BF-5 hemispheric sunshine sensor.

Results. On a seasonal basis, average direct radiation reaching the OF areas was 683 µmol m-2s-1 vs 361 µmol m-2s-1 (-47.2%). In both varieties, seasonal and diurnal reduction of canopy net CO2 exchange rate (NCER) and transpiration (T) generally diminished by 10-14% in SP as compared to OF, indicating that a wide margin of solar energy capture does exist without greatly compromising canopy function. When canopy water use efficiency (WUE) was calculated as the NCER/T ratio, average values for the two treatments were almost identical (5.3µmolCO2/mmolH2O). However, looking at averaged diurnal trends, it was clear that during the two daily time windows when solar panels cast direct shading over the canopies (8:00-9-30 and 13:30-16:00) the WUE significantly decreases under panels. This is likely due to the fact that PAR levels are lowered down the linear portion of the light response curve, whereas transpiration is less limited with VPD being the main driver under those conditions. Data are under completion for more single-leaf assessment, thermal analyses and agronomic behavior of the two varieties.

FLASH ORAL

Agrivoltaic: chances preparing riesling towards a better climate resilience

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Keywords: eAgrivoltaics, climate change mitigation, vineyard microclimate management, sustainable viticulture

ABSTRACT

Agrivoltaics (AV), the innovative dual-use of land for agriculture and photovoltaic energy production on the same land, offers a promising solution to the challenges of expanding renewable energy without compromising valuable agricultural land. Climate change has brought many challenges not just for viticulture but for the whole agricultural sector with issues such as late frost, excessive heat, intense solar radiation, unpredictable precipitation patterns including hail damage and drought. These climate stressors can accelerate phenology, grape ripening, alter aromatic profiles, and lead to higher alcohol content with reduced acidity in wines. There is an urgent need to explore mitigation strategies, whereas AV can serve as a promising solution with multiple synergies. To explore this potential, the VitiVoltaic research platform, established at Hochschule Geisenheim University, focuses on integrating AV technology within a Riesling vineyard to assess its capacity for mitigating climate change impacts on grapevines while simultaneously producing solar energy. The project specifically targets challenges such as water scarcity, extreme heat, and threats to crop quality due to increasing temperatures. The VitiVoltaic research facility is built on a 0.3-hectare Riesling vineyard in the Rheingau Valley. Semi-transparent, sun-tracking photovoltaic modules cover half of the vineyard whereas the other half serves as a control, designed to provide moderate shading, while maintaining the accesability for vineyard machinery. Equipped with sensors, the VitiVoltaic platform monitors microclimatic factors such as air temperature, humidity, soil moisture, and solar radiation, allowing for in-depth analysis of the AV's overall effects on grapevines. Initial observations show that the AV structure effectively lowers peak air temperatures, conserves soil moisture, and reduces the percentage of sunburn incidence, thereby supporting crop health and resilience. The alterations in microclimate may lead to slower ripening rates and preservation of acidity, ultimately potentially improving grape and wine quality under controlled shading conditions.

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FLASH ORAL

Effect of the shade generated by simulated solar panels in two row orientation on the physiology and productivity of *Vitis vinifera* L. cv. Malbec

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Keywords: grapevine, agrivoltaic system, climate change, wines

ABSTRACT

Context and purpose of the study. In regions where grapevines are grown under irrigation, like most regions in Argentina, the wine industry should adopt more sustainable strategies and production systems towards a higher water use efficiency and a reduction in no-renewable energy consumption. To contribute to these strategies, an agrivolatic trial was started in 2020 in a vineyard at INTA Mendoza Experimental Station. Agrivoltaics combines in the same site agricultural production with energy generation by solar panels installed over the crop.

This study compared the microclimate, physiology and productivity of vines under the partial shade (47%) generated by simulated photovoltaic panels with vines without shade grown in North-South and East-West row orientation.

Material and methods. The experiment was installed in a vineyard planted in 2011 with cv. Malbec. During 2020, solar panels were simulated installing shade nets over the rows covering 47% of the surface. The transmittance of the nets was 0%. The experiment consisted in two treatments, with two levels each, radiation, with shade (SH) and control (C), and row orientation, with North-South (N-S) and East-West (E-W). For each treatment level: SH/N-S; SH/E-W; C/N-S and C/E-W there were 3 repetitions, in total 12 plots under study.

Canopy microclimate, water consumption, vegetative growth and yield were measured. Midday leaf water potential was used to decide irrigation. At harvest (24°Brix) the content of total polyphenols and anthocyanins per berry was measured by spectrophotometry. After harvest the wines from each replicate were elaborated and anthocyanin contents were measured by spectrophotometry. FTIR spectroscopy was used to measure pH, total acidity and alcohol. Wines were analyzed by a trained panel on descriptors previously selected.

Results. The accumulated intercepted radiation on shaded canopies was 45% less than the controls plants and average daily temperature was 2°C lower than the controls throughout the season. Plants under shade regardless of row orientation required 31.7% less water than those without shade. Grapes from shaded vines were harvested four days later and yielded 25.4% less than control vines.

No differences were found in the content of polyphenols and anthocyanins per berry at harvest. Wines from shaded vines showed higher levels of total acidity and less pH and % alcohol than those without shade.

FLASH ORAL

Shading grapevines with dynamic agrivoltaics address the challenge of early ripening and wine quality related with climate change

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Keywords: dynamic shading, climatic protection, berry quality, organoleptic profile

ABSTRACT

Context and purpose of the study. Climate change accelerates grapevine's phenology, advancing harvests by 2–3 weeks over the past 40 years negatively affecting wine style due to a lack of acidity and too much alcohol. Therefore, mitigation strategies are necessary to reduce heat and water stress, and preserve must quality. Sun'Agri with INRAE and CA84, have tested over six years (2019-2024) dynamic agrivoltaic system (DAV) to shade grapevines and address early ripening and wine quality challenges.

Material and Methods. A dynamic agrivoltaic system (DAV) was installed in 2019 over a 'Grenache Noir' vineyard in Piolenc, France, using 2 structures of 340 m2 with trackers above grapevine, oriented South-North with tilting opaque solar panels. 500 m2 in the same vineyard without panels were used as control. Two levels of shading (different steering policies at season scale) and two irrigation strategies (irrigated and non-irrigated in 2023 and 2024) were tested. Since 2019, microclimate, phenology, water status, yield determinants and berry quality have been evaluated. Since 2020, microvinifications in 100 l barrels were carried out. Wines were tested by an expert panel to characterize their sensorial profile and quantify their main descriptors (CATA method). For the 2023 wines a detailed analysis of aromas was conducted.

Results. Shading grapevines with dynamic agrivoltaics (DAV) improved the microclimate, reducing heat stress and preventing damage like defoliation or berry shrivelling. Veraison was delayed by 2–5 days, and harvest to 7 days. While yield remained similar across shading level, significant differences were observed across irrigation strategies. DAV increased acidity despite a similar level of sugar content in berries. Sensory analysis showed DAV wines were consistently fruitier, while control wines were more astringent. A difference in color was also noticed with more colorful wines for the control plots. The 2024 chemical analysis highlights how shading grapevines with dynamic agrivoltaics can influence wine profiles by increasing volatile compounds like 2-phényléthanol, isoamyl acetate, damascenone-beta, and terpenols, enhancing fruity aromas. Using dynamic agrivoltaics to control shading of grapevines when needed offers a strategy to delay ripening, improve berry quality and postpone harvesting. By modifying wine organoleptic profile, it helps winemakers achieve desired wine quality without suffering the effects of climate change.


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POSTER SESSION

POSTER COMMUNICATION

Identification and evaluation of the winemaking sub-zones of the PDO Amyndeo winegrowing region

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Keywords: terroir, sub-zoning, mapping, remote sensing, Xinomavro

ABSTRACT

Context and purpose of the study. The concept of terroir encompasses the investigation of the physical environment's influence on grapevine physiology, grape composition, and wine quality, with an emphasis on employing viticultural zoning techniques to systematically characterize and analyze terroirs. These interactions are fundamental in determining vine development, grape composition, and, ultimately, the sensory characteristics of the resulting wine. Despite its importance, the integration of remote sensing technologies with established zoning methodologies has not been extensively examined. Moreover, the application of zoning techniques is particularly challenging in regions where data on climate and grape cultivation are scarce or unavailable. The primary aim of this study is to identify and validate the viticultural subzones within the PDO Amyndeon wine-growing area by integrating remote sensing data with viticultural data collected over two consecutive growing seasons. This process of identification and validation will pave the way for future research to evaluate the correlation between the combined data and the organoleptic properties of wines produced from each experimental vineyard.

Material and methods. The study area is the PDO Amyndeo wine growing region in the area of Western Macedonia. To identify and evaluate the subzones, freely accessible satellite data were employed, selected based on their documented influence on grape quality as reported in the literature. Specifically, data related to soil properties, climatic conditions, and topography within the broader study area were analyzed to produce maps. These maps facilitated the selection of experimental vineyards, which were subsequently used to validate the preliminary zoning assessment. Over two consecutive growing seasons, detailed measurements of the vineyards' qualitative and quantitative characteristics were conducted, providing a robust dataset for the verification and refinement of the identified subzones.

Results. The initial mapping of the broader PDO Amyndeon region classified the area into four distinct suitability categories for the cultivation of Xinomavro and the production of premium red wine. The validity of these suitability classifications was substantiated through measurements conducted in experimental vineyards. More specifically, the vineyards in the Fanos area exhibited statistically significant differences in skin weight, grape weight, and pruning wood weight compared to the vineyards in the Limni, Vegora, and Lofos areas. In contrast, no statistically significant differences were observed when compared with vineyards in the Xino Nero area, aligning with the findings derived from satellite data estimations. Additionally, the Limni, Vegora, and Lofos areas showed statistical differences only in leaf area and total anthocyanin content, further confirming their lower suitability for Xinomavro cultivation relative to the Fanos and Xino Nero areas.

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POSTER COMMUNICATION

Seasonal dynamics of water and sugar compartmentalization in grape clusters under deficit irrigation

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Keywords: *Vitis vinifera*, leaf water potential, stomatal conductance, hydraulic conductance, AQPs, sugar transporters

ABSTRACT

Water stress triggers functional compartmentalization in grapevines, influencing how resources are allocated to different plant organs. However, comprehensive insights on how water availability affects xylem functionality in each specific grape berry organ remain scarce. This study aims to explore the impact of irrigation regimes (different water stress levels) on hydraulic adjustments in berry clusters of 'Touriga Nacional' (TN) and 'Syrah' (SY) varieties, at key seasonal growth stages. Plants from a commercial vineyard were exposed to three long-term irrigation treatments over five consecutive years: full irrigation (FI, 100% ETc); deficit irrigation (DI, 50% FI); and no irrigation (NI, rain-fed).

Measurements of stomatal conductance (gs), predawn leaf water potential (ψpd), and hydraulic conductance of berry cluster (Khrachis+pedicel and Khrachis)) were taken at four phenological phases during 2022 growing season: peppercorn-size (PCS), pea-size (PS), veraison (VER), and full maturation (FM). Additionally, the gene expression of ten aquaporins (AQPs) and five sugar transporters was analyzed in the rachis, pedicel, berry pulp and skin.

The results indicate that Kh varies depending on the variety, the specific grapevine organ and phenology. Following PCS, Khcluster dropped sharply in the three irrigation treatments and in both varieties. In TN, after VER, Khcluster significantly rose across all treatments, despite the significant differences in ψpd. In SY, on the contrary, after PCS, Khcluster maintained relatively stable values across all phenological stages, and irrigation treatments, despite the significant differences in ψpd, except in FI plants at PS, AQPs were regulated differently depending on variety, treatment, organ, and phenological stage. In general, low gene expression level was observed in the rachis of both varieties. The most pronounced treatment-related differences were seen at VER and FM. Irrigation influenced sugar transporter activity in both leaves and berry clusters. Notably, the sugar transporter VviSWEET14 was up-regulated in both DI and NI conditions from PCS onward in leaves and berries, while other hexose transporters were mainly down-regulated. The influence of hydraulic and molecular mechanisms in the ecophysiology of both varieties will be thoroughly explored, along with its impact on irrigation management.

POSTER COMMUNICATION

Soil humidity and early leaf water potential affected by water recharge before budbreak in cv. Tempranillo deficitary irrigated during the summer in the D. O. Ribera del Duero

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Keywords: grapevine, photosynthesis, water stress

ABSTRACT

The availability of water for irrigation is usually greater at the beginning of spring than in the following months, until the end of summer, in most regions of Spain. The physiological activity and vegetative development of the vine can benefit, from budbreak, from the water in the soil, so it is important to know the real impact that the possible contribution of water at the time of budbreak can have on the moisture content of the soil and the water status of the plant, in situations where the vineyard is usually deficitary watered during the summer, when it suffers greater evapotranspiration demand and needs irrigation to avoid excessive water stress.

The aim is to study the response of soil moisture content (60 cm) and foliar water potential, measured at 7 solar hours on leaves in the shade side, to the application of pre-budbreak irrigation in a vineyard subjected to deficit irrigation (30% ETo) during the summer: T7P vs T07, in cv. Tempranillo, grafted on 110R. The work was carried out over the period 2021-2023, in a vineyard located in the D.O. Ribera del Duero, with vine distances of 3.0 x 1.2 m, trained on vertical trellis and pruned as bilateral Royat cordon, where 4 blocks were established at random, with elementary plots of 48 vines, distributed in 4 rows, of which the 2 central rows were considered for control.

The results show that the moisture content in the first 60 cm of soil was not affected throughout the summer, when weekly deficit irrigation was already applied, by the application of recharge irrigation just at budbreak time. The leaf water potential, however, was slightly favoured by the budbreak recharge until mid-summer, depending on the meteorological conditions of the year. It would be advisable to extend the study temporally and, above all, spatially to different types of soil, considering the impact of the early application of irrigation also on the productive and qualitative response of the vineyard.

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POSTER COMMUNICATION

Irrigation frequency: variation and agronomic and qualitative effects on cv. Tempranillo in the D. O. Ribera del Duero

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Keywords: grape, grapevine, pruning weight, quality, yield

ABSTRACT

The application of irrigation in vineyard cultivation continues to be a highly debated aspect in terms of the quantity and distribution of water throughout the vegetative growth period. This requires a deeper understanding of the influence that such application can have on the physiological activity of the vine in a context of climatic variation such as the current one. In this sense, it is operationally interesting to know the effect that the frequency of application of deficit irrigation during the vegetative cycle can have on the vegetative, productive and qualitative behaviour of the vineyard in order to optimise decision-making in its water management.

A work is proposed on the agronomic response to the variation in the frequency of deficit irrigation (30% ETo) during the summer, with three treatments: 2 irrigations per week (T03), 1 irrigation per week (T07), 1 irrigation every two weeks (T15), in cv. Tempranillo, grafted on 110R rootstock. The work was carried out throughout the period 2021-2023, in a vineyard located in the D.O. Ribera del Duero, with vine distances of 3.0 x 1.2 m, conducted in vertical trellis pruned as bilateral Royat cordon, where 4 blocks were established at random, with elementary plots of 48 vines, distributed in 4 rows, of which the 2 central rows were considered for control.

The results show interannual variation in the response of the vineyard to the frequency of deficit irrigation, both in terms of production and grape composition, with weekly irrigation (T07) being the most stable in its behaviour, while the other two frequencies were more variable, indicating that the highest frequency (T03) tended to favour vegetative growth, while the low frequency (T15) showed a certain tendency to increase acids in the grape.

It is advisable to extend the study of irrigation frequency in different soil types temporally and spatially, taking into account the overall response of the vineyard.

POSTER COMMUNICATION

Permanent *vs* temporary cover crops in a Sangiovese vineyard: preliminary results on vine physiology and productive traits

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Keywords: berry composition, green manure, organic mulching, soil management, water potential

ABSTRACT

Cover crops in vineyards have been extensively studied, as the choice of grass species and their management significantly influence soil properties and vine performance. However, the anomalous distribution and intensity of rainfall events driven by climate change have renewed interest in soil management, highlighting the need to update our knowledge.

Considering the importance of this issue, this study aimed to evaluate the effects of different permanent and temporary cover crop management strategies on vine physiology and productive traits.

The trial was conducted in a Sangiovese vineyard in the Senio Valley (Emilia-Romagna, Italy) and vines, clone VCR4 grafted onto SO4 rootstock, were trained to free cordon. In November 2023, two specific cover crop mixes were sown in the interrow following a randomized block experimental design: a) mix of Lolium perenne, Festuca Rubra, Poa pratense and Trifolium repens to establish a permanent sward that was mown twice in the following spring/summer (P+M); b) mix of Hordeum vulgare, Brassica napus, Avena strigosa, Phacelia tanacetifolia and Trifolium incarnatum to establish a temporary cover crop that in May 2024 was mowed with a trimmer and incorporated to the soil by tillage, realizing a green manure (T+GM) or mowed and laid down in the interrow as organic mulching (T+OM).

Midday stem water potential measurements of July and August 2024 showed lower potentials of P+M vines compared to those of the other treatments, in two of the five days they were performed, but no difference of net assimilation between treatments was noted in the three days in which gas exchange measurements were conducted. At harvest, cluster and berry weight of P+M grapes resulted lower than the other treatments, leading to a slight and not significant lower yield. Quite surprisingly, total soluble solids concentration resulted higher in T+GM than in P+M, while T+OM showed an intermediate value. No difference in pH and titratable acidity was found. These results appear related to the competition of the permanent cover crops in terms of nutrients and water uptake, which may have reduced the development of main and lateral shoots, resulting in a lower leaf area compared to T+GM vines. This hypothesis will soon be tested by assessing vegetative growth through the measurement of pruning weight.

The preliminary results of this trial bring to light some interesting insights on soil management which need to be evaluated in the coming years.

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POSTER COMMUNICATION

Grapevine abiotic stress induce tolerance to bunch rot

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Keywords: vegetative growth, nitrogen, bunch rot tolerance, under vine cover crop, water status

ABSTRACT

Context. Botrytis bunch rot occurrence is the most important limitation for the wine industry in humid climate viticulture. Previous studies of our group showed strong differences in bunch rot incidence between floor management treatments: cover crop (CC) vs weed-free strips under the trellis with herbicide (H). We observed that in some circumstances this reduction in bunch rot incidence occurred without major vine growth differences among treatments. The aim of the present study was better understanding the factors involved in this differential response observed.

Materials and methods. The experiment was conducted over two growing seasons in southern Uruguay (34°44′ S, 56°13′ W). Ninety-six plants of Vitis vinifera (Tannat), grafted on to SO4 rootstocks, grown in 100 L pots were used each season. The four years old vines were trained on vertical shoot positioning system (VSP) located inside an experimental vineyard. We tested the effect and interactions of soil management treatments and grapevine water status (irrigation schedules) on grapevine tolerance to disease development. Treatments were arranged in a split-plot randomized block design with 6 replications, whit cover crop schemes as main plots and water availability during pre-veraison period as subplots. Cover crop treatment (CC), consisting of full cover of the plot soil with tall fescue versus bare soil (H). Main plots, comprising 16 adjacent vines. Supplementary irrigation was applied daily to maintain equal water status during the entire growing season regardless soil management treatment. In no water stress treatment (NWS) irrigation thresholds were −0.5 MPa MDSWP until fruit set, −0.6 MPa from fruit set to veraison and −0.8 MPa from veraison to harvest. The same thresholds were used for water stress (WS) treatment except for the period of 20 days previous veraison were plants were not irrigated until reach −1.1 MPa MDSWP.

Results. Bunch rot incidence and severity were remarkably lower in CC compared to H treatments while water restriction during perversion period also reduce significatively bunch root incidence. The results were consistently significant both seasons even when vegetative expression, PAR% at the fruit zone, cluster size and compactness and fruit composition were comparable among treatments. Our results do allow us to affirm that other factors besides vegetative expression/bunch compactness, and fruit zone environment, are playing an important role on the disease development.

POSTER COMMUNICATION

Analysis of vineyard soil after mulching with municipal solid waste (MSW)-compost

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Keywords: municipal soild waste (MSW)-compost, vineyard, mulching, antigermination effect, physico-chemical analyses

ABSTRACT

The use of compost as amendment in agriculture is a well-established practice, strongly recommended for numerous benefits. Compost is a source of organic matter, necessary for both improving soil fertility and preventing erosion. Additionally, it provides nutrients for plants, allowing the reduction of mineral fertilization, and enhances soil microbial diversity both directly, by introducing a pool of microorganisms into the soil, and indirectly, by improving habitat suitability for microbial life. In the last years, compost has been also tested as mulching material for weed control as an alternative to plastic films, which generates pollution issues. Organic mulching allows reducing soil drying and regulates soil temperature fluctuations. Thanks to all these properties, use of high-quality compost is particularly recommended for marginal areas, such as Southern Italy, which are exposed to desertification risk and are increasingly threatened by climate changes.

In this study, a compost obtained from the organic fraction of municipal solid waste (MSW-compost), mixed with pruning waste and a minor fraction of agro-industrial sludge, was used for mulching in a wine vineyard in Salento (Apulia, Southern Italy). The vineyard soil was sandy loam and poor in organic matter (~ 10 g kg-1). Compost was applied in March along the row at three different doses (8, 15 and 22 kg plant-1) to create a mulching layer ~50 cm-wide and of increasing thickness depending on the amount of compost used. The compost treatments were compared with conventional mulching (black polyethylene film) and mulching with a biodegradable film. All the treatments, and the un-mulched control, were run in triplicate using a completely randomized design. Every three months, soil samples were collected and analysed for main physico-chemical parameters. Growth of weed plants along the row and crop morphological and yield parameters were also periodically measured.

Soil electrical conductivity slightly increased in all the treatments with compost, remaining always below the threshold of 2 dS m-1. The use of compost implemented the soil organic matter content and exerted an antigermination effect on weeds.

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POSTER COMMUNICATION

Water retention properties of viticultural calcisols from D. O. P. Valdepeñas (Spain)

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Keywords: vineyard soils, water availability, field capacity, permanent wilting point, physicochemical properties

ABSTRACT

A good knowledge of the soil physicochemical properties, as well as its ability to retain and put the necessary water available to the plants, is essential when it comes at the design of an irrigation plan. The latter must be capable of satisfying the water needs of the crops, avoiding both excess water (which is not used and causes soil´s leaching) and its deficit, since that ends up harming both the crops and their yields.

In growing vineyard for winemaking, the quality of the grapes used will depend on the frequency and the amount of water supplied to the plant. Therefore, this aspect is especially relevant for viticulture in Mediterranean climates where water scarcity is an increasingly limiting reality (which is expected to be worse due to the influence of climate change).

The purpose of the study is the determination of the moisture retention properties corresponding to 33 vineyard calcisols selected as representative from the Protected Designation of Origin "Valdepeñas" in Castilla-La Mancha (Spain) and also, related them with other physicochemical soil properties to determine which of them are stadistically correlated.

In this research, standard commercial pressure plate apparatus from Soilmoisture Equipment Corp. (Santa Barbara, California, USA), was used to apply the specified pressures from -10 kPa to -1500 kPa to the soil samples of the surface and subsurface horizons from the 33 calcisols soils (6 of them do not have subsurface horizon). After that, the gravimetric method was carried out on those same soils, and finally, the soil water retention curves were developed.

The moisture values at Field Capacity (-33 kPa), Permanent Wilting Point (-1500 kPa) and Available Water of the surface (A) and subsurface (B) horizons were compared, concluding that soil depth statistically influences these parameters. The available water values of each horizon were related to the most relevant physicochemical properties of the soil in terms of moisture retention (apparent density, sand, silt, clay, organic matter, calcium carbonate and active calcium carbonate) to know whether they were correlated. For the horizon A, silt and active calcium carbonate are positive correlated with available water ($r = 0.43$ and $r = 0.42$, respectively), however, calcium carbonate and active calcium carbonate are the most positive correlated properties with the available water of the horizon B ($r = 0.68$ and $r = 0.57$, respectively).

POSTER COMMUNICATION

Delayed irrigation nearly doubles yield loss compared to anthocyanin gain in Southern Oregon Pinot noir

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Keywords: grapevine productivity, berry quality, irrigation timing, stem water potential, yield components

ABSTRACT

Irrigation initiation timing is a critical annual management decision that has cascading effects on grapevine productivity and wine quality. A three-year multilocation trial was conducted to optimize irrigation initiation timing using midday stem water potential (Ψstem) thresholds. Plant material, vine and row spacing, and trellising systems were concomitant among sites, while vine age, soil type, and pruning systems varied. Five target Ψstem thresholds were arranged in an RCBD and replicated eight times at each site: -0.7, -0.9, -1.1, -1.3, and -1.5 MPa (T1, T2, T3, T4, and T5, respectively). When thresholds were reached, plots were irrigated weekly at 70% ETc. Yield components, berry chemistry, and anthocyanins were quantified at harvest. Across sites and years, irrigation was initiated at Ψstem = -0.69, -0.96, -1.15, -1.38, and -1.40 MPa for T1, T2, T3, T4, and T5, respectively. Consistent significant linear trends were found for key yield and berry quality parameters across sites and years. Yield decreased by 6.2, 16.9, 24.4, and 34.0% for T2, T3, T4, and T5, respectively, compared to T1 across sites and years that were driven by similarly linear reductions in berry weight and to a lesser extent clusters per vine. Comparatively, berry chemistry variables (Brix, pH, TA) responded weakly and/or inconsistently to treatments across sites and years. However, berry anthocyanin response to treatments was consistent and significant across all sites, increasing linearly with delayed irrigation initiation. Regression analyses of percent change relative to T1 revealed that for every 0.1 MPa of delay past -0.7 MPa, yield decreased by 4.2% ($R2 = 0.71$, $p < 0.001$) and anthocyanins increased by 2.3% ($R2 = 0.47$, $p = 0.005$) with no change in Brix nor differences among years. Because producers are paid by weight, and contracts typically stipulate a target maturity level, results suggest that there may not be an economic incentive to delay irrigation initiation regardless of vineyard site.

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POSTER COMMUNICATION

Responses of grape yield and quality, soil physicochemical and microbial properties to different planting years

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Keywords: grape yield, planting years, continuous cropping, soil physicochemical properties, microbial community

ABSTRACT

As an economically important fruit crop, continuous cropping of grapes can potentially impact soil health resulting in decreased yields. However, the mechanism of how soil microecological environment of continuous cropping affects grape quality at different growth stages is not fully understood. To address this, a field experiment was conducted in the Beijing area, which was a major grape-growing region in China. We investigated the effects of continuous grape cultivation for 0, 7, and 12 (CK, G7Y and G12Y) years on soil physicochemical properties and microbial community at different growth periods and soil depths, as well as on grape yield and quality. The results showed that grape yield, aroma compound contents, soil and grape leaf nutrients decreased significantly with the increase of planting years, soil acidification and secondary salinization intensified. Compared to G7Y, the relative abundance of the beneficial soil microorganisms Mortierella, Bacillus and Pseudomonas decreased significantly in G12Y, while the relative abundance of the potential pathogenic fungi Pseudaleuria and Aspergillus increased significantly. In addition, the nutrient content and biomarkers in the subsoil were lower than those in the topsoil. Particularly, the fruit setting stage appeared to be more sensitive to shifts in soil microbial communities over different planting years. Correlation analysis showed that grape yield was positively correlated with Bacillus and Mortierella, and negatively correlated with Fusarium. Grape yield was more sensitive to phosphorus and potassium fertilizers than to nitrogen fertilizer. In conclusion, continuous cropping reduced the content of soil nutrients and the number of soil beneficial microorganisms, increased the abundance of soil pathogenic microorganisms, and jointly caused changes in grape yield and quality. Therefore, it is necessary to optimize the management strategies to improve the soil microbial diversities especially beneficial microbial diversity to maintain the soil health and then to promote sustainable production of vineyards.

POSTER COMMUNICATION

Growing characteristics of new PIWI varieties from the breeding program in the Czech Republic

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Keywords: grapevine variety, resistence to fungal disease, grape quality, agrobiological parameters

ABSTRACT

Context and purpose of the study. The breeding of PIWI varieties has a long tradition in the Czech Republic. In the last two years, 9 new PIWI varieties have been registered. In the Czech Republic, PIWI varieties are cultivated on an area of almost 1000 ha. The most cultivated varietiy is Hibernal. The most cultivated varieties bred in the Czech Republic are Savilon, Rinot, Malverina, Sevar and Laurot. They are grown under organic or integrated production, which represents an intersection between fungicide reduction and organic practices. This study presents selected new PIWI varieties, their agrobiological, qualitative parameters and recommendation for viticulture practice.

Material and methods. The following varieties were evaluated for growing characteristics: Cristal Wikra, Flower Riesling, Marcus blanc, Pinot écru, Riesling gris (white w.v.) and Fragment, L 108-23-11, Ruby Pinot (red w.v.). Experimental sites are located in the wine-growing villages of Lednice, Perná, Přítluky and Rakvice. Basic agrobiological parameters, resistance to fungal disease and quality parameters during harvest were evaluated. Chemical protection of the vineyards was carried out before and after flowering. The varieties are planted in space of 2.2 x 1.0 m (Lednice location) and 1.2 x 0.8 m (other locations).

Results. Based on the evaluation of agrobiological properties, it can be observed that the varietiy Ruby Pinot shows significantly earlier bud break, which may be consequence of V.amurensis in the pedigree. Time of flowering is also earlier in the varieties Ruby Pinot and Marcus blanc. Other varieties show an average time of bud break and flowering. Significantly early time of maturation is shown by the varieties Pinot écru, Flower Riesling and Fragment (early September). All varieties show good to very good resistance to fungal pathogens. The highest resistance is shown by Ruby Pinot and Marcus blanc. The evaluation of qualitative parameters showed that the highest sugar content had varieties Pinot écru and Flower Riesling. Other varieties have a medium to late ripening period. It is possible to find a high variability in wines from these varieties, which is due to the origin of the varieties.

ACKNOWLEDGEMENTS

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POSTER COMMUNICATION

ViniGWAS – improving the selection of climate-resilient grapevine varieties

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Keywords: GWAS, breeding, markers, climate

ABSTRACT

Climate change and its consequences are becoming an increasing challenge for viticulture. The breeding of new grapevine varieties that are better adapted to the changing conditions offers a possible solution. Using genetic markers to assist selection in breeding already during the sapling stage increases breeding efficiency tremendously. Unlike markers for fungal resistance in grapevine that already exist, there is still a lack of markers for climate-relevant traits. To identify and characterize genomic regions of those traits, in order to allow the development of markers for breeding, is the aim of this project. A whole-genome sequencing approach coupled with genome-wide association studies (GWAS) is used to accomplish this. Several hundred different varieties of cultivated grapevine have been sequenced with a coverage of 30x as the genotypic basis of this research. Phenotypic data of relevant traits (like the time of budburst or of the start of ripening) of these genotypes exist for several years and will be continued to be recorded for the duration of the project. The genetic association of these traits shall then be clarified, using the advantages of GWAS like better detection power or higher resolution for polygenetic traits. By plugging these developed markers into a marker-assisted selection breeding workflow, the breeding of new and better climate-resilient grapevine varieties can be accelerated.

POSTER COMMUNICATION

Citizen science for promoting a disease-resistant grape variety through a wine competition

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Keywords: PIWI, Souvignier gris, wine contest

ABSTRACT

The societal pressure to reduce the use of pesticides in Switzerland is steadily increasing. Viticulture is particularly in focus due to the frequent use of fungicides to combat downy and powdery mildew. Around 60% of all fungicides in Switzerland are used in viticulture. The most effective countermeasure is the cultivation of disease-resistant grape varieties (Piwis). Despite the many advantages of these varieties, they are only grown on 3.6% of the vineyard area in Switzerland. A significant reason for this lies in the still low acceptance of Piwi wines, more in the wine industry than among consumers. In this project, measures were implemented using the example of the Souvignier gris variety to convince stakeholders in the wine industry of the high quality potential and diversity of this variety. The goal was to develop best practice examples within the framework of a wine competition and to present the winning wines at selected events. Two workshops were held in preparation for the competition. The first workshop started in the field, where the producers shared their experiences of cultivation. Subsequently, trial variants and wines from practice were tasted and discussed. In the second workshop, the young wines were tasted. The aim of the exchange of experiences was to provide producers with further tips for optimizing their wines for the competition. The actual "Best of Souvignier gris" competition then took place in two stages. The first stage consisted of the nomination tasting, in which three wine experts evaluated the 23 submitted wines on a 100-point scale. Nine wines were nominated for the award tasting, which took place during the Wädenswil Wine Days. In the award tasting, the nominated wines were evaluated by a professional and a public jury. The professional jury consisted of eight professional and sensory-skilled representatives of the wine industry from the fields of production, trade, gastronomy, and journalism. The public jury was made up of 151 participants of the Conference. Remarkably, the evaluation showed how similarly the professional and public juries ranked, although the public jury's ratings were much more varied. The results of the workshops and the nomination and award tastings were incorporated into a fact sheet. The nominated wines were presented at further events attended by representatives from gastronomy and wine trade. A repeat of this project with a red fungus-resistant grape variety is being planned.

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POSTER COMMUNICATION

Adaptation and resilience of scions and rootstocks to water constraint? It's complicated and requires an integrated approach

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Keywords: scion, rootstock, water stress, epigenetics, grapevine microbiome

ABSTRACT

The ability, and the underlying mechanisms of grapevines to cope with and adapt to recurring water constraints, are the focuses of this study. It is an important topic given the growing climate extremes, droughts and water-scarce conditions experienced in the vineyards of the world. Our approach relies on integrative analyses where relationships between a plant's environment, its intrinsic responses to stressful conditions, and extrinsic biotic factors such as microbial populations are interrogated. Experiments were first conducted in a potted vineyard containing scions (Cabernet Sauvignon, Merlot, Pinotage, Petit Verdot, and Shiraz) and rootstocks (Ramsey, 110 Richter, 101-14 Mgt, and USVIT 8-7) on their own roots, as well as in grafted combinations. This allows control over when, how long, to what level and how many recurring events of water constraint are applied, using active drying workflows. Profiles of the responses of the scions, rootstocks and their grafted combinations as water constraints increase and relax were achieved. The plasticity in responses, specifically linked to stomatal conductance and transpiration (day and night) is strongly influenced by the scion/rootstock combinations, with evidence of adapted responses with recurring drying events. The contribution of intrinsic (morphological, physiological and epigenetic) and extrinsic (rootzone microbial community) factors to water stress resilience were investigated in a second vineyard resource, a validated model vineyard where three scion cultivars (Pinotage, Shiraz, and Cabernet Sauvignon) on two rootstocks (Richter 110 and USVIT8-7) grow under dryland and well-watered scenarios. Profiling of the site, soil, atmospheric conditions, plants, and their physiological responses provide contextual data for a diurnal transpiration analysis, as well as an epigenetic and soil microbiomics evaluation. On the latter, we will show that each cultivar is surrounded by different microbial communities, but of similar traits. For example, a mixture of genera that can tolerate extreme environments in the soil was found under dryland conditions, whereas the well-watered plants were surrounded by saprobes and decomposers, suggesting that each cultivar has a different pool of genera from which to recruit microorganisms to the rhizosphere under different irrigation levels. The combined data provides insight into the adaptability of grapevines and confirms the value of the approach to investigate resilience.

POSTER COMMUNICATION

Evaluation of new fem grapevine varieties resistant to the main fungal diseases

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Keywords: crossbreeding, field assessment, marker-assisted selection, resistance super-donors, *Vitis*

ABSTRACT

Context and purpose of the study. The genetic improvement of grapevines at the Edmund Mach Foundation (FEM) has evolved significantly since its inception, and its philosophy on sustainable viticulture through crossbreeding techniques aligns with the urgent need to reduce chemical use in agriculture. Initial breeding efforts concentrated on enhancing agronomic and qualitative traits, while more recent initiatives have focused on developing disease-resistant varieties and improving resilience to climate change challenges such as late frost, sunburn and early ripening, with special attention to the market trends i.e., sparkling wines.

Material and methods. The strategy employed by FEM include controlled crossings (i) between hybrid genotypes to create parental super-donors with stacked resistance loci and (ii) between super-donors and Vitis vinifera cultivars, to introduce resistance traits against the major biotic stresses. The program has utilized optimized marker-assisted selection (MAS) and phenotyping protocols coupled with multi-year agronomic surveys, grape quality evaluation and wine tastings.

Results. Over the years, FEM has successfully registered eight new grape varieties noted for their organoleptic qualities, late ripening, tolerance to gray mold, and resistance to downy mildew, powdery mildew and, in some cases, black rot. In parallel, several disease resistant super-donors have been selected and recurrently employed both for institutional crossbreeding goals and for co-developing programs with external entities. Under the hat of the EU GrapeBreed4IPM project, four collaborations across Italy are ongoing to leverage parental super-donors to enhance élite varieties of regional interest: Corvina, Sangiovese, Lambrusco e Verdicchio. The derived F1 evaluation is ongoing relatively to agronomic, disease resistance, climate resilience, and oenological performance.

Finally FEM, contributing to the EU OSCAR program, meets the goal of reducing chemical inputs while maintaining high-quality wine production.

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POSTER COMMUNICATION

Development of breeding of PIWI varieties in the Czech Republic

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Keywords: loci of resistance, grapevine, *Plasmopara viticola, Erysiphe necator*

ABSTRACT

Context and purpose of the study. The Czech Republic is one of the most important grape growers of PIWI varieties in the Europe, as the total area planted with PIWI varieties is almost 1000 ha. The tradition of breeding dates back to the 1960s, when Vitis amurensis was used in the breeding program. There are currently 20 PIWI varieties registered in the Czech Republic. The aim of the study was to test the markers, that are bound to Plamopara viticola and Erysiphe necator resistance loci in all Czech varieties. The obtained results will be used in the further breeding program.

Material and methods. DNA was isolated from young leaves using the DNA Plant Mini Kit (Qiagen). To detect resistance loci, SSR markers closely related to them were used: Rpv3 (UDV305, UDV737), Rpv4 (VMC7h3), Rpv7 (UDV097), Rpv10 (GF09-44, GF09-46, GF09-47), Rpv11 (VVMD27), Rpv12 (UDV340, UDV370, GF14-63), Ren3 (ScORGF15-02) and Ren9 (CenGen6). PCR was prepared with GoTaq G2 Flexi DNA polymerase (Promega). Together with the tested varieties, the reference genotypes (Rpv3,4 – Regent, Rpv7 – Bianca, Rpv10,11 – Solaris, Rpv12 – Vostorg, Ren3 and 9 – Regent) were analyzed. Fluorescently labeled primers were used and the amplicons were separated in the capillary of the genetic analyzer (ABIPrism 310, Applied Biosystems) with Gene Trace 400ROX size standard (Carolina Biosystems). The size of the alleles was evaluated using the relevant Gene Scan software and compared with the results of the reference genotypes.

Results. Based on the analyses of resistance loci, it was found that the following loci of downy mildew are represented in the varieties: Rpv3, Rpv4, Rpv7, Rpv11 and Rpv12. The results show that only one resistance loci are present in 5 varieties, two resistance loci are present in 11 varieties, three resistance loci in 3 varieties, and even 4 resistance loci in one variety. The most interesting varieties are Marcus blanc (Rpv3, Rpv12) and Ruby Pinot (Rpv3, Rpv7, Rpv11, Rpv12). They show very high resistance to downy mildew in the field conditions. From the point of view of resistance loci to powdery mildew, these are Ren3 and Ren 9 resistance loci. In 14 varieties both resistance loci are present and in one variety only Ren3 locus, in 5 varieties these resistance loci were not detected. The highest resistance in the field conditions is provided by the varieties Savilon, Vesna, Cerason and Ruby Pinot.

ACKNOWLEDGEMENTS

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POSTER COMMUNICATION

The "green gold" @fem: assessing grapevine germplasm diversity to crossbreed the varieties of the future

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Keywords: genotyping, phenotyping, resilience, resistance, *Vitis*

ABSTRACT

Context and purpose of the study. To date over 3,000 grapevine accessions have been collected at Fondazione Edmund Mach (FEM). The responsibility is not only to conserve the biodiversity heritage but also to valorize this "green gold" through the study of its genotypic and phenotypic diversity, so as to exploit this information for the development of new superior varieties.

Material and methods. The germplasm is grafted onto SO4 rootstock (except rootstock varieties), and is generally maintained in treated fields, with untreated vineyards dedicated to genotypes under the biotic stress resistance crossbreeding program. The nine reference microsatellites were used to genetically characterize the germplasm, defining unique profiles and parent-offspring (PO) relationships. Robust R-loci associated markers were adopted to screen putative resistant genotypes, and SNParray characterization is oncoming. Up to 80 phenotypic variables were collected across at least three seasons, and all information is hosted in the new FAIR FEM Vitis Database.

Results. A total of 2,116 unique genetic profiles were identified, along with 57 somatic variants of 30 varieties (cépages). The Vitis International Variety Catalogue (VIVC) served as a reference to determine known profiles, revealing 928 unknown and therefore uncharted genotypes that will enrich the asset of the grapevine community. Putative PO relationships were identified for 1,873 genotypes, 898 belonging to the unknown cohort. Through reciprocal relationship investigation, families within the germplasm were generated, with the largest encompassing 1,749 profiles. Phenology (from wooly bud to ripening) and fertility metrics were filed for the entire collection, with ongoing surveys to assess flower sex and emergent diseases. Biotic stress resistance was recorded using OIV descriptors for cluster and leaf downy mildew, powdery mildew, black rot; leaf erinosis, phylloxera, flavescence dorée; cluster gray mold; and five viroses. For the phase II crossbreeding selections, data were also collected on 50 ampelography-related OIV descriptors, ripening curve (from veraison to 18°Brix), plant yield, cluster and berry weight, berry and must anthocyanin and total polyphenol content.

This work uncovers the FEM germplasm diversity, exploring trait distribution and unique trends to inform grapevine crossbreeding programs towards the development of improved parental-lines and new disease resistant and climate resilient varieties.

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POSTER COMMUNICATION

Clones of 10 *Vitis vinifera* varieties: degree of inter- and intra-varietal variation and putative mechanisms underlying clonal variability

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Keywords: clonal variation, carbon isotope composition, stomatal conductance, leaf-to-fruit ratio, climate change

ABSTRACT

Context and purpose of the study. Intra-varietal variability for key physiological and oenologically important traits can be exploit in viticulture following the consistently higher environmental pressure driven by climate change. Previous studies provided evidence of a significant variability (e.g. phenology, intrinsic water use efficiency) between varieties and within the same variety of Vitis vinifera. Our work aimed at 1) evaluating the phenotypic variability for adaptive traits under stressful environments in a clonal panel including ten red grape varieties and 2) exploring the physiological bases of this variation.

Material and methods. The work was carried out in a clonal experimental vineyard over three vintages (2022, 2023, 2024) followed by a series of controlled environment experiments. Within ten internationally valuable red grape varieties, an unbalanced number of clones (n = from 3 to 24) were included in the experimental design and based on the bioclimatic basin of selection. Over three years, canopy temperature traits, gas exchanges, leaf carbon isotopic composition, water status and chlorophyll content were collected on different days and meteorological dynamics (20 to >35°C air temperature) in post-veraison. Under controlled-environmental conditions, contrasting clones selected from 2022 and 2023 data for Sangiovese and Montepulciano were subjected to different degrees of progressive stresses.

Results. Clonal variability nullifies the expected anisohydric-isohydric responses hypothesized in contrasting varieties, putatively owing to the broad clonal variation detected. Indeed, clonal variability was significant for all varieties and for all traits of interest with leaf carbon isotope composition appearing to explain part of the daily stomatal dynamics observed over specific days in the vineyard. A portion of the variability found in the vineyard, and particularly associated with stomatal kinetics, was associated with differences in the foliar emission of volatile organic compounds while crop load was indeed negatively correlated with water-use efficiency. Intra-varietal variability appears to be a valuable source of phenotypic variation that can be exploited to adapt viticulture to a warmer climate, while maintaining varietal typicity.

POSTER COMMUNICATION

The effect of short and long-term water deficit on physiological performance and leaf microbiome of different rootstock and scion combinations

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Keywords: rootstocks, rewatering, water deficit, drought

ABSTRACT

Climate change, particularly drought stress, threatens viticulture sustainability. Understanding scion-rootstock interactions and their link to the grapevine microbiome is key to improving vine health, productivity, and drought resilience. Our work had two main objectives: 1) to investigate some physiological and morphological characteristics of the Furmint grape variety during short and long-term water deficit and under rewatering 2) to study the effect of short and long-term water deficit on the leaf microbiome of Furmint varieties grafted on different rootstocks.

The pot experiment was conducted in the summer of 2024. Furmint variety was grafted onto Teleki 5C and Richter 110 rootstocks, which have different drought tolerance. Two water deficit treatments were applied for both scion-rootstock combination, 50% and 100% filed capacity, respectively. In addition, drought stressed plants were subjected to a short- (14 days) and a long-term (42 days) water deficit. After both types of water withdrawal, the plants were re-watered. During the experiment, leaf gas-exchange parameters were monitored with a CIRAS-4 portable photosynthesis system, with a particular focus on the pre- and post-rewatering phases. Also, pilot midday- and stem water potential measurements were conducted with Scholander-type pressure chamber. Leaf samples were collected for DNA and RNA extraction from each treatment, enabling microbiome and metatranscriptomic analyses.

Moderate water deficit greatly affected leaf water potential, gas-exchange parameters (A, E, gs), root lengths, root dry matter and individual leaf area. However, the length of the water deficit period significantly affected the gas-exchange parameters of the post-rewatering period. Indeed, during recovery after the 6 weeks from water deficit, stomatal conductance values increased slowly than during the previous rewatering phase. In addition, root growth was significantly affected by water availability and the type of rootstock. In particular, the water deficit has caused the length of the Richter 110 root to increase significantly.

In conclusion, based on the gas-exchange parameters length of water deficit had a significant effect on recovery phase of the plants. Furthermore, we have observed different behaviour of different rootstock-scion combinations under water deficit. Our ongoing microbiome studies aim to characterize the composition and functionality of the grapevine microbiome under drought stress.

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POSTER COMMUNICATION

Integrating genomic prediction into grapevine breeding programs

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Keywords: grapevine, breeding, genomic selection, prediction accuracy, GWAS

ABSTRACT

Genomic selection (GS) has emerged as a transformative tool for accelerating breeding programs by predicting the genetic potential of individuals using genome-wide markers. In grapevine breeding, GS holds significant promise for enhancing genetic gains, reducing breeding cycles, and efficiently addressing complex traits such as yield, wine quality and climate adaptability. Despite its widespread success in animal breeding, the routine implementation of GS in plant breeding, remains limited due to challenges in prediction accuracy influenced by various factors.

We will share the first results from ongoing genomic prediction (GP) studies within the French breeding program INRAE-ResDur. This program aims to develop durable disease-resistant grapevine cultivars by integrating multiple sources of resistance. We conducted GP across several breeding populations, focusing on key phenological traits (e.g., flowering time, ripening date) and agronomic traits (e.g., berry weight, yield components, quality parameters). Our findings demonstrate that GP models can achieve moderate to high prediction accuracies for these traits, varying with the genetic architecture and design of the training population. We will also discuss how factors such as marker density, statistical models, and the inclusion of pedigree information influence the predictive ability of GP models.

To complement GP, we performed genome-wide association studies (GWAS) to identify significant loci and candidate genes controlling traits of interest. By incorporating these loci as fixed effects or employing marker-assisted selection alongside GS, we aim to enhance prediction accuracies and facilitate the introgression of desirable alleles. Integrating GS and GWAS into traditional breeding efforts offers a transformative approach to grapevine breeding. This combined strategy enables the evaluation of a larger number of seedlings at early stages, increasing selection efficiency and reducing the time and resources required for extensive field evaluations. Ultimately, applying genomics-based tools has the potential to accelerate the development of innovative cultivars better adapted to future challenges, such as emerging diseases and climate change. We will discuss practical considerations, potential limitations, and future directions for integrating these genomic tools into breeding strategies.

POSTER COMMUNICATION

Chromatic characteristics of Nermantis and Termantis wines from traditional and withered grapes

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Keywords: resistant varieties, CIELab, Amarone, Reboro

ABSTRACT

The work aims to characterise the colour features of the wines of two new resistant varieties breeeded at the Edmund Mach Foundation (Italy) and recently inscribed in the Italian National Registriy of Vine Varieties.

Twenty-seven experimental wines of Nermantis and twenty-six of Termantis were produced using the same skin-contact fermentation protocol over six consecutive vintages, with grapes harvested according to the technological maturity for each year and plot. The colour characteristics of wines were determined according to CIELab colour space with a D65 standard illuminant, as well as spectrophotometric measurement of absorbance at 420 nm, 520 nm, and 620 nm wavelengths. Analyses were performed during aging, indicatively between 5 and 9 months after harvest, ensuring uniformity for all wines within the same year. Among the CIELab parameters, only lightness (L*) was found to be different between varieties ($p<0.05$), being higher in Nermantis, consistent with the lower colour intensity depicted by the spectrophotometric measurements. Although hue (h) was not differentiated, b* was 5 units higher in Termantis, contributing to an overall dE*>14 between varieties in favour of the former. Noteworthy, the colour intensity of Termantis was higher than that of its parental variety, Teroldego; however, no h differences were observed for either Nermantis or Termantis with Teroldego.

During three consecutive vintages, grapes of both varieties were withered to 28-29°Brix, consistent with the sugar concentration target for the production of Reboro and Amarone wine styles. L*, a*, and h decreased in wines produced from withered grapes for both varieties, whereas colour intensity significantly increased in all instances, maintaining the distinctions between cultivars in traditional wines. The chromatic characteristics of withered wines were compared to those of the principal varieties typically employed in their production. In relation to those of Amarone, Nermantis and Termantis improved every colour parameter of wines. The colour intensity was 3.5-fold and 7-fold higher than that of the Croatina, the richest among those studied, and consistent with the lower L*. The chromatic characteristics of Rebo wines exhibited similarity to those of Nermantis wines. In comparison to Termantis, Reboro wines demonstrated a lower colour intensity, whilst no discernible differences in h were observed.

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POSTER COMMUNICATION

Genome editing applications on grapevine cv. Aglianico for the knockout of susceptibility genes related to fungal diseases

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Keywords: *Vitis vinifera*, biodiversity, protoplasts isolation, CRISPR/Cas9, susceptibility genes

ABSTRACT

Context and purpose of the study. Italy hosts diverse grapevine varieties crucial for viticultural biodiversity. Preserving this biodiversity is essential for maintaining a diversified genetic pool and addressing future challenges such as climate change and emerging plant diseases. Biotechnological approaches, such as genome editing through CRISPR/Cas9 system, have emerged as a significant player in tackling modern viticulture challenge but, until now, its application has been restricted on a few cultivars. Genetic improvement via in vitro delivery of desired constructs requires the regeneration of genome-edited plants. In vitro plant regeneration, a pivotal process in genetic engineering, encounters obstacles, due to factors like genotype and explant-dependent responses. The study focuses on developing an efficient in vitro plant regeneration protocol via somatic embryogenesis to facilitate genome editing of Aglianico, the most important grapevine variety of southern Italy regions.

Material and methods. Stamens and pistils were collected from fruit cuttings at both mature and immature pollen developmental stages. These explants were cultured on three media (MSII, PIV, and NNder) to induce embryogenic callus formation. The embryogenic calli were then transferred to two different media: C1, for long-term propagation, and X6, for embryo formation. Properly developed embryos were transferred to a rooting medium and later to four different media for shoot regeneration. The well-grown shoots were cultured on 3/4 MS medium for micropropagation. Calli propagated in C1 medium were used to isolate protoplasts, providing a platform for the delivery of pDNA and ribonucleoprotein particles (RNPs) to target different susceptibility genes related to fungal diseases.

Results. Preliminary results indicate that the regeneration system employed through the somatic embryogenesis process is optimal for the poorly studied grapevine cv. Aglianico. It successfully produces a high number of plantlets from a small amount of embryogenic calli. From these calli, protoplasts were efficiently isolated, providing an excellent platform for transfection with pDNA and RNPs to target two susceptibility genes: Downy Mildew Resistant 6.1 (DMR6.1) and CERK1 Interacting Protein Phosphatase 1 (CIPP1).

POSTER COMMUNICATION

Characterization of the mechanisms underlying the tolerance of genotypes of Uva Cão to climate change: A transcriptomic and genomic study

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Keywords: abiotic stress, molecular markers, RNAseq, tolerant clones, sensitive clones

ABSTRACT

Climate change has been influencing viticulture and changing wine profiles in the past years, and effects are expected to get worse. Innovative approaches that explore intravarietal variability to identify genotypes tolerant to abiotic stress have been developed in the past decade, with results already available for some varieties. A variety can be clearly characterized by its unique phenotype, be it its ampelographic characteristics or its physiological behavior, and by its genotype, through molecular markers or genome sequencing.

In the current work, 77 genotypes of the variety Uva Cão, established in an experimental field according to a resolvable row-column design with 6 replicates, were characterized for their level of tolerance to abiotic stress, using expedite measurements of physiological parameters. Linear mixed models were fitted to the data of the traits evaluated, and the empirical best linear unbiased predictors (EBLUPs) of genotypic effects for each trait were obtained as well as the coefficient of genotypic variation (CVG) and broad sense heritability. These genotypes were ranked according to their tolerance to abiotic stress. The group of genotypes with increased tolerance and the group of most sensitive genotypes were sampled for RNAseq and DNAseq analyses. RNA Samples were taken prior to veraison, on conditions of intense environmental stress. These analyses enabled the characterization of the transcriptome of the sensitive and of the tolerant genotypes and the identification of several markers of tolerance. Whole genome sequencing (WGS) is a highly detailed method to identify grapevine varieties but also to differentiate clones within those varieties, as well as to characterize the genetic features that may confer tolerance to stress to the set of tolerant clones.

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POSTER COMMUNICATION

Generation and characterization of a training population in *Vitis vinifera* for enhanced genomic selection

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Keywords: climate change, genomic selection, genotyping, hyperspectral imaging, breeding

ABSTRACT

Context and purpose of the study. Modern viticulture is facing significant challenges due to global climate changes, spanning from extreme heat spells and water scarcity to the acceleration of grapevine's phenological development with important consequences from budbreak to harvest. These include increased spring frost vulnerability, as well as changes in grape quality and composition. Genomic selection (GS) has emerged as a powerful tool to address such challenges, being capable of accelerating breeding programs by supporting the prediction of phenotypic performance based on genomic data. A robust training population that captures the genetic diversity and trait variability of interest is crucial to implement GS.

Materials and methods. On these premises, a semidiallelic cross including 7 parental genotypes of interest was carried out in spring 2023 to generate a GS training population. The resulting seedlings from 21 biparental combinations were genotyped via ddRAD-seq. The implementation of hyperspectral imaging by infrared sensors is under way to capture hidden phenotypes of early developmental stages.

Results. The cross yielded a total population size of approximately 2100 individual plants, namely 100 from each of the 21 combinations. We successfully obtained sequencing data from an excess of 40,000 loci across the genome and detected point polymorphisms in an average of 90,000 sites. Collection of hyperspectral images is scheduled for Spring 2025.

This training population will serve as a foundational asset for the development of predictive models aimed at guiding the selection of superior Vitis vinifera cultivars. These efforts are expected to contribute substantially to the advancement of breeding programs, enabling the identification of traits associated with resilience and quality under the challenges posed by global climate change.

POSTER COMMUNICATION

Survey of phenological stages of disease-resistant varieties in Friuli Venezia Giulia region

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Keywords: resistent varieties, budburst, flowering, veraison, maturation

ABSTRACT

Context and purpose of the study. The primary fungal diseases affecting grapevines in Europe are downy mildew and powdery mildew. European viticulture accounts for approximately 3% of the agricultural surface, although it accounts for 65% of all fungicides used in agriculture. Since the adoption of varieties produced with cis-genesis or genome editing is currently not allowed in Europe, disease resistance genes have been introduced into grapevine genotypes with controlled interspecific crosses. In recent decades, breeding programs have been established across Europe and overseas, leading to the investigation of different hybrids, many of which also adopted for cultivation.

Material and methods. Starting from 2021, a four years project was funded with the aim of understanding the suitability of different grapevine hybrids for cultivation in Friuli Venezia Giulia region (Northern Italy). During each season, grapevine phenology was monitored weekly in 38 resistant cultivars to assess the phenological progression of vegetative and reproductive stages. Budburst (BBCH 08), full flowering (BBCH 65), veraison (BBCH 81) and maturation (BBCH 89) dates were precisely determined. Weather data were used to calculate GDDs relative to each phenological stage and variety.

Results. Phenology data explored using PCA revealed distinct budbreak, flowering and veraison timings among different grapevine hybrids. Cultivars Fleurtai, Civit 2 and Prior appeared the most representative early budbreak varieties. On the other hand, Aromera and Sauvignon Rytos were clearly distinguishable as the latest varieties. Several early-flowering varieties were detected, with Solaris and Prior as models. The least precocious cultivars included Sauvignon Rytos and Cabernet Eidos. Interestingly, Civit 2 was detected among the most delayed varieties in terms of veraison despite being early for both budbreak and flowering. Helios and Cabernet Volos resulted instead as quickest in reaching the same phenological phase. The multivariate analysis adopted also made it possible to categorize the varieties according to their stability throughout the seasons.

These data, together with the grape maturity parameters (soluble solids, titratable acidity, etc.), will be of importance to understand the most promising varieties to be cultivated in the Friuli Venezia Giulia region in the frame of climate change.

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POSTER COMMUNICATION

Multiple description and validation of autochthone grape varieties in the Carpathian Basin

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Keywords: Carpathian Basin varieties, ampelographic, ampelometric, SNP analyis, bioinformatics

ABSTRACT

Context and Purpose of the Study. In many countries, the preservation of grape varieties with heritage value is ensured by genebanks of outstanding significance, which allow for the study of these varieties and the assessment of their future roles in response to environmental, market, and social challenges. The Carpathian Basin, like an ancient viticultural region, has local varieties that once played a crucial role in wine production of their respective regions and could regain their importance in the future.

Morphological characterization is a basic method for identifying grape varieties but has limitations due to narrow time windows for observation and environmental variability. Over the past decade, molecular characterization of grape varieties has gained increasing importance. Genetic studies enable the determination of the origins and pedigree relations of grape varieties. For individual varieties, uncovering ancestral lineages provides insights into their development timeline, origin and migration routes.

Material and Methods. Ampelographic data were conducted identifying approximately 77 OIV descriptors per variety in the grapevine collection of our institute (IPGRI, UPOV, OIV, 1997). To facilitate the objective description of grape varieties, the GRA.LE.D. software was used (Bodor et al., 2014). This free raster graphic software analysed grapevine leaves for 36 OIV traits and 19 non-OIV parameters from 32 marker points on scanned leaves. In recent years, SNP analysis of 110 ancient grape varieties has evaluated and visualized a specified distance matrix. Correlation analyses between SNPs, ampelographic descriptors, and ampelometric data were conducted using genebank databases and bioinformatics tools.

Results. Data on variety-specific combinations of DNA sequence variations can be correlated with existing grape variety knowledge, enabling the determination of the origins of Carpathian Basin varieties.

By combining morphological and advanced genetic analysis, it becomes possible to verify existing varietal groups and subvarieties, create new categories, or reclassify and reinterpret certain varieties and their subtaxons. We are planning to include quality-determining parameters comprehensive evaluations, such as resistance sources, aromatic and colour compounds, ripening periods, berry consistency, and drought tolerance characteristics.

POSTER COMMUNICATION

Studying PIWIs in three dimensions: agronomic, economic and ecological evaluation of 14 fungus-tolerant cultivars in Luxembourg

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Keywords: fungus-tolerant varieties, Luxembourgish Moselle, ecological impact, black rot

ABSTRACT

Growing fungus-tolerant cultivars (PIWIs) reduces the need of fungicide use by 50-80 %. PIWIs have the potential to address climate change adaptation and mitigation simultaneously. However, despite the obvious advantages of PIWI cultivation only 0.5% of the viticultural area in Luxembourg is covered with PIWIs at present. Consequently, the present investigations aimed at addressing knowledge and experience gaps of PIWI cultivation and quantifying their economic and ecological advantages.

The project PIWI3 characterizes 14 PIWI cultivars in three dimensions: (1) agronomically, (2) economically and (3) ecologically for the years 2023-2025. White and red PIWIs are compared to the traditional cultivars Rivaner and Pinot Noir, respectively. The present study focuses on the susceptibility of selected cultivars towards major fungal diseases such as powdery and downy mildew, gray mold and black rot. Furthermore, susceptibility to Drosophila suzukii is monitored as well as average yield and the phenological development. To evaluate the ecological impact, a life cycle assessment is undertaken and costs per ha are evaluated.

Weather conditions in 2024 resulted in severe disease pressure. Disease severities recorded for downy and powdery mildew differed between the PIWI cultivars. Sauvignac, Johanniter and Cabernet Blanc showed high disease severities of black rot. The onset of Botrytis cinerea epidemics was observed later in PIWI cultivars than in the traditional cultivars. The cvs Pinotin, Calardis Blanc and Villaris showed the highest bunch rot disease severities prior to harvest in 2024. However, in cv Pinotin bunch rot symptoms were mainly caused by sour rot, due to the infestation with D. suzukii.

Phenological development differed widely within the PIWI cultivars. The PIWIs studied here were generally ripening earlier compared to the traditional cultivars Rivaner and Pinot noir. The earliest cultivar reaching full maturity was cv Solaris. The highest average yield was observed for cv Bronner.

Cultivation of PIWIs reduced the overall environmental impact by two-thirds, compared to the cultivation of traditional cultivars. The reduced need of pesticide applications decreased the total annual costs of production by 56-62%, making PIWIs a viable and sustainable alternative for winegrowers.

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POSTER COMMUNICATION

The Gibberellic-Acid Insensitive gene Vvgai1 impacts both vegetative growth and organogenesis rate in *Vitis labruscana*

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Keywords: climate change, *Vitis labrusca*, microvine, plant dwarfism, phyllochron

ABSTRACT

Context and purpose of the study. As other perennial crops grapevine is facing the challenges of climate changes. One of the major issues is global warming and variations of the water budget. Vitis labrusca, originated from the east coast of north america was largely used in breeding varieties adapted to warm and humid summers in USA, Brazil and Japan for instance. In order to develop innovative material to explore the mechanisms of adaptation to climate changes, we introduced the Vvgai1 mutation in V. vinifera x V. labrusca hybrids.

Material and methods. According to Chaib et al. (2010) and Chatbangyong and Torregrosa (2015), 24 plants were recovered from crossing V. labruscana cv. Isabelle x V. vinifera microvine V3. The V3 genotype displays female flowers and carries the Vvgai1 mutation at heterozygous status, allowing the obtention of both macro (MaV) and microvines (MiV) when crossed with a non dwarf genotype. Plants were acclimatized in 3 l pots and established in a greenhouse in semi-controlled climatic conditions. The progeny was phenotyped by assessing various parameters, including: phyllotaxis, leaf and shoot sizes, phytomer initiation rate, shoot lignification, level of tendrils and inflorescence initiation and distribution and sex ratio.

Results. The phenotyping confirmed that the dwarf trait of V. vinifera and the semi-discontinuous tendril production of V. labrusca could be introgressed into V. vinifera x labrusca background through crossbreeding. Vvgail1 mutation induced a strong miniaturisation of leaf and internodes size in half of the progeny as observed in crosses involving V. vinifera genotypes. Microlabruscana lines exhibited a significant reduction of shoot growth, due to the reduction of both internode length and phyllochron. The lignification process was two fold quicker in MaV than MiV. The shift from the alternate spiral (juvenil) to distichous (adult) phyllotaxis and the appearance of the first tendril occurred at lower node rank in MaV when compared to MiV. While MaV did not produce any reproductive organs during the first vegetative cycle, MiV displayed the first flowers around the internode 18, a few months after embryo rescue. As the sex ratio observed was 50% female and 50% hermaphroditic MiV, confirming V. labrusca progenitor to be heterozygous for the sex locus. These experiments provide a new set of microvine genotypes and morphology data for studying the response of V. labruscana to abiotic and biotic factors.

POSTER COMMUNICATION

Rootstock effects on Grüner Veltliner ecophysiology in the Kremstal wine region of Austria

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Keywords: rootstock effect, Grüner Veltliner, ecophysiological response, water relation

ABSTRACT

Understanding the impact of rootstocks on grapevine water relations is crucial to face climate change maintaining vineyard productivity and sustainability. Grüner Veltliner, the most important grape cultivar in Austria, is at risk of being severely affected by changing climate conditions, resulting in lower yields and unfavourable berry composition for low-intervention winemaking.

This study investigates the ecophysiological behaviour of Grüner Veltliner when grafted on four different commercial rootstocks: Fercal, Kober 5BB, 1103 Paulsen and SO4. The vineyard, planted in 2020 and located in Sandgrube Krems (Kremstal), was monitored over two growing seasons (2023 and 2024).

Our first results indicate some differences in ecophysiological parameters and biomass production, but limited impact on yield and berry composition. In particular, our results suggest a lower stomatal conductance of plants grafted on SO4 rootstock, in contrast to the higher values of those grafted on 1103 Paulsen; this trend was particularly strong throughout the 2023 season, while in 2024 it was only observed on some sampling dates. SO4 also resulted in lower pruning weights. Interestingly, the difference between pre-dawn and midday water potential (which increased over the season in all rootstocks) was smaller in SO4, while the relationship between water potential and stomatal conductance was not affected by the rootstock. The project will continue to investigate the response in the field in 2025. This study is part of an international project (DiverGrape) that will combine similar results obtained in other regions (France and Spain) with the aim of elucidating the variability induced by rootstock/cultivar combinations in the ecophysiology of grapevines.

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POSTER COMMUNICATION

Vegetative propagation during domestication – rooting ability of wild grapevines

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Keywords: rhizogenesis, *Vitis vinifera sylvestris*, *Vitis vinifera sativa*, asexual reproduction, adventitious roots, cuttings

ABSTRACT

The origins of plant propagation trace back to the moment of early humans' transition from a nomadic existence to settled agricultural societies, cultivating their food. Vegetative propagation significantly shortens the time for trees to start their sexual cycle, necessary to produce fruits, avoiding the long-lasting juvenility phase. Rhizogenesis refers to the process of root formation in plants, both under natural conditions and in agricultural practices. Vegetative propagation through cuttings is one of the earliest known agricultural practices, with historical literature indicating its widespread use for grapevines. Nevertheless, little is known concerning the role of vegetative propagation in grapevine domestication. In this experiment, a total of 1061 cuttings were studied over 200 days in two different experimental fields in Georgia, the birthplace of viticulture. In detail, 485 Vitis vinifera sylvestris (belonging to 5 different genotypes) and 576 Vitis vinifera sativa (belonging to 4 different genotypes) cuttings were considered. Both wild and cultivated accessions came from the same ampelographic collection. Results indicate a good ability of wild grapevine to bud break and shoot growth in the beginning of vegetative propagation, however, the survival of these plants decreases with a stronger intensity compared to sativa cultivars, indicating a worse rhizogenesis ability. Thus, the greater rooting ability of sativa cuttings suggests that this is a trait selected (more or less consciously) during the domestication process. These data concretely support the hypothesis that grapevine propagation during grapevine domestication was mainly done through asexual reproduction. Little is known about the techniques of grapevine cultivation in prehistoric times because, unlike food processing techniques, it is not possible to discover specific archaeological finds, such as wine-making amphorae, related to plant cultivation techniques. However, the comparison between Vitis vinifera sylvestris and Vitis vinifera sativa characteristics allows us to figure out some viticultural techniques during the domestication era.

POSTER COMMUNICATION

Cascading effects of spring weather conditions into grape berry ripening

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Keywords: climate change mitigation, dormancy, phenology, ripening, temperature

ABSTRACT

The effects of climate change on viticulture are complex due to interactions among factors and cascading effects. As temperature rises phenological stages are shortened, pushing ripening towards the warmest part of the season. The aim of this study is to assess the impact of shifts in bud break date on berry ripening. An experiment was conducted with Tempranillo (TE) and Cabernet sauvignon (CS) potted plants with treatments consisting in ambient, cold and warm temperatures for 20 days during the forcing period (end February and beginning of March). Forcing period temperature (FPT) influenced bud break date on average 25 days for TE and 19.5 days for CS (warm vs cold). These differences in phenology tended to moderate when plants reached flowering (23 days TE and 15 days CS) but remained quite spread by veraison (29 days TE and 14 days CS). Remarkably, maturity (ca. 23oBrix) came 33 days apart among treatments for TE while CS plants fully synchronized among treatments. Different ripening speeds were somewhat explained by the crop loads being affected by FPT. However, FPT greatly affected the mean temperature during ripening 3.3oC for TE and 0.7oC for CS. Ultimately, the different temperature during ripening affected berry and wine composition, demonstrating the benefits of delayed phenology. These results help to assess the potential of strategies involving late veraison as an adaptation for climate change.

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POSTER COMMUNICATION

A lower rate of grape berry transpiration delays ripening and reduces flavonoid content

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Keywords: climate change, antitranspirant, solar radiation, temperature, phenolic compounds

ABSTRACT

Exposing berries to solar radiation improves most berry composition traits. Many of these effects have been linked to photomorphogenic mechanisms and berry temperature. However, new findings are highlighting the importance of berry transpiration in an adequate ripening. The present study was carried out with the aim of evaluating the effect of two factors that affect grape transpiration (heavy shading nets and antitranspirant) on berry ripening. An experiment was carried out with fruiting-bearing cuttings of grapevine (Vitis vinifera L. cv. Malbec), applying an antitranspirant (10% v/v dimenthene) every 15 days from veraison and heavy shading nets (polyethylene with a 75% shading factor) in a factorial design (2 by 2). Berry temperature was reduced by shading but not by the antitranspirants. The treatment with shading nets reduced the total soluble solids (TSS) and the pH, while increasing the acidity. The application of the antitranspirant reduced the fresh weight of the berry, the TSS and the pH. The reduction in TSS levels, and therefore in berry ripening, could be related to a lower grape transpiration caused by both treatments, reducing the water potential gradient between the stem and the berry necessary for the correct discharge of phloem content into the fruit. In turn, both shading and antitranspirant application reduced the anthocyanin and flavonol content of the berry. This was possibly due to the lower incidence of solar radiation on the grapes. Shading reduced the flavan-3-ol content at maturity, and the antitranspirant reduced the levels of hydroxycinnamic acids and gallic acid. In our results, two treatments reducing berry transpiration through different methods induced similar impairment of ripening affecting not only the speed of technological ripening but also the accumulation of phenolic compounds.

POSTER COMMUNICATION

Vitis vinifera 'Ráthay' on the rootstocks 'Kober 5BB', 'Fercal', and '3309 C': results of a long-term field trial

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Keywords: 'Ráthay', 'Kober 5BB', 'Fercal', '3309 Couderc', yield, ripeness, nutrient content of leaves

ABSTRACT

Context and purpose of the study. Ráthay is an Austrian red quality wine variety with increased resistance to fungi. However, little is known about the effect of rootstock varieties on vigour, yield and grape quality of Ráthay. The aim of the present study was to analyse the influence the three rootstock varieties 'Kober 5BB', 'Fercal' and '3309 C' on yield, cluster weight, must weight, titratable acidity and pH-value of the must, pruning wood weight, nutrient content of leaves and the lifespan of the vines.

Material and methods. The grafted vines were planted in 1997 at a spacing of 2.0 x 1.0 metres and raised in a medium-high trellis training system with a tying wire (h = 0.85 m), a cordon wire (h = 0.89 m) and three stitching wire pairs (h = 1.25 m, 1.55 m and 1.95 m). Pruning was carried out as follows: one fruit cane with seven to nine buds and one spur with two buds (= single Guyot). Thus, the number of buds per vine was 9 to 11 or the equivalent of 4.5 to 5.5 buds per m^2. The trial vineyard was located on a steep slope (gradient: 40 to 50 %) facing southeast. The soil type was a carbonate-containing brown soil on flysch marl. The parent rock is flysch marl, a marine sedimentary rock consisting of limestone and clay. The soil has a pH-value of 7.4 and is slightly alkaline. Lime content in the A- and B-horizons is high (23 to 25 %) and active lime is medium (15 to 20 %). The soil has an average humus content of 3.0 % in the topsoil. It is a heavy soil with a clay content of 28 – 30 %. Yield, cluster weight, must weight and titratable acidity and pH-value in the must were determined for 'Ráthay' in the form of four replicates per graft combination (10 to 20 vines per replicate) over 22 years. Pooled samples from five vines per repetition were analysed. Beery samples were taken immediately before harvest to determine the maturity parameters. The pruning wood weight was determined after pruning according to the experimental design. In twelve years, leaves were removed from the grape zone in July, dried, ground and the contents of nitrogen, potassium, magnesium, phosphorus, calcium, iron, copper, zinc, manganese and boron were analysed. By the 25th year of growth, the number of vines that had failed by then was evaluated depending on the grafting combination.

Results. Yield was significantly lower on '3309 C' than on 'Kober 5BB'. Cluster weight was significantly higher on 'Kober 5BB' than on 'Fercal' and '3309 C'. With must weight and pH-value of the musts there were no significant differences between the graft combinations. Titratable acidity in the must was significantly higher on 'Kober 5BB' than on '3309 C'. Pruning wood weight was significantly lower on '3309 C' than on the other two rootstock varieties. Potassium content of the leaves was significantly lower on 'Fercal' than on '3309 C' and magnesium content was significantly lower on 'Kober 5BB' than on '3309 C' and 'Fercal'. Calcium content of the leaves was significantly lower on '3309 C' than on 'Fercal' and 'Kober 5BB' and phosphorus content was significantly lower on '3309 C' than on 'Kober 5BB'. The contents of nitrogen, iron, copper and zinc in the leaves of Ráthay were not influenced by the rootstock varieties. Manganese content of the leaves was significantly lower on 'Kober 5BB' and '3309 C' than on 'Fercal' and the boron content was significantly lower on '3309 C' than on 'Fercal'. By the 25th year of growth with 'Kober 5BB' 19.0 %, with 'Fercal' 21.9 % and with '3309 C' 28.8 % of the vines had failed. The main reason for the dieback of the vines was an increasing incidence of Esca with vine age. Furthermore a high incidence of chlorosis was triggered by '3309 C', which increased the number of dead vines.

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POSTER COMMUNICATION

Harnessing biodiversity to improve grapevine rootstock adaptation to drought

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Keywords: drought, genetic diversity, metabolomics, roots, wild *Vitis* sp.

ABSTRACT

Drought is one of the most challenging threats for viticulture because of its impact on reducing yield and on the composition of grapes. In this sense, rootstocks will play a crucial role in improving vineyard resilience to drought because of their functions in water acquisition and transport. However, most of the rootstocks currently used today rely on a narrow genetic background, which could compromise their ability to respond to new environmental conditions. In this work, we aimed to explore the scope for innovation in rootstock adaptation to drought using unexplored wild Vitis species. For this purpose, we selected a panel of 12 wild Vitis sp (total=50 accessions) present in European germplasm collections. We characterized their adventitious rooting ability and root morphology at different developmental stages (3 weeks, 4 and 7 months) by image analysis. We then explored their response to a moderate and long-lasting drought in controlled conditions, focusing on root morphology, function (i.e. osmotic adjustment) and molecular changes (metabolites and transcripts). We estimated moderate levels of heritability and found varying degrees of intra-specific or inter-specific variation in root morphology. We identified root syndromes correlated with shoot gas exchange responses to drought, maintenance of growth in early stages of drought, and the strategy of root: shoot biomass allocation. In order to explore proxies of root drought responses, we identified root metabolic features from untargeted metabolomic analysis as biomarkers of the genetic variation in root osmotic adjustment. Finally, we identified metabolic and gene expression changes underlying genetic variation of root drought responses among species. The results obtained in this work will help to identify new genetic resources, to be used in rootstocks breeding programs to improve drought adaptation. For instance, V. acerifolia showed promising results regarding its rooting ability and drought responses. In addition, we will provide tools to accelerate the screening of desirable traits in rootstocks using intermediate molecular phenotypes as a proxy of complex root responses.

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POSTER COMMUNICATION

Resistance profiling of PIWI accessions: insights from Geisenheim university's breeding program

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Keywords: PIWI, downy mildew, powdery mildew, *Rpv*, *Ren*

ABSTRACT

Context and purpose of the study. Fungus-resistant grape varieties (PIWIs) represent a significant advancement toward more environmentally sustainable viticulture. Resistance to the primary pathogens Plasmopara viticola and Erysiphe necator, the causal agents of downy mildew (DM) and powdery mildew (PM) in grapevines, has been a major focus of PIWI breeding for over 150 years. This study examines 17 genotypes, selected for their viticultural characteristics and developed at Hochschule Geisenheim University from the late 1970s to the early 2000s. These breeding strains were phenotyped for their resistance and analyzed for the presence of resistance alleles against PM and DM for the most commonly used quantitative trait loci (QTLs). The aim of this study is to evaluate and compare these genotypes to commercial elite cultivars to assess their potential for future breeding programs.

Material and methods. DNA from all 17 accessions was analyzed for key markers related to resistance to Plasmopara viticola (Rpv) and resistance to Erysiphe necator (Ren) at the following loci: Rpv1, Rpv3.1, Rpv3.2, Rpv3.3, Rpv10, Rpv12, Run1, Ren3, and Ren9. The breeding lines and elite cultivars were phenotyped for their resistance using leaf disc assays (DM), evaluations of resistance in potted plants (PM and DM), and field assessments on leaves and grapes (PM).

Results. All 17 accessions exhibited varying degrees of phenotypic resistance. Significant differences were observed in their resistance behavior toward PM and DM, with some accessions outperforming popular elite cultivars such as Cabernet Cortis and Souvignier Gris. The 17 breeding lines exhibited different combinations of Rpv and Ren resistance alleles, with the most commonly encountered alleles being Rpv3.1, Rpv3.3, Rpv10, Ren3, and Ren9. In contrast, Rpv1, Run1, and Rpv12 resistance alleles were not detected in any of the accessions. Notably, some accessions displayed resistance levels much higher than expected based on the analysis of these common markers, making these accessions interesting for future resistance breeding and genetics research.

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POSTER COMMUNICATION

Improving grapevine cloning material of Welshriesling by comprehensive analysis

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Keywords: biodiversity, clonal selection, aroma analysis, genotyping, Mg deficiency

ABSTRACT

The important grape variety Welschriesling for Austrian and Southeast European viticulture has been selectively bred over the years for improving some quantitative traits. Collected genotypes as well as the local clones were examined from agricultural, analytical, sensory, and genetic perspectives. The yield among the clones was relatively constant, while stronger differences appeared among the genotypes. The ripeness was further advanced in the B clones than in the H clones – both in terms of sugar and acidity. Thus, genotypes with lower yield and later ripening, which would be favorable for climate change, were also found. Differences between the selections could be verified with regard to growth vigor, shoot development, grape structure (density and length), as well as Mg content. Since Welschriesling is considered inefficient in Mg uptake, the genotype with the significantly better Mg supply will receive increased attention. The sensory evaluation of the clones showed a preference for the B clones, particularly B1-16, which was rated better than all other clones, while H 6 performed worse. The selections showed sensorial that they do not produce wines that are in any way inferior to the certified clones. One genotype stood out with higher terpene levels. The better rating of B1-16 was not based on a high content of the typical varietal aromas. Differences between the clones could be found in acetate esters, aromatic esters, ethyl esters, and others. Using PCA analysis, genotypes could be defined that are similar based on the wine aromas. Despite close phenotypes and some relationship in aromatic structure individual genotypes could be detected by genotyping and sequencing. Nevertheless genetic closer are genotypes derived from same region. Agricultural data were collected during 5 years of observations. The sensory tests were carried out by a commission and anonymously wines were presented with repetitions in series consisting of 4 wines. The assessment was carried out using the unstructured scale for overall quality. The magnesium and all other minerals contents of leaves were evaluated visually and analysed by quantitative atomic absorption. The genetic analyses were carried out using 50 SSR , 10 InterSSR and 150 RAPD markers. Sequences were gained by applying NGS technology. The aroma analyses were performed by using different GC-SIM-MS methods for displaying 70 volatile substances. The data was calculated using SPSS program.

POSTER COMMUNICATION

Microclimate manipulation: leveraging the microclimatic differences created by diverse trellis systems to investigate the metabolic plasticity of *Vitis vinifera* cv. Chenin blanc in a model vineyard

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Keywords: water-use efficiency, stomatal conductance, leaf area, canopy density, PAR

ABSTRACT

Field-grown crops such as grapevines, rely on ambient environmental conditions for growth and development. Grapevine growth and performance is intricately linked to the specific cultivar/rootstock (genotype) combination, interactions with the environment (macro-, meso- and microclimate), and management practices that influence sun exposure, photosynthetic activity as well as crop load. Selecting an appropriate trellising system over the long term is still crucial for controlling and assessing possible grapevine growth and, consequently, the quality of the resulting grapes and wine. Integrated studies where basic viticultural workflows are merged with robust experimental design to study and understand the genotype X environment X management (GxExM) interactions of grape cultivars are essential to future proof grape and wine production in the current era of climatic changes taking effect in most of the grape-growing areas of the world. Globally, Chenin blanc is known for being adaptable to a wide range of growing conditions, and in South Africa, has resulted in its vinification to a variety of different wine styles. In this study, we have access to a Chenin Blanc model vineyard where the cultivar was planted to 19 different trellis systems. We will present data regarding the impact of the modification of the microclimate, as a result of the configuration of six divergent trellis systems. The systems chosen comprise untrellised vines, vertically shoot positioning systems as well as single and double split canopies (2K2T, Lyre, High Wire Perold, 7-strand double lengthened, posted vines and bush vines). The impacts on phenology, physiology (growth, morphology, resource allocation), viticultural parameters, as well as the plasticity of metabolites used by Chenin Blanc to counter microclimatic extremes will be highlighted.

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Are biochemical markers the key to predicting wine aroma balance?

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Keywords: volatolome, untargeted approach, ripening, comprehensive profiling, grape composition

ABSTRACT

Wine aroma quality is a complex interplay of factors like terroir, vinification techniques, that modulate aroma compound composition. Nowadays, due to the versatility of stringent climatic conditions, complex dynamic changes in volatile profiles shaped by cultivar and ripening stage highlight the need for advanced analytical tools to fully explore and predict aroma balance. Thus, integrative strategies using diverse cultivars under field conditions are essential to assess the aromatic matrix and identify biomarkers to manage aroma profiles across harvest dates, particularly in climate-sensitive cultivars. While targeted is often used with a limited number of cultivars to evaluate the impact of maturation conditions on the composition and sensory balance of the wine we propose to explore the potentiality of non-targeted analysis.

We studied musts and wines from eight Vitis vinifera cultivars (VITADAPT program, 2022 vintage): Cabernet franc, Cabernet Sauvignon, Carménère, Castets, Cot, Merlot, Petit Verdot, and Touriga Nacional. Grapes were harvested at five stages (mid-veraison, half-maturity, 7 days before maturity, maturity, and 10 days post-maturity). Samples were analysed by headspace solid-phase microextraction (HS-SPME) combined with comprehensive two-dimensional gas chromatography and time-of-flight mass spectrometry (GC×GC-TOF/MS). Deconvolution of chromatogram produced approximately 20000 signatures in must and around 10100 in wine. Thanks to a scrip developed on R we identified 40–150 and 200–300 significant compounds, respectively, depending on the cultivar. Aldehydes, ketones, and terpenes showed the most pronounced shifts in must, while esters and lactones prevailed in wine, shaping the aroma profile. Mathematical modelling provided a deep understanding of the kinetics of these compounds, uncovering critical interactions and dynamics within chemical families. This approach not only enhances our ability to decode the complex biochemical processes underlying aroma development but also offers a robust framework for optimizing vineyard management and winemaking strategies.

POSTER COMMUNICATION

Using gene editing to improve the hydraulic properties of grapevine roots under water stress conditions

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Keywords: *Vitis* spp., gene knock-out, drought, root architecture, lignin

ABSTRACT

Context and purpose of the study. Epidermal Patterning Factors are a family of small peptides that are highly conserved in the plant kingdom and are involved in several physiological and developmental processes. While EPFL9 has been shown to positively regulate leaf stomatal formation in many crops, including grapevine, its role in other organs remains to be fully elucidated. The aim of our study is to investigate whether VviEPFL9-2 may have a specific biological function in grapevine roots.

Material and methods. To this end, epfl9-2 knock-out (KO) lines of the genotype Kober 5BB (Vitis berlandieri x Vitis riparia) were generated using CRISPR/Cas9 technology, and their root morphological traits were evaluated under both well water and water stress conditions, in conjunction with shoot physiological characterization. A transcriptomic analysis was also performed for the root tissues. Finally, grafting experiments were carried out with all possible combinations of WT and epfl9-2 mutants using Syrah as scions and Kober 5BB as rootstock.

Results. Phenotypic evaluation in the greenhouse showed that the root system of the mutants was less expanded than that of the wild type, with a significant reduction in the geotropic angle and root length. Interestingly, the secondary roots of the mutants were quantitatively less than those of the WT, but had a larger diameter, similar to that of the primary roots. In addition, grafting showed that the different root phenotype of Kober epfl9-2 KO persisted even in the presence of the unaltered shoot apparatus of the WT scion. Furthermore, RNAseq data from edited Kober roots revealed a strong activation of the lignin pathway compared to WT. Our results demonstrate for the first time that VviEPFL9-2 has a specific role in roots and suggest the existence of a mechanism regulated by EPFL9 that may lead to increased lignin deposition in root tissues. Since lignin is a valuable component of the secondary cell wall that contributes to the improvement of the hydraulic properties of roots under drought, VviEPFL9-2 appeared to be an interesting target for the application of new genomic techniques to make rootstocks better adapted to cope with drier soil environments.

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POSTER COMMUNICATION

New genomic techniques for sustainable management of water stress and pathogen control

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Keywords: NGT, gene editing, cisgenesis, abiotic stress, biotic stress

ABSTRACT

Context and purpose of the study. Climate changes pose the need to develop new grapevine varieties and rootstocks that are more tolerant to stress and diseases. Grapevine can tolerate moderate water deficits, however, extreme drought scenarios, such as those experienced in recent years in major wine-growing regions, represent a threat to viticulture. Furthermore, a more sustainable control of fungal pathogens, which is generally based on multiple chemical treatments during the growing season, is being advocated. While traditional breeding has always been fundamental to generate genetic variability, over the last ten years New Genomic Techniques (NGT), such as gene editing and cisgenesis, have emerged as powerful tools to obtain improved varieties in shorter times, while maintaining their genetic background.

Material and methods. In order to apply NGTs, it is essential to know the key genes that, when modified, can lead to a desired phenotypic effect. At the Edmund Mach Foundation, several projects are underway to study and functionally characterize genes involved in water stress dynamics as well as in the response to the main pathogenic fungi. The experimental workflow consists firstly in the production of transgenic lines through classical genetic transformation to investigate gene function under controlled conditions. Secondly, depending on whether the gene of interest is to be knocked out or expressed, NGT1 edited lines (regenerated from protoplasts previously transfected with the CRISPR/Cas9 ribonucleoprotein complex) or cisgenic lines are generated, respectively, to be tested in the field and observed over several years (in Italy, experimental field trials are allowed for gene edited and cisgenic organisms).

Results. The results of the physiological characterization of epfl9-2 'Sugraone' mutants with reduced stomatal density are presented here as a case study. The edited plants showed improved water use efficiency compared to WT. In addition, under high vapor pressure deficit (VPD) conditions, epfl9-2 edited plants closed their stomata more slowly than WT plants, indicating that they may have an advantage in evaporative cooling dynamics. Our study suggests that knocking out the VviEPFL9-2 gene may be beneficial for grapevine in mitigating the impact of water and heat stress. The next step will be to confirm such improved traits under field conditions.

POSTER COMMUNICATION

Evaluation of clonal variability of phenolic compounds in *Vitis vinifera* L. cv. Trnjak crni grown in Croatia

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Keywords: clonal selection, polyphenolic compounds, native varieties, Croatia

ABSTRACT

Context and purpose of the study. Croatia has rich grapevine genetic resources with more than 130 native varieties preserved. Coastal region of Croatia, Dalmatia, is well known for grape and wine production based on native grapevine varieties. Nevertheless, only a few of varieties play major role on Croatian wine map. In the last three decades, large efforts were made in preservation and revitalization of native grapevine varieties in Croatia. One of the main problems is a lack of certified planting material. Despite the enormous efforts till today, only 16 varieties are involved in the process of clonal selection. Clonal selection is one of the finest tools for preservation, control virus diseases and targeted selection within a certain gene pool.

Material and methods. Clonal selection of Trnjak cultivar resulted in 22 clone candidates, which were planted in experimental vineyard in Imotski winegrowing area, Dalmatia. The evaluation of clone candidates included agronomic and ampelographic parameters, among which polyphenolic profiles were also included. Polyphenolic compounds, as secondary metabolites, are significant factors in the red grape quality. Grapes were collected at full maturity, collecting ten randomly chosen clusters. The analysis of individual polyphenolic compounds was performed by HPLC, and it included anthocyanins, flavonol-glycosides, phenolic acids, stilbenes, and flavan-3-ols.

Results. The clone candidates differed significantly in the content of all analyzed groups of polyphenolic compounds. Clone candidates TRN19, TRN15 and TRN34 were characterized by high concentration of anthocyanins and flavonol-glycosides, while TRN53, TRN70 and TRN112 were characterized by high concentration of flavan-3-ols and phenolic acids. Clone candidates that had significantly low concentrations of analyzed polyphenolic compounds were TRN11, TRN48, TRN118 and TRN71. These results show the high variability in the content of secondary metabolites and the importance of investigating the clonal variation in metabolomics.

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POSTER COMMUNICATION

Simulating the effect of heat waves on disease-resistant varieties

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Keywords: heat wave, PIWI, multi-stress, abiotic-biotic

ABSTRACT

Agro-ecological transition and adaptation to climate change are the two major challenges facing modern agriculture. Viticulture is particularly sensitive to them, given the heavy use of pesticides in vineyards and the need to adapt the grape varieties used to climate change. At the INRAE Grand Est-Colmar center, researchers have successfully implemented the ResDur varietal selection program, which has produced several varieties resistant to both downy mildew (Plasmopara viticola) and powdery mildew (Erysiphe necator), the two main grapevine pathogens. They are are a potent tool to decrease the use of pesticides in vineyards, supporting agroecological transition in viticulture. However, their suitability towards future climate scenarios remains largely unexplored. Another key question is to understand what is the effect of climate change-triggered abiotic stresses on the efficacy of the resistances carried by ResDur varieties. Here, we attempt to study the effect of heat stress on ResDur varieties to answer these questions. As one of the most detrimental consequences of climate change is the increase of intensity and frequency of heat waves, we have developed a device based on infrared (IR) radiators to simulate heat waves with unprecedented accuracy. The principle of the device is to is to generate a fixed temperature difference (ΔT) between controls and treated plants throughout a period of several days in semi-controlled conditions, in a way to mimic to increase of temperatures typical of heat waves throughout the day/night cycle. Here, we present the results of the device establishment, which started with the construction and validation of a small-scale prototype in summer 2024. The prototype was built with IP65 IR radiatiors of 1000W connected to a CR1000X Campbell datalog central. Treated and control plants were provided with LAT-B3 leaf temperature sensors that feed the algorithm of the Campbell central, allowing it to pilote the IR radiators in a way to generate a stable ΔT between treated and control plants. This provided a proof-of-concept of the functioning and led to the establishment of bigger scale device to use to perform experiments on ResDur varieties that combine heat and biotic (downy mildew) stress. These experiments are going to take place in spring/summer 2025.

POSTER COMMUNICATION

Back to the roots: how an underutilised biotechnological tool can support research to improve grapevine resilience against biotic stressors in an unpredictable future

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Keywords: *Rhizobium rhizogenes*, grapevine hairy roots, antimicrobial peptides, bioprospecting, bio-pesticides

ABSTRACT

Hairy roots (HRs) are a symptom of a natural genetic modification by the soil-borne phytopathogen Rhizobium rhizogenes. Transfer DNA is stably integrated into the hosts genome and subsequently expressed by the plant, leading to the characteristic prolific non-geotropic root growth. This infection strategy can be hijacked to introduce DNA of interest and establish HR cultures (HRCs) which can be used for functional characterisation of genes, the bioproduction of metabolites or recombinant proteins, root-pathogen studies and for biotechnological improvement. To date, HRCs have been generated from numerous plant species, including over 50 Vitis species, rootstock hybrids or V. vinifera scion cultivars, highlighting the scientific interest and feasibility of this biotechnological tool. Our work on grapevine HRCs started with an attempt to establish a standardised Vitis HRC induction, maintenance, and validation protocol for the reliable, reproducible, and routine cross-cultivar use of the HR system in grapevine. The optimisations included the analysis of two infection protocols for HR induction, three R. rhizogenes strains, seven Vitis cultivars (three V. vinifera cultivars and four Vitis rootstock hybrids), a range of explant tissue types, different co-cultivation times, growth media with various anti-browning agents, and the design of universal multiplex primer pairs for HR confirmation. Three visual reporter genes (DsRed, eyGFPuv and VvMYBA1) and two antibiotic resistance marker genes (nptII and hptII) were evaluated for selection of HRs. The next phase of the research employs a bioprospecting approach to identify and test potentially useful grapevine antimicrobial peptides (AMPs). Computational analyses were used to identify AMPs by utilising core amino acid motifs, length of peptides and predicted tertiary structures in combination with available grapevine genomic resources. HRCs overexpressing candidate AMPs from different grapevine genotypes will be used to assess the bioproduction capacity and evaluate whether the system can produce functional antimicrobial compounds. Furthermore, the AMP overexpressing HRCs are useful to analyse the impact newly identified AMPs have on grapevine pathogens in bioassays. The presented research aims to connect science with industry by showcasing how biotechnological tools can be applied to generate sustainable and eco-friendly biopesticides, to combat emerging pests and pathogens, by harnessing what nature has provided.

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POSTER COMMUNICATION

The effectiveness of proximal remote sensors in plant water status evaluation of grapevine

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Keywords: Grapevine genotype X environment sensors water

ABSTRACT

Extensive studies have been conducted on grapevine responses to water deficit, but these responses are difficult to generalise since numerous factors can influence the response(s), including genotype, developmental stage, soil, climate, and season. Plant water stress responses are therefore most relevant in the environmental context in which a study is conducted. Moreover, there is a lack of high throughput methods that enable multi-scale plant water stress assessment for large spatial areas. Remote sensing gained popularity due to its non-destructive nature and generating rapid high throughput data for large spatial areas. However, the effectiveness of these sensors needs to be validated for different cultivars and environmental conditions. This study was conducted on potted own-rooted scion (Cabernet Sauvignon, Petit Verdot, Merlot, Pinotage and Shiraz), rootstock (Ramsey, 101-14 Mgt, 110Richter, USVit 8-7) and their grafted combinations (29 unique combinations) that were established in a randomised block design. The plants were grown under field conditions and phenology and physiological responses (Ψstem and gsw) were followed under full irrigation (FI) and water stress (WS) was implemented via two active drying (AD) cycles. The proximal remote sensors (Thermal infrared, TIR; spectral reflectance) were tested on all genotypes under water stress conditions. The genotypes allowed testing of sensors on plants with variable stress responses to water deficit. Phenology progression was comparable between combinations with the same scion, regardless of grafting status and the development of own-rooted rootstock cultivars varied. The strictest stomatal control in each cultivar category was observed in the own-rooted CS and US and the grafted Me/Mg, Sh/US, PV/Mg and PV/Ra which showed more drastic gsw lowering as Ψstem decreased. Both the proximal thermal and spectral reflectance sensors detected changes in canopy temperature and reflectance patterns in response to water status. However, the TIR sensor was more consistent, although its correlation to the canopy temperature was cultivar-dependant due to the observed differences in stomatal conductance, both within and between genotypes. The proximal spectral reflectance sensor's ability to detect changes in leaf canopy was variable between wavebands from the same genotypes, and between cultivar combinations.

POSTER COMMUNICATION

Physical-mechanical berry skin traits as additional indicators of resistance to botrytis bunch rot and grape sunburn

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Keywords: PIWI, (a)biotic stress resilience, berry skin traits, high-throughput phenotyping, QTL analysis

ABSTRACT

Climate change increasingly leads to altered growing conditions in viticulture, such as heat stress, drought or high infection pressure favoring pathogen infection. However, for one of the major diseases, Botrytis bunch rot (BBR), no resistance genes have yet been described in grapevine. Physical-mechanical traits like loose bunch structure and thick, impermeable berry cuticles, phenotyped with high-throughput sensors, have been shown to be effective parameters to prevent BBR infections. Further, berry skin traits like berry impedance (indicator for cuticle thickness), seems to be correlated with sensitivity of berries towards induced heat stress (HS), an indicator for grape sunburn susceptibility. Within the collaborative project WiVitis these traits will be objectively investigated by sensors (physical), microscopic (visible) and metabolomic studies (analytical) in order to characterize and compare PIWIs, traditional varieties and elite breeding lines. This spatial and temporal high-resolution dataset of promising characteristics will be used to unravel the complex trait of BBR resilience and to check the transferability of gained knowledge to grape sunburn. Therefore, selected varieties were phenotyped by measuring berry impedance and berry texture (indicator for berry skin resistance) twice during berry ripening. Further, their sensitivity to induced HS and BBR was investigated under controlled lab conditions. Hereby, most of the investigated PIWI varieties and breeding lines showed resilience to both, HS and BBR as well as high values for the physical berry traits. As berry skin traits seems to be variety-specific, Quantitative Trait Locus (QTL) mapping was done aiming at the development of molecular markers. Therefore, 364 genotypes (F1 progeny of 'Dakapo' (VIVC 14728) x 'Cabernet Sauvignon' (VIVC 1929)) were phenotyped at harvest maturity in three consecutive years. The genetic map was constructed based on 737 genotypes and 322 SSR (Simple Sequence Repeats) markers mapped on 19 linkage groups. QTLs for berry impedance and berry texture were identified on chromosome 2, 6, 11, 15, 16 and 17. The identified QTLs were narrowed down by the newly developed SSRs resulting in an enhancement of LOD values. All of these findings will provide new options to characterize grapevine varieties objectively and will develop new molecular markers for more efficient and targeted breeding of resistant, climate change-adapted grape varieties for sustainable viticulture.

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POSTER COMMUNICATION

GrapeBreed4IPM: developing sustainable solutions for viticulture through multi-actor innovation targeting breeding for integrated pest management

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Keywords: integrated pest management, plant protection, resistance breeding, disease-resistant varieties, PIWI

ABSTRACT

According to the World Economic Forum and the European Union's Biodiversity Strategy for 2030, the loss of biodiversity and the collapse of ecosystems are major threats facing humanity in the future. Viticulture ranks high among the crops that depend on a massive use of chemical pesticides. It consumes approximately sixty percent of the fungicides applied in the EU, making it a priority target for reducing the use of chemical plant protection products. At the same time, grapevine is of great economic and cultural importance in the EU, with wine being one of the largest EU agri-food sector. Recent advances in grapevine breeding have opened up the possibility of tackling the reduction of fungicides. Consumers are gradually recognizing PIWI (pilzwiderstandsfähig, pioneering wine, disease-resistant) varieties as alternatives of equal quality to traditional grape varieties, which also allow the need for fungicides to be reduced by an average of 50 to 80%. However, the reduced need for fungicides cannot be easily implemented and requires holistic pest control strategies and varieties adapted to future conditions.

Therefore, the project develops grapevine varieties with resistance to relevant diseases, adapted to local environmental and pedoclimatic conditions, and with the goal of reducing reliance on chemical pesticides. Methods like for example genomic selection are used to improve and accelerate the breeding process. In addition, the project will provide farmers, winegrowers and advisers with best practices and guidelines for integrated pest management adapted to disease-resistant varieties. These instructions are critical for the professional cultivation of PIWIs and their widest possible distribution, leading to a long-awaited more environmentally friendly and sustainable viticulture in Europe.

Previous experience in viticulture has shown that improving sustainability can only be successful if as many actors as possible are involved, from research to wine production. This is why 21 partners (7 countries) from research, grapevine breeding, grapevine nurseries and various stakeholders along the value chain are working together in a multi-actor and co-design approach to produce the best insights for maximum impact.

FUNDING

GrapeBreed4IPM is a 4-year project funded by the EU in the frame of Horizon Europe with a total of EUR 5 million, runs from 2024-2028 and is coordinated by INRAE in Colmar.

POSTER COMMUNICATION

Genomics and phenomics of root system architecture in grapevine

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Keywords: drought, grape rootstocks, root system architecture, genetics

ABSTRACT

Adapting viticulture to climate change is crucial, as it presents significant challenges for future grape production. One key challenge is cultivating grapevines under limited water availability, driven by irregular rainfall patterns, stricter water-use regulations, and hotter, drier conditions. Developing drought-tolerant rootstocks has, therefore, become a major objective in grapevine breeding. However, this effort is constrained by the complexity of phenotyping; evaluating drought tolerance in dry field conditions for thousands of genotypes is both time- and cost-intensive. To make drought tolerance a practical breeding target, it must be broken down into constituent traits, such as root architecture, which is closely linked to drought tolerance and the plant's capacity to access water in soil zones with stable reserves. These traits can then be reliably assessed in small plants at high throughput. This study aimed to develop a low-cost methodology that combines minirhizotrons, AI-powered computer vision, and genetics to characterize root system architecture and root growth dynamics across commercial rootstocks and a mapping population derived from 110R (V. berlandieri × V. rupestris) and 101-14Mgt (V. riparia × V. rupestris), two rootstocks with contrasting root architectures and hydraulic characteristics. We will share how this study revealed substantial variability in root architecture and growth dynamics across the evaluated germplasm. Leveraging genotypic data from the mapping population, we identified genomic regions associated with root architecture, creating new opportunities for applying molecular breeding strategies to accelerate rootstock development. We will also discuss how the low-cost, high-throughput phenotyping methodology developed in this study holds promise for expanding our understanding of root hydraulic characteristics and morphology, which is essential for breeding efforts and the genetic mapping of other, more complex traits.

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POSTER COMMUNICATION

The selection of *Vitis vinifera* L. cultivars based on berry texture, iPBS genetic markers, and noble rot susceptibility analysis

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Keywords: Furmint, clone selection, noble rot, IPBS, berry texture

ABSTRACT

The selection of a suitable grape variety (Vitis vinifera L.) for specific viticulture and oenology objectives is a considerable challenge in the context of climate change. To enhance varietal management practices, such as clone selection or breeding, a substantial volume of fundamental and applied research is focused not only on the selection of varieties for various crops but also on the development of the selection methodologies themselves. In this study, clones of the Furmint grape variety, the most widely cultivated in Hungary's Tokaj wine region, were analysed. These clones, in contrast to earlier breeding lines, were selected for the purpose of producing dry white wine, a distinction from the majority of previously chosen clones, which were deemed suitable for the production of Tokaj's aszú wine, a distinguished botrytized wine endemic to the region.The present study focuses on evaluating the susceptibility of grapevines to Botrytis cinerea infection and the ampelographic characteristics associated with the production of premium dry wine. The 13 chosen clone candidates were evaluated alongside 14 clones from earlier selection lines during cultivation.Analyses of inter-primer binding site (iPBS) markers, phylogenetic comparisons based on retrotransposons, oenological measurements, and assessments of berry texture were performed.The findings indicate that the three clone candidates recognised as later infected by Botrytis show variations in the texture data, when compared to other candidate clones as well as clones from different selection lines. While the iPBS marker assay and multivariate statistical examination of oenological measurements can distinguish new clonal candidates from older ones, they cannot effectively identify the three clonal candidates that possess outstanding traits for dry Furmint vinification. Our research findings have revealed three new candidates for Furmint clones that exhibit increased resistance to Botrytis infection.

POSTER COMMUNICATION

Why aren't farmers using precision viticulture frequently? A case study

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Keywords: precision viticulture, satellite images, pressure chamber, farmers

ABSTRACT

In the last years, viticulture precision tools have been made available for farmers for different crops. The feeling that these tools are mandatory on an agriculture of the future have been disseminated by commercial entities but also from policy makers. However, the amount of data and the difficulty by farmers to understand it, lead to avoidable expenses and frustration. Maybe driven by past video games, it's expected that in the future all practices, decision and operations will be done by machines and farmers will only be watch. It's true that these data could help analysing the plot and in some case could provide help on achieving better results, but most of the farmers don't understand this information and the lack of extension services just brings more difficulty on the establishment of these tools. In addition, some of the models don't consider different susceptibilities to grapevine varieties, soil type, training method or historical data. In all tools and models, a field validation should always be done to correct and set a better decision support system.

AVIPE is involved in AGRARIAN EU project where precision viticulture tools are tested for irrigation and yield estimation and where validation is crucial on achieving good results. Results have shown a problem on the model to understand grapevine varieties. Moreover, it was a clear a difficulty on relating satellite images and water status data collected by pressure chamber.

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POSTER COMMUNICATION

Precision viticultural strategy for managing intra-vineyard variability in grape aroma using UAV-based vigour indices

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Keywords: aroma, remote-sensing, selective harvest, vine nutritional status, zonal management

ABSTRACT

In several cultivars, such as Gewürztraminer and Riesling, grape and wine aromas are determined by volatile terpenoids. Intra-vineyard variations in vine nutritional state, vegetative growth, physiological performance, and yield might result in variations in volatile terpenoid concentration and overall grape quality. Precision viticulture strategies such as zonal management can deal with these intra-vineyard variations allowing to separate grapes of different quality, and produce wines of distinct quality from the same vineyards.

We investigated the intra-vineyard variation in canopy growth, nutritional state, physiological performance, and yield, and grape technological quality and grape volatile terpenoids. We then evaluated the use of UAV-based indices to perform zone delineation to separate grapes with higher or lower volatile terpenoid concentrations.

The study was conducted in a Gewürztraminer vineyard for two seasons (2022, 2023) and in a Riesling vineyard for three seasons (2021, 2022, 2023). Both vineyards were located in the Okanagan Valley wine region (British Columbia, Canada). Plant water status (stem water potential), leaf area, and leaf gas exchanges (CO2 assimilation, transpiration, stomatal conductance) were measured at anthesis and veraison. At the same stages, normalized difference vegetation index (NDVI) and normalized difference red edge index (NDRE) were calculated from multispectral drone images to assess vine vigor. Vine nutritional status was determined by petiole analysis at veraison. Yield and berry technological quality (total soluble solids, pH, and titratable acidity) were determined at harvest. Grape volatile terpenoid concentration at harvest was assessed via SPME GC-MS analyses.

The results showed that grape volatile terpenoids positively correlated to petiole nitrogen content and yield in Gewürztraminer, and to leaf area, petiole nitrogen content, and yield in Riesling. NDVI and NDRE positively correlated to leaf area, petiole nitrogen content, yield, and volatile terpenoids in both vineyards. Our study showed that remote sensing-based NDVI and NDRE can serve for estimating vegetative growth and volatile terpenoids within vineyards. These indices allowed to segregate, using statistical approaches such as unsupervised k-means clustering analysis, zones of different volatile terpenoid concentrations within vineyards, which would allow the production of distinct wine styles under selective harvest.

POSTER COMMUNICATION

VitiCanopy to measure vine pruning mass and assess above ground vineyard carbon storage

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Keywords: digital tools, carbon accounting, dry matter, vineyard variability

ABSTRACT

The wine industry is increasingly focused on carbon accounting due to consumer's demand and the industry's goal of reducing carbon emissions. Vineyards exhibit a greater amount of carbon fixation per unit area relative to annual crops and most of the carbon stored within a vine is located in perennial organs like canes, cordons, trunks, and roots.

Dry matter production reflects a vineyard's performance and can be used to estimate carbon storage and hence inform vineyard management decisions.

This study used VitiCanopy to assess the pruning mass of dormant vines as a way to estimate above-ground dry matter production. In 2020 and 2021images of vines before and after pruning and measures of the pruning mass of each vine were taken and analysed using VitiCanopy. The coefficients of determination of the relationships between the values obtained with VitiCanopy and the measured pruning weight for the four vineyards were all above 0.93, to confirm that VitiCanopy can be used to measure vineyard pruning mass.

Combining VitiCanopy measurements of plant area index during the growing season and pruning mass during dormancy could allow for accurate estimations of above-ground biomass production for individual vines or entire vineyards, bringing viticultural landscapes closer to accurate carbon accounting. This technique could also help researchers build models to determine how vineyard carbon storage is affected by vine age, variety, management, and location.

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POSTER COMMUNICATION

Development of a novel UAV based approach for assessing the severity of spring frost and hail damages in vineyards

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Keywords: precision viticulture, UAV, climate change, risk map, severity damages assessment

ABSTRACT

A solid feature of climate change is that the frequency and severity of weather extremes are increasing. Ranking European countries for the number of crop failures related to extreme events reports France on top followed by Italy and Spain (COM 2021). While the severity and extent of a late frost damage is dependent upon several factors (e.g. altitude, flat vs sloped sites, distance of the vine from the ground, type of floor management, etc.), the increase of frost risk is primarily due to earlier bud burst which widens the time frame within which the probability of incurring freezing temperatures is greater. Both events share the need of appropriate damage assessment at either close time distance from the event (i.e. a few days) and later in the season for vines yield recovery estimation. Insurance agents often provide crop hail damage estimates based on their personal experience and field samples which are not always representative of the investigated field's spatial variability. For this reason, farmers and the insurance market itself ask for a reliable, objective and less labor-intensive method to determine crop frost and hail losses. Remote sensing technologies offer significant potential to meet these needs. However, existing vegetation index-based solutions are often insufficiently specific or accurate. To address these limitations, the FROSTVINE-UAV project, funded by the European Union under the NextGenerationEU framework, aims to develop a novel methodology using 3D reconstruction of young shoots from ultra-high-resolution imagery captured by low-altitude unmanned aerial vehicles (UAVs). During the 2024 season, the first year of the project, UAV monitoring campaigns were conducted across four vineyards in Italy. These campaigns focused on developing an innovative protocol for detecting and estimating grapevine canopy damage caused by late spring frost and hail, both immediately after the events and over time to assess vine recovery and yield. Remote sensing data were validated through multitemporal ground-based observations and measurements. Preliminary results highlight a robust methodological workflow, from field monitoring to data analysis, capable of producing risk incidence maps within days of the event with an accuracy exceeding 85%. The UAV-based approach proposed in this research demonstrated significant potential to reduce operational costs for damage monitoring while enhancing the efficiency of viticulture practices.

POSTER COMMUNICATION

Advancing wine authentication: non-invasive near-infrared spectroscopy and machine learning for vintage and quality traits assessment

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Keywords: wine fraud, digital technologies, Shiraz, rapid methods, provenance

ABSTRACT

Wine fraud, encompassing counterfeiting and adulteration, poses a significant threat to the wine industry, resulting in annual losses totalling billions of dollars. Therefore, the development of rapid, accurate, and non-invasive techniques for detecting fraud-related indicators such as wine provenance and quality traits is critical. This study aimed to develop a novel non-invasive approach utilizing a handheld near-infrared (NIR) spectroscopy device to analyse wines through their bottles. Machine learning models were developed for Shiraz wines from an Australian winery using the NIR absorbance values to predict the wine vintage (Model 1) as a classification model and the intensity of sensory descriptors (Model 2) as a regression model. The models had high accuracies of 97% for Model 1 and an R = 0.95 for Model 2. This method offers a cost-effective and rapid solution for winemakers and retailers to evaluate wine quality and authenticity without the need to open bottles. Furthermore, it holds potential for expanding assessments to include additional authentication criteria such as region, country of origin, and grape variety, thus enhancing the integrity of the wine market.

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POSTER COMMUNICATION

PyExpress – A pipeline for fast and reliable UAV image processing in vineyards

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Keywords: UAV, precision viticulture, photogrammetry, thermography

ABSTRACT

Increasing drought poses a challenge to viticulture, with complex impacts on grape yield and quality. The use of Unmanned Aerial Vehicles (UAV) in Precision Viticulture offers a valuable tool to detect drought stress, capturing its spatio-temporal variability and thus, supports management strategies. UAV-based infrared or multispectral imagery enables high-resolution, non-invasive assessment of vegetation characteristics and drought stress. However, despite the increasing use of UAVs in vineyard management, a robust and comprehensive methodology for continuous and rapid image processing - providing orthophotos for timely decision support and research analysis - is still lacking.

To address this gap, the PyExpress software package was developed to enable rapid and automated photogrammetric image analysis with particular suitability for applications in vineyards. It builds on the functionality of the Agisoft Metashape API and adapts it to create fully customized and automated workflows for, e.g., UAV-based image processing. Sample workflows have been developed to automate the generation of diverse data products, including e.g. point clouds, camera and reference parameters, and digital elevation models (DEMs). These outputs serve as input data for a variety of applications and further analysis to provide decision support for vineyard management or research, e.g., using Geographic Information Systems (GIS) or 3D point cloud processing software such as CloudCompare. To manage large image and project data sets, PyExpress incorporates the interaction with MinIO, a high-performance object storage system. The automated workflows were extensively tested on infrared UAV datasets for temporal and spatial dynamics assessment of drought stress in a steep slope vineyard (Seußlitz, Germany).

PyExpress reliably provides high-quality analysis results across different measurement, flight, and drought stress conditions. Object storage systems such as MinIO demonstrated excellent suitability for UAV data processing workflows. To ensure precise separation of grapevine canopies from surrounding vineyard environment, PyExpress integrates a classification functionality for distinguishing canopy and soil, with adjustable parameters tailored to specific datasets. This filtering of the point cloud was a critical step in subsequent data processing, mainly concerning the differentiation between, e.g., the temperature of vine canopy and the surrounding vineyard.

POSTER COMMUNICATION

Using RGB images and LiDAR data to characterise fruit-to-leaf ratios in grapevine collections

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Keywords: fruit-to-leaf ratio, sugar accumulation, genetic variability

ABSTRACT

One of the main effects of global warming is an increase in the sugar concentration of grapes at harvest time, resulting in wines with a high alcohol content and an unbalanced structure. The fruit to leaf ratio is a key factor in determining the final sugar concentration, and training systems and management techniques can help to control this parameter. There is also variability in the ability of grapevine genotypes to accumulate sugars, which depends on the ripening date, the fruit/leaf ratio, but also on unclear mechanisms at berry level. Indeed, some varieties have been described as 'low sugar accumulators', but the genetic determinism(s) of such a trait remains to be described.

When describing genetic variability for sugar accumulation, it is easy to take into account veraison dates and yield levels, but it is difficult to characterise leaf volume and activity across a large number of genotypes.

To gain access to such a trait, we have developed a high-throughput digital phenotyping system. Image analysis based on RGB images and cloud points from LiDAR data is used to obtain estimates of canopy characteristics.

This system has been used to characterise several varieties in the germplasm collection and in breeding populations at INRAE, Colmar, as well as the kinetics of sugar accumulation.

We will present how these data can be used to estimate the effects of fruit/leaf ratio on the rate of sugar accumulation and to identify genetic effects that are independent of development stage and fruit/leaf ratio.

OPEN ACCESS

POSTER COMMUNICATION

Using Landsat LST data to predict vineyard productivity anomalies: A case study in the Euganean Hills wine region, Italy

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Keywords: productivity, satellite, anomalies, remote sensing, spatial analysis

ABSTRACT

Context and purpose of the study. In the current scenario of climatic variability, even though the vine (Vitis vinifera) is a species generally considered very fertile, the process of bud differentiation is particularly influenced by the weather trend not only of the current year but also of the previous one. To accurately determine this influence, buds' fruitfulness data are usually compared with meteorological data collected in nearby weather stations but most of the time this is not possible. The study aimed to use Landsat-derived Land Surface Temperature (LST) data to develop a framework of single pixel-based LST climatology to assess bud's fruitfulness anomalies in five Vitis vinifera L. varieties in the Euganean Hills wine district in Norther-East Italy.

Material and methods. A 23-year dataset (2000-2023) from Landsat 7, 8, and 9 imagery was used and for each pixel the seasonal (DJF, MAM, JJA, SON) and annual (ANN) LST climatology was computed. Five years of the following bud's fruitfulness parameters: potential and real fruitfulness, n. blind buds, n. of sterile buds, were collected on ten vineyards of five Vitis vinifera varieties (Cabernet Sauvignon, Chardonnay, Merlot, Glera, and Moscato Giallo). Statistical analyses were performed to correlate the fruitfulness variables at each vineyard with the pixel-based LST anomalies, and risk maps were generated.

Results. Temperature anomalies influenced buds' fruitfulness differently across grape varieties and areas. In Cabernet Sauvignon and Chardonnay, higher summer temperatures in the previous summer were linked to lower bud fruitfulness, while in Glera increased fruitfulness under similar conditions was observed. Warm winter temperatures increased blind and sterile buds in certain varieties. Risk maps indicated that the Central and Northeast areas were more susceptible to temperature variability, especially during winter and spring, with late frosts posing a significant risk. The results suggest that using LST data in vineyard management can aid in reducing the unfavourable impacts of temperature fluctuations. Vineyard productivity and sustainability can be improved by employing adaptive approaches, such as relocating varieties to sites with cooler microclimates, adjusting irrigation, or using shading techniques.

POSTER COMMUNICATION

Applying artificial intelligence for improving grape yield estimation: A case study of wine and table grapes in South Africa

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Keywords: artificial intelligence, yield estimation, precision viticulture

ABSTRACT

Accurate grape yield estimation is essential for effective vineyard management, crop planning, and resource allocation. Traditional methods often involve time-consuming and labour-intensive processes, which may introduce errors due to the large size and inherent spatial variability of the vineyard blocks. In this sense, artificial intelligence (AI) can contribute to increasing the number of samples by using images or videos which can be proposed by trained AI models reducing the uncertainties of the yield estimation, especially those associated with the number of bunches per vine, being one of the most import yield components. This study explores the use AI as a novel approach to improve yield estimation for both wine and table grapes in the context of the standard viticulture practices of South Africa. Four field experiments were conducted to capture RGB images of selected vines of Cabernet Sauvignon and Chenin Blanc (wine grape cultivars) and Crimson Seedless and Sugar Crisp™ (table grape cultivars). Different protocols of image acquisition considering the particularities of the trellising systems and multiple phenological periods were analysed. RGB images captured under field conditions were used to train the AI models based on YOLO architecture for bunch detection. Statistical indicators were used to evaluate the performance of the calibrated models by comparing the results with images labelled by human experts. The preliminary results obtained with this methodology show errors of the AI models varied from the different conditions analysed, presenting error rates ranging from 0.8 to 1.8 bunches per vine. These results demonstrate the potential of AI to enhance vineyard yield estimation. However, further studies and technical adaptations are needed to scale the methodology to a vineyard block level and advance its practical application.

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POSTER COMMUNICATION

Cluster trait prediction using hyperspectral signatures in a population of 221 Riesling clones

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Keywords: clonal variation, hyperspectral reflectance, cluster architecture, PLSR, vegetation indices

ABSTRACT

Context and purpose of the study. Cluster architecture in grapevine plays a critical role in influencing bunch microclimate, thus quality traits, including sugar content, phenolic composition, and disease susceptibility. This study focuses on exploring the use of hyperspectral spectroscopy as a high-throughput phenotyping (HTP) alternative to predict cluster architecture and quality traits by analysing spectral properties of leaves and clusters. Our goal was to develop predictive models based on spectral properties of leaves and clusters, aiming to enhance breeding selection efficiency for cluster traits in 221 clones of white Riesling.

Materials and methods. A subset of 221 Riesling clones displaying diverse cluster architecture were studied. A phenotyping pipeline was established where spectral signatures in three clusters per clone were measured using a spectroradiometer. Additionally, the berries were pressed to obtain juice and analyse its quality by means of density, pH, tartrate, malate, NOPA and the sugar free extract in the juice. In addition to cluster reflectance, leaf reflectance was collected on the same population of study and two methods were used to predict the traits, partial least squares regression (PLSR) and vegetation indices (VI).

Results. PLSR models showed higher accuracy when using cluster reflectance compared to leaf reflectance. Cluster weight prediction with cluster reflectance showed R2 = 0.31, RMSE = 54.58 g, and rachis weight predictions had R2 = 0.19, RMSE = 4.54 g. For cluster weight prediction, the key wavelengths influencing predictions were located at 532-556 nm and 678-700 nm, while those for rachis weight were located at 400-408 nm and 680-713 nm. VI models using cluster reflectance offered comparable accuracy for cluster weight (R2 = 0.31) or better (R2 = 0.28) for rachis weight. For the quality traits, sugar free extract, density and malate content were predicted using vegetation indices related to chlorophyll content and water stress with a very high accuracy (R2 = 0.7, 0.66, 0.52, respectively) using cluster reflectance. However, the prediction accuracy reduced when using leaf reflectance (R2 = 0.21, 0.12, 0.19, respectively). These results indicate the potential uses of spectroscopy to select clones based on cluster architecture and quality traits and the importance of measuring different organs of the canopy, as cluster reflectance derived models performed better than the ones using leaf reflectance.

POSTER COMMUNICATION

Managing local field variability in the framework of precision viticulture

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Keywords: precision viticulture, physiological parameters, grape quality, spatial variation

ABSTRACT

Managing grapevines according to the practices of Precision Agriculture (PA), may prove to be an asset in the hands of the modern grape growers. Precision Viticulture (PV), namely the application of PA in viticulture has gained significant attention from the grape growers and scientist in the recent decades enhanced by the emergence and availability of digital technologies dedicated to farming applications.

In this work, the outcomes of applying PV practices and digital technologies in a commercial vineyard in the region of Attica in Greece are presented from a study conducted in the framework of "AGROSYS" project. The experimental area was 3.5 ha, a subsection of a 26 ha vineyard grown with Savvatiano (Vitis vinifera L.) a traditional Greek variety. The apparent soil electrical conductivity was initially mapped and a digital elevation model was prepared utilizing measurements from an RTK-GNSS. The soil and terrain properties were analysed using Fuzzy clustering algorithm and management zones were created based on which the experimental plots were set up. Three representative sample vines were selected in each plot and were measured for their physiological and phenotypical status utilizing both traditional sampling and analysis and digital sensing technologies.

Preliminary results showed statistically significant differences of key physiological and quality parameters of vines and grapes among the different management zones. This finding indicates the significance and potential benefits of managing local field variability in commercial vineyards.

FUNDING

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POSTER COMMUNICATION

Comparison of destructive and non-destructive measurements of table grape berries to assess quality parameters using spectroscopy

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Keywords: table grapes, fruit quality assessment, spectroscopy, non-destructive measurements

ABSTRACT

The quality of table grapes is critically influenced by several parameters, including sugar content, acidity, firmness, and overall appearance. Traditional methods for assessing these attributes often involve destructive sampling, which can be labour-intensive and impractical for large-scale analysis. In this study, we compare destructive and non-destructive techniques for evaluating the quality of table grape berries of two table grape cultivars (Crimson Seedless and Sugar CrispTM) in a controlled laboratory setting, focusing on using spectroscopy as a means of measurement. Destructive measurements involved conventional techniques such as sugar content determination (refractometry) and a benchtop commercially calibrated Fourier Transform Mid-Infrared (FT-MIR) spectrometer, which delivers total soluble solids (TSS), titratable acidity (TA), pH, and malic acid (MA) values from small samples (2 mL). For non-destructive measurements, we employed spectral data obtained from four spectrometers: two portable, low-cost spectrometers i.e., NIR-S-G1 and Stellarnet BLACK-comet C-SR, and two benchtop spectrometers i.e., FT-MIR and Solid Probe Multi-Purpose Analyser Fourier Transform Near-infrared (SP-MPA-FT-NIR). The characteristics and accuracy of each method were compared and analysed from samples obtained during the whole ripening period in both cultivars. Results confirmed that the destructive spectroscopic technique was highly reliable for TSS estimations with determination coefficients (R2) and root-mean-square error (RMSE) around 0.97 and 0.83 ºBx for both cultivars during the whole ripening period. The non-destructive spectroscopy methods presented promising results, with R2 values ranging from 0.72 to 0.88 for all configurations and quality parameters tested in this study. These results demonstrated a high potential of the non-destructive spectroscopy offering a low-cost, faster and more efficient approach for quality assessment facilitating improved fruit selection and quality monitoring of table grapes.

POSTER COMMUNICATION

Non-invasive grapevine inflorescence detection using YOLOv11 under field conditions

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Keywords: yield prediction, inflorescence, precision viticulture, deep learning, object detection, YOLOv11

ABSTRACT

Accurate and early yield estimation in vineyards is essential for the effective management of resources and informed decision-making in viticulture. Winemakers and vineyard managers rely on these predictions to optimize agricultural practices and efficiently manage winemaking processes (Laurent et al., 2021). Furthermore, more efficient management based on precise predictions contributes to the sustainability of the sector, helping to mitigate the effects of climate change and promoting a more responsible use of natural resources.

Traditionally, estimation techniques such as manual bunch counting or destructive sampling have been the primary tools. However, these practices, aside from being costly and labour-intensive, fail to capture the inherent spatial and temporal variability of vineyards (Martin et al., 2003).

In recent years, the development of emerging technologies has transformed precision viticulture, offering new opportunities for yield estimation. Computer vision (Nuske et al., 2014) and deep learning (Iñiguez et al., 2024) have proven to be effective tools for non-invasive crop monitoring, enabling the automated detection and counting of grape bunches.

The use of object detection algorithms has become increasingly prominent in grape bunch estimation, particularly at stages closer to harvest when bunches are fully developed (Iñiguez et al., 2024). For instance, Sozzi et al. (2022) showcased the effectiveness of various YOLO versions in detecting white grape bunches during these late phenological stages, achieving notable accuracy under controlled conditions.

However, as vines approach harvest, challenges such as leaf occlusion and overlapping bunches significantly complicate estimations, limiting the reliability of these methods in less ideal scenarios (Iñiguez et al., 2021). Many studies addressing these difficulties have relied on images captured under optimal conditions, where minimal foliage or occlusion ensures better bunch visibility, simplifying detection tasks (Santos et al., 2020). The phenology of grapevines plays a pivotal role in yield estimation, as conducting earlier sampling during stages with reduced foliage can mitigate occlusion and provide more timely and actionable predictions. These advancements highlight the potential to optimize vineyard management and decision-making throughout the growing season.

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POSTER COMMUNICATION

Morphological image analysis for determining bunch grape characteristics: A case study on bunch weight in Cabernet-Sauvignon

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Keywords: yield estimation, morphological image analysis, precision viticulture, bunch weight

ABSTRACT

Morphological image analysis is a powerful technique used in various fields, including agriculture, to quantitatively assess the physical characteristics of objects. In viticulture, the accurate assessment of grapevine characteristics is essential for optimizing crop management and improving the quality of wine production. Among these characteristics, bunch weight is a critical factor influencing vine health, yield potential, and the quality of grapes harvested. Accurate vineyard yield estimation is crucial for the wine industry as it enables optimization in harvest planning, winery management, and marketing strategies (Victorino et al., 2022). However, the significant spatial and temporal variability within vineyards complicates precise predictions of grape bunch weight (Bramley et al., 2011). Conventional methods, such as manual grape bunch sampling, are destructive, labour-intensive, and prone to significant errors that can exceed 30%, depending on the sampling technique used and vineyard heterogeneity (Dunn & Martin, 2008). To overcome these limitations, sensor-based technologies, particularly image analysis, have shown great potential in addressing these challenges. These tools enable the inspection of a large number of grape bunches within a short time, reducing reliance on extrapolations and errors associated with variability (Liu & Zeng, 2020). Non-contact measurements based on two-dimensional image processing have been proven to be useful in the detection of several key agricultural traits, especially in single fruits with regular and uncomplicated shapes, such as apples and apricots (e.g., Khojastehnazhand et al., 2019; Wu et al., 2019). Other studies also present the potential of these techniques for more complicated fruit shapes, such as grape bunches, where the shape and size are highly dependent of the cultivar, viticulture practices and edaphoclimatic conditions. Diago et al., (2014) demonstrated that features such as the projected area of the bunch, the number of visible berries, and the perimeter are key predictors of bunch weight in two-dimensional analyses, achieving significant correlations across various cultivars. Moreover, the use of two-dimensional imaging has become an effective tool for the automatic segmentation of grape bunches and the counting of visible berries (Aquino et al., 2018; Milella et al., 2018). Advanced methods, such as algorithms based on convolutional neural networks, have significantly improved segmentation and counting under field conditions, bringing these technologies closer to practical applications in commercial vineyards (Liu & Zeng, 2020). However, the dependence of these correlations on the cultivar remains a challenge, as differences in bunch architecture and environmental conditions significantly affect the accuracy of proposed models (Tello et al., 2015; Victorino et al., 2022). Despite these advances, several open questions persist regarding image-based weight estimation. These include berry occlusion, variability in image capture conditions, and cultivar dependence, all which limit model generalization (Diago et al., 2014; Victorino et al., 2022).

POSTER COMMUNICATION

Simulating single band multispectral imaging from hyperspectral imaging: A study into the application of single band visible to near-infrared multispectral imaging for determining table grape quality

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Keywords: hyperspectral imaging, multispectral imaging, table grape, quality

ABSTRACT

To be accepted by the market and consumers table grapes need to meet certain requirements in terms of physical and chemical quality parameters. Chemical quality parameters of importance include total soluble solids (TSS), total titratable acidity (TA) and pH (Herrera et al., 2003; Jayasena & Cameron, 2008). The standard reference methods used to determine these parameters are generally destructive, time-consuming and may require specialized equipment or complex sample preparation (Daniels et al., 2019; Fernández-Novales et al., 2019). Due to inherent intra-bunch and inter-bunch variability large samples are also required to ensure accurate representation of the vineyard. Alternative methods such as spectroscopy and spectral imaging may be the solution to providing fast, accurate and efficient evaluation of table grapes.

Spectroscopy methods including visible to near-infrared (VNIR) spectroscopy, Fourier-Transform near-infrared (FT-NIR) spectroscopy and short-wave infrared (SWIR) spectroscopy have been proposed and tested for the evaluation of fruit and vegetable quality. These methods are mostly laboratory-based and require highly sophisticated and expensive equipment. Being laboratory-based means that these methods still need samples to be removed from the vine i.e., are also destructive. Some in-field spectrometer options are available, but they remain expensive. Spectroscopy techniques are also generally limited to point measurements yielding one-dimensional data i.e., a spectral signature for the specific point. This makes it difficult to upscale measurements to a bunch-level investigation because the decision of how many points should be measured and what the distribution of these points across the bunch should be is not an easy one to make. Technologies such as hyperspectral imaging (HSI) and multispectral imaging (MSI) may assist in overcoming this challenge as they provide three-dimensional data comprised of the one-dimensional spectral and two-dimensional spatial data i.e., spectral signatures for each pixel in the image (Nicolaï et al., 2007).

HSI and MSI technologies are however not easily transferred to in-field applications due to the potential interference of ambient conditions (light conditions in particular) on the measured spectral data (Nicolaï et al., 2007). Some studies have successfully used HSI for in-field applications under specific conditions (Shao et al., 2021). Portable HSI sensors are still expensive and MSI options can provide a cost-effective alternative. MSI technologies have not been widely used in determining fruit quality and to our knowledge no studies on table grapes specifically exist. HSI provides a large amount of information, but MSI is generally limited to much fewer spectral bands or even single bands. This core difference may impact on the successful application of MSI technology for determining table grape quality parameters.

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POSTER COMMUNICATION

VineAI: artificial intelligence for fungal disease

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Keywords: grapevine disease, satellite imagery, machine learning

ABSTRACT

Early and accurate grapevine disease detection and surveillance are crucial for optimizing vineyard management practices. However, traditional disease control methods are often labor-intensive, costly, and challenging to scale across large areas. The objective of our study is to detect the three most common and destructive grapevine diseases in the United Kingdom (UK) using advanced machine learning models and high-resolution satellite imagery. The targeted diseases include Downy Mildew (Plasmopara viticola), Powdery Mildew (Uncinula necator), and Botrytis Cinerea. Disease data was collected by agronomists in Chardonnay and Pinot Noir vineyard blocks in four vineyards in the Southeast of England from August to October 2024, with each disease rated for severity and prevalence.

We investigated vegetation indices (VIs) and spectral band values extracted from high-resolution satellite imagery such as Sentinel-2 (10m resolution) and PlanetScope (3m resolution) along with other environmental variables, obtained from SoilGrids and weather station data. The result shows these metrics provide essential information in differentiating infected grapevines from healthy ones. Using tree-based machine learning models, we achieved disease detection accuracies around 90% for each disease.

For all the diseases, the outputs of the model represent a disease probability at a per-pixel level, overlayed on the vineyard map. The resulting disease maps show spatial patterns of disease impact across vineyard blocks. These findings show the ability of AI models to accurately detect the disease occurrence in the vineyard and to predict the early infections of the disease in the vineyard with accuracy of 89.6%, 93.7% and 91.5% or Downy Mildew, Powdery Mildew, and Botrytis Cinerea, respectively.

POSTER COMMUNICATION

Spectral discrimination between *Vitis vinifera* and *labrusca* by spectroradiometric techniques

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Keywords: spectroradiometry, *Vitis labrusca*, spectral classification

ABSTRACT

Context and purpose of the study. Brazil is one of the few countries where vineyards of Vitis labrusca and Vitis vinifera coexist in the same geographical spaces, due to complex processes of territorial occupation by successive waves of European settlers. This situation presently leads to difficulties in the monitoring of grape and wine production, a necessary task to enforce regulations on wine quality. As an alternative to vineyard inventories informed by farmers, detection and discrimination of both Vitis species can be performed by Remote and Proximal Sensing techniques.

Material and Methods. Spectroradiometry was performed on living leaves of plants of Vitis vinifera and labrusca. Vineyards were separated by 200 meters to minimize confusion effects from environmental factors. Resulting reflectance spectra were analyzed by PCA and other statistical techniques, looking for wavelengths where both species can be discriminated.

Results. Spectral traits typical of each species are mainly located at visible and near-infrared wavelengths. Accuracies as high as 85% in discrimination were attained, characterizing these techniques as a potentially useful tool to vineyard monitoring.

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POSTER COMMUNICATION

Untangle berry shrivel environmental risk factors and quantify symptoms with AI – GeomAbs meets BAISIQ

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Keywords: berry shrivel, geology, maps, image analyses

ABSTRACT

Berry Shrivel (BS, Traubenwelke) is a sugar accumulation disorder of grapevine of unknown causes, having a great negative impact on grape quality and incalculable risks for yield losses, and for which no reliable curative practices are available. The Austrian autochthonous red wine cultivar Blauer Zweigelt is heavily affected by BS, but the intensity of the damage can change from year to year making it unpredictable and hard to quantify. The induction of BS may include environmental factors and imaging technologies in combination with AI may facilitate a yield loss prediction. These questions are the aims of two projects starting 2025. In GeomaBS, we are going to identify the potential underlying environmental factors influencing BS abundance in vineyards to develop BS risk factors. Our experimental approach involves a) to link BS information with spatial and temporal maps representing geology, soil, management and climate, b) to determine the consequences of BS grapes on wine aroma profiles, and c) to extract BS risk factors of a study region and to translate the obtained information also to other viticulture risks. A reliable and standardized, easy and cost-effective, method to quantify BS in vineyards would be very helpful to support growers' decisions. The project BAISIQ aims to establish an image-base quantification method of BS in vineyards using explainable AI. The BAISIQ partnership includes experts in the fields of grapevine biology working on BS, explainable artificial intelligence and data science, and image acquiring on the proximal and remote scale and their processing. Our results will close current knowledge gaps on BS, establish methods for BS quantification, develop a database of BS, combine multi-sensor data with machine learning methods for yield quantification, further develop algorithm for image analyses, and provide tools and recommendations for wine growers to cope with BS.

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POSTER COMMUNICATION

High-resolution climate modelling for the Cognac region under climate change

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ABSTRACT

Context and purpose of the study. Climate change has varied effects across French vineyards, with marked regional differences in temperature shifts. Fine-scale studies highlight significant local climate variability, emphasizing the need for precise regional characterization to adapt vineyard management at the regional scale. This study focuses on the Cognac region, France's leading area for white grape production, covering nearly 87,000 hectares and known for its oak-barrel-aged brandy, Cognac. It aims to establish a high-resolution climate zoning model through extensive on-site climate measurements, facilitating the calculation of agro- and eco-climatic indicators tailored to viticulture.

Material and method. Data for this study were gathered from three distinct measurement networks across the Cognac region. The first network consists of 26 Météo-France weather stations with historical data spanning 20 to 70 years. The second network includes 50 connected weather stations operational since 2018, and the third, a network of 100 temperature sensors, was deployed in the vineyards in 2022. Using this data, three statistical models were tested to interpolate temperature and rainfall on a 1 km² grid: artificial neural networks (ANNs), support vector regression (using non-linear regressions), and multiple linear regression model with smoothing of residuals that incorporates environmental variables such as altitude, slope, distance from the sea, etc.

Results. Preliminary model comparisons suggest slight differences in efficiency. Once interpolation at a fine scale was achieved, it allowed the calculation of agro- and eco-climatic indicators, revealing significant spatial variations across the Cognac region. This method will also be used to assess the impact of future climate projections, offering insights into potential regional adaptations for viticulture.

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POSTER COMMUNICATION

SmartGrape: early detection of cicada-borne vine diseases using field spectroscopy and detection of volatile plant scents

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Keywords: bois noir, flavescence dorée, plant volatiles, machine learning

ABSTRACT

Bois noir (BN) is a cicada-transmitted grapevine disease that today causes up to 50% yield and vine loss in vineyards. It is caused by the phytoplasma Candidatus Phytoplasma solani (16SrXII-A). The cicada Hyalesthes obsoletus Signoret (Hemiptera: Cixiidae) transmits the phytoplasma from host plants in the undergrowth of vineyards to grapevines (Vitis vinifera). Infected plants cannot be cured and temperature anomalies associated with climate change have been seen to increase the risk of infection. In Switzerland, BN is a 'regulated non-quarantine organism', a classification for 'particularly dangerous plant pathogens and pests that are already widespread'. Since there are no possibilities for direct control of BN, practical methods for systematic and early detection are urgently needed to support its management and prevention. Such methods will also be useful for preventing other invasive cicada-transmitted vine diseases, such as the quarantine disease flavescence dorée (FD). The aim of the study is to develop a package of innovative monitoring and early detection methods. Spectral imaging will enable efficient mapping of BN and support experts in calculating the proportion of infected vineyard area. Analyses of plant volatiles and the leaf metabolome of symptomatic vines will be used to determine whether they contain biomarkers for BN that can contribute to early detection. The data will be integrated to train machine learning models that categorize diseased vines and highlight distinguishing features. This package will be developed in a transdisciplinary, co-creative, step-wise process involving winegrowers, wine industry representatives and experts from the Swiss Plant Protection Service. Initial spectral, volatile and metabolomic results will be presented for a Zweigelt and Pinot Noir vineyards in Stäfa, Switzerland.

POSTER COMMUNICATION

Impact of genotypic variability on grapevine architecture and light interception: A functional-structural modelling approach

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Keywords: functional-structural plant model, architecture, genotypic variability, light interception, microclimate

ABSTRACT

Aerial architecture plays a key role in plant functioning as it affects light interception and microclimate. In grapevine, this architecture is primarily shaped by winter pruning and further adjusted through practices such as leaf thinning and topping during the growth cycle. Additionally, substantial variation in architectural traits, such as leaf size and branching intensity, exists among cultivars. While numerous studies have examined the effects of training practices on light interception and microclimate, the impact of genotypic variability remains understudied.

To address this, we defined a set of 16 genotypic parameters, based on measurements from 15 grapevine cultivars, in order to describe architectural differences. These parameters also account for the large variability among shoots of the same cultivar and the spatial heterogeneity in traits (e.g., leaf area, internode length) along individual shoots. We extensively modified the 3D functional-structural model TopVine (Louarn et al. 2008) that was previously validated on Syrah and Grenache cultivars to incorporate these levels of variability.

Simulations revealed a significant impact of cultivar architecture on total light interception and mean leaf irradiance. Notably, a trade-off emerged between total light interception at the plant scale and self-shading within the canopy. High self-shading in the most vigorous cultivars negatively affected photosynthetic activity at the plant scale, as simulated by our model. Furthermore, the results highlighted the importance of considering both intra- and inter-shoot variability, demonstrating that simulations relying on the replication of homogeneous shoots to represent the entire plant fail do not accurately reflect cultivar-specific differences.

This study provides a robust framework for simulating architectural variability in grapevine and opens new ways for analyzing its impact on plant functioning across a wider range of cultivars.

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POSTER COMMUNICATION

Advances in phenology modelling of the grapevine

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Keywords: grapevine, phenology, temperature, climate change, modelling

ABSTRACT

Context of the study. Historical records of grapevine phenology have been collected over decades throughout different winegrowing regions. These records have demonstrated advances in key developmental stages such as budburst, flowering and veraison because of increased temperatures due to climate change. This context has driven a demand to improve modelling phenology to understand past, present and future impacts of climate change on grapevines, and to provide frameworks for adaptation.

Purpose of the study. To review the recent advances made in the development and use of grapevine phenology models and make recommendations for the best practice.

Material and methods. A suite of phenological models with different forms (linear and non-linear) have been tested to understand spatial and temporal variability and cultivar differences for historic, current and future trends. We evaluate different approaches for budburst, flowering and veraison. For the maturity phase the use of sugar concentrations as a proxy for phenology is considered, and assessment of nitrogen and water status for time to target sugar concentrations. Field manipulation of canopy and yield treatments were also used to evaluate impacts on model outcomes.

Results. Our findings demonstrate that research objectives should determine modelling approaches used. Cultivar differences and diversity have been successfully characterised at different scales. While spatial and temporal diversity play an important role in phenological databases and within region variability, longer time series had the greater impact on model calibration and performance. Through model selection combined with climate change scenarios, future phenology predictions were possible, but under higher emission scenarios, model outcomes significantly diverged for non-linear and linear models. Leaf area: fruit weight ratios substantially modulated model predictions indicating the need to include this in impacts assessment as well as in adaptation strategies to delay sugar accumulation, a proxy used for maturity. However, environmental factors of water nitrogen did not significantly impact sugar concentrations.

Significance of study. The collation of findings across a range of studies has provided insights into climate change impacts and adaptation strategies for the grapevine, emphasizing the importance of phenology records and ongoing model improvement to better understand climate change consequences in the future.

POSTER COMMUNICATION

Moving beyond visible flower counting: RGB image-based flower number and yield prediction in grapevine

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Keywords: computer vision, *Vitis vinifera* L., linear regression, berry number

ABSTRACT

Accurate yield estimation is crucial for optimizing vineyard management and logistical organization. Traditional methods relying on manual and destructive flower or berry counts are labor-intensive and unsuitable for large-scale applications. To address these limitations, this study evaluated the potential of RGB image analysis for non-destructive estimation of flower number in grapevine inflorescences and its relationship with yield components. The objectives were: (i) to correlate the number of actual flowers with the number of pixels in inflorescence images considering the projected area and not visible flower count; (ii) to assess the model's capacity for predicting yield components such as the number of berries and bunch weight.

The study was conducted during the 2023 vintage in a cv Catarratto/1103P vineyard located in Sicily, on 36 vines divided into two vigor classes (high and low). The vines were trained on a vertical shoot positioning trellis system with a bilateral cordon spur pruned. All the inflorescences, categorized into six length classes, were photographed using a smartphone and white cardboard under field conditions. Images were analyzed using FIJI/ImageJ© software, where inflorescences were segmented via Otsu's method, and pixel counts were used to estimate flower numbers through linear regression. Flower counts were validated through manual counts of detached calyptra. Yield components were assessed by harvesting the vines, measuring bunch weight, and counting berries to calculate fruit set percentage. External model validation was performed on datasets from Catarratto, Chardonnay, and Vermentino cvs.

Results showed a strong correlation between inflorescence pixel count and flower number both on single inflorescences (R^2 = 0.85; MAPE 29%; n = 300) and in terms of total flowers per vine (R^2 = 0.95; MAPE 26%), with estimation accuracy unaffected by vine vigor class but varying slightly by inflorescence length class. External validation yielded a MAPE of 20% in Catarratto, 40% in Chardonnay and 34% in Vermentino. The model reliably estimated also the number of berries (R^2 = 0.94; MAPE 13%) and bunch weight (R^2 = 0.78; MAPE 20%) per vine. While environmental factors such as fruit set can affect yield, this study highlights the potential for early yield prediction with image analysis. The methodology holds promise for scalable application and integration into vineyard management technologies in vine and table grapes.

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POSTER COMMUNICATION

Grapesoil: An integrated model to simulate water and nitrogen fluxes in diversified vineyards

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Keywords: grapevine, covercrop, R model, evaluation, model quality

ABSTRACT

Cover crops in vineyards bring numerous benefits, including enhanced soil health, improved water infiltration, and potential pest reduction. However, they also present risks, such as reduced vine vigour and yield due to competition for water and nutrients (Celette & Gary 2013, Garcia et al., 2018). Understanding these interactions is crucial for vineyard management. To address this challenge, the GrapeSoil model was recently developed to simulate the effects of various practices on grapevine growth and yield, vineyard water balance and N balance at field scale. The vineyard and cover crop water balance is based on Walis, which was initially developed by Celette et al. (2010) and subsequently validated and utilized (Guilpart et al. (2014) and Delpuech & Metay (2018)). Constructed in R, the GrapeSoil model is built on independent functions and requires approximately 250 parameters and 20 inputs. These inputs may be sourced from surveys with winegrowers, field measurements, and literature reviews. The present study evaluates the consistency and sensitivity to key soil and plant parameters of the preliminary GrapeSoil model. This evaluation used a dataset collected by Nicolas Guilpart (2014) from a Mediterranean vineyard (South of France). Key model outputs, such as grapevine growth, yield, and soil water and N levels, were compared to observations using statistical indicators (Root Mean Square Error 'RMSE', Relative Root Mean Square Error 'RRMSE', and Efficiency). Sensitivity analysis explored the influence of parameters like berry number, canopy height, soil water holding capacity, and initial soil inorganic N levels on model outcomes. Results showed that GrapeSoil properly simulated the Fraction of Transpirable Soil Water (FTSW). Yet, the RMSE was ~ 0.1 across all modalities, representing less than 20% of variations, with efficiency around 0.9 for most modalities. All modalities combined, the RMSE remained at 0.1, representing an RRMSE of 21% and a model efficiency of 0.79. Simulations of soil inorganic N content lacked accuracy due to limited and inconsistent data. For most modalities, the RMSE was ~ 10 kg N/ha, which represented a low N amount. The RRMSE was 91% across all modalities and model efficiency -1.06. Lastly, the model permitted to predict yield and biomass with an error of 66% (from 29 to 91%). In the actual version of the model berry number is fixed. Further improvement of the model is required to simulate berry numbers and berry fresh weight.

POSTER COMMUNICATION

Yield prediction assessment before bloom and at veraison in a cv. Airén high yielding vineyard in Toledo (La Mancha, Spain)

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Keywords: yield prediction, modelling, veraison, grapevine, growing cycle

ABSTRACT

Anticipation in the possible responses of grapevines to environmental variations is key to adjust field work in view of a more effective management. This idea has been the driving force behind the current work, which seeks to understand the interaction patterns of the vine with its habitat throughout the growing cycle.

The experimental site is located at 'Viñedos del Río Tajo' company. It is a complex of 250 hectares of irrigated vineyards of cv Airén, Vitis vinifera, L., located in Guadamur (Toledo, Spain). Vine spacing is 2.0 x 3.3 m2, and the training system is a single curtain with minimal pruning, where the cordon is 1.80m above the ground.

The study is based on data collected throughout 2023 and 2024 from 10 plots. Within these plots, 3 to 4 replicates of 25 plants each were sampled. In each replicate, two measurements were taken in consecutive rows, each covering 2 meters of row, corresponding to one plant.

The number of clusters was collected at separated clusters phenological phase. Berry weight and the number of berries per cluster were taken at veraison. Yield partitioning was determined at harvest along 4 m of row per replication. Other parameters, such as plant water status, surface area, pruning weight, and shoot weight were also measured.

In addition, 100 berries per replication were used for basic must analysis (SST, pH, titratable acidity). Besides, YAN (yeast available nitrogen) and K+ content was also determined.

Based on the geospatial, climatic, and phenological data measured, the purpose is to identify the main factors influencing the yield. Up to now, the global yield, expressed as the product (yield/m of row · SST), has mainly been explained by surface area/kg, number of clusters per meter of row, average shoot weight, and number of berries per cluster, arranged in order of significance (R2=0.87**). Due to the high proportion of variance explained by these variables, which we can already know in spring, we perform an early prediction of the yield based on the number of clusters per meter row, the number of shoots per cluster and the average cluster weight.

This work highlights the importance of integrating spatial and temporal analysis tools into decision-making in the wine sector, and presents a replicable methodological framework for other vine crops with similar objectives.

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POSTER COMMUNICATION

Grapevine drought tolerant ideotypes to adapt viticulture to climate change

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Keywords: grapevine, drought tolerance, ideotype, stomatal conductance, hydraulic safety margin, xylem vulnerability

ABSTRACT

Context and purpose of the study. Climate change is challenging the resilience of grapevine, one of the most important crops worldwide. Adapting viticulture to a hotter and drier future will require a multifaceted approach that must include new management strategies, increased irrigation efficiency, and the identification of more drought tolerant genotypes. In this study we used a multi-trait phenotyping approach and model-assisted analyses to identify grapevine drought tolerant ideotypes.

Material and methods. We quantified a broad range of hydraulic traits under drought across and within Vitis species (5 different species and 5 different cultivars of V. vinifera). We then created in silico libraries of new trait combinations by varying and rearranging these quantified traits at random. Finally, by modelling the performance of existing cultivars, along with these novel trait combinations, we identified elite grapevine ideotypes with increased drought tolerance and superior performance under future climate change scenarios.

Results. The results of our study demonstrated that elite ideotypes have the potential to outperform existing varieties across important wine regions and under future climate scenarios. Overall, elite genotypes exhibited traits that reduce plant transpiration such as leaf area and minimum conductance, an increased net photosynthesis and hydraulic safety margins, and a longer time to reach hydraulic failure. This study reveals the traits and trait combinations that can be leveraged to guide breeding programs aimed at increasing grapevine drought tolerance.

POSTER COMMUNICATION

Projected changes of grapevine phenology in Belgian and South African vineyards under climate change scenarios

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Keywords: climate change, grapevine, phenology

ABSTRACT

The concept of 'terroir' describes the interplay of the environmental factors that affect the grapevine. This includes but is not limited to climate, soil composition, vineyard management, topography, and geology. Climate is considered one of the most important factors and is receiving increased attention, as climate change has a considerable impact on grapevines. Temperature is the main driver of grapevine phenology, and its increase can affect grape growth by shifting phenological stages. Significant advancements of phenological stages have been recorded over recent decades and are predicted to continue in the future, changing the suitability of certain varieties for specific regions. In this study, we analysed the relationship between grapevine phenology variability and weather conditions in vineyards in two regions of interest, namely Belgium and South Africa, and predicted the potential changes under climate change. Dates of budbreak, flowering, veraison and maturity were evaluated for Chardonnay and Pinot noir, and projections were made for 2050 and 2070 under two climate change scenarios: SSP1-2.6 and SSP5-8.5. The onset of veraison in the Belgian vineyard was predicted to be on average up to 27 days earlier by 2070 under the worst case scenario, while harvest in the South African vineyard will on average be 35 days earlier under the same scenario by 2070 according to our results. The ripening period will also shift to a warmer period of summer, which can potentially change grape composition and ultimately also wine quality. Our findings have the potential to provide winegrowers with a more detailed understanding of grapevine responses to climate change, enabling them to anticipate on this by changing their vineyard management or changing rootstocks and/or varieties.

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POSTER COMMUNICATION

Impact of sample size on yield estimation in commercial vineyards

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Keywords: yield, sampling strategy, variability, precision viticulture

ABSTRACT

The accurate estimation of yield is a fundamental for suitable viticulture, playing a pivotal role in the planning of logistics, the allocation of resources and the formulation of commercial strategies. The capacity to make yield projections enables producers to anticipate market demands and optimize operations, enhancing both efficiency and sustainability (Komm & Moyer, 2015). However, the intrinsic spatial and temporal variability of yield in vineyards presents considerable challenges to the collection of representative and precise data (e.g., Bramley and Proffitt 1999; Clingeleffer et al. 2001; Carrillo et al. 2015). Historically, the yield estimation has been dependent on manual techniques, such as the counting of bunches on a restricted sample of vines and the extrapolation of results to the entirety of the vineyard. Despite their widespread use, these techniques have notable limitations. They are costly in terms of labour and time, and they are prone to sampling errors due to the lack of representativeness, particularly in large or spatially heterogeneous vineyards (Dami, 2011).

To address these shortcomings, advanced techniques have been developed that integrate historical data and refined sampling designs. For example, Araya-Alman et al. (2019) proposed a methodology based on historical yield patterns to identify key sampling areas, thereby reducing estimation errors. Similarly, Oger et al. (2021) investigated the potential for optimising the number of sampled vines to minimise errors, emphasising the value of systematic approaches for more accurately capturing spatial variability. The adoption of emerging technologies has further transformed yield estimation practices. Torres-Sánchez et al. (2021) demonstrated how unmanned aerial vehicles (UAVs) equipped with high-resolution cameras and photogrammetric point cloud analysis can provide detailed spatial data on cluster distribution across extensive vineyard areas. In a further development of the techniques described above, Meyers et al. (2011) devised a dynamic spatial optimisation model which enhances the representativeness of the samples taken while reducing the costs of the operation. Moreover, Nuske et al. (2011) implemented computer vision algorithms for automated cluster detection and counting, thereby eliminating the necessity for destructive sampling. The integration of machine learning has expanded the scope of these technologies. Palacios et al. (2023) applied computer vision and machine learning to enable early yield predictions across different grapevine varieties, facilitating adaptive management strategies early in the growth cycle. Similarly, Íñiguez et al. (2024) developed deep learning models capable of detecting grape clusters even under complex occlusion conditions, improving data accuracy in challenging environments.

In this context, all these new methodologies and technologies can help to optimise the sampling strategy. To achieve a satisfactory yield estimation from punctual measurements, the number of measurements must reflect the expected yield variance at the desired scale. However, field measurements represent a significant effort in terms of labour and time, logistics and cost associated with equipment and the technology used. Therefore, a proper definition of sampling size is a key aspect of the success of the yield estimation approach used.

POSTER COMMUNICATION

New training methods to manage climatic and ecological transitions in perennial fruit crops

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Keywords: climate change, perennial fruit crops, viticulture, apple culture, challenge-based learning, Erasmus+ strategic partnership

ABSTRACT

Context and purpose. Climate change and the demand for reducing inputs, including chemical compounds, present significant challenges for perennial fruit crops like grapes and apples. Thus, there is a need for innovative educational programs to train students and professionals in the development of smarter resilient cropping systems that integrate the latest scientific advances. The Newclim project (2023–2026), funded by the EU ERASMUS+ program, fosters collaboration between universities in France (L'Institut Agro - IA), Sweden (Swedish University of Agricultural Sciences, SLU), Germany (Weincampus Neustadt), and Chile (University of Chile, CH). The project aims to create innovative activities and resources for students and professionals, focusing on climate transition and sustainable management in wine and apple production.

Material and methods. The Newclim project is developing an open training platform based on the Challenge-Based Learning (CBL) method. CBL constitutes three interconnected phases (engage, investigate and act), involving activities supported by continuous documentation, reflection, and sharing. As part of the project, educational tools will be developed to address identified challenges. Additionally, an online student laboratory (including a social network) was launched to promote brainstorming and collaboration. A guide on the CBL methodology, with workshops conducted in summer schools, will be shared with all participating institutions in higher education, research and extension sectors.

Results. In 2024, a workshop for PhD and Master's students, tutored by the four universities, followed by online barcamp sessions (participative workshop-events), was held at SLU to complete the first phase of CBL 'engage'. Students identified four to six challenges for each country, which will form the basis for the second CBL phase, 'investigate'. In the upcoming hybrid summer schools at Weincampus Neustadt in 2025 and IA in 2026, the challenges will be refined through local interactions with stakeholders and the pedagogical and research resources to address these challenges will be gathered. In the final CBL phase 'act', engineering projects will be proposed in collaboration with local stakeholders at each universit. Ultimately, Newclim's activities will help to unite an international community of students, teachers, and stakeholders to contribute to facilitating the ongoing ecological transition in viticulture and pomiculture.

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POSTER COMMUNICATION

Biophysical and agronomical drivers of the distribution of *Plasmopara viticola* oospores in vineyard soils

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Keywords: grapevine downy mildew, oomycete life cycle, soil inoculum, soil management, sustainability

ABSTRACT

Grapevine downy mildew (GDM), caused by the obligate biotroph oomycete Plasmopara viticola, is one of the most destructive diseases in viticulture. P. viticola's life cycle is comprised of two parts: the asexual phase, which occurs during the grapevine's growing season and in which the zoospores propagate on green parts of the vine; and the sexual phase, in which the crossing of strains in the leaves leads to the formation of oospores that overwinter in grapevine leaf debris and the surrounding soil. Oospores constitute the primary inoculum for downy mildew epidemics during the following growing season. While conventional GDM management relies primarily on fungicides to prevent the asexual propagation of the pathogen, the primary inoculum is increasingly thought to play a major role in GDM epidemics. This suggests that measures based on reducing primary inoculum or interrupting the pathogen's sexual cycle have the potential to significantly reduce epidemic pressure. Such a paradigm shift in management strategy will require a thorough understanding of the environmental drivers of GDM primary inoculum spatio-temporal distribution.

With this in mind, we carried out an extensive study of P. viticola oospore concentrations in vineyard soils across Saint-Emilion. In November 2023 and February 2024, soil samples were collected across 63 Bordeaux châteaux. The soils were analysed for GDM oospore concentrations using droplet digital Polymerase Chain Reaction (ddPCR) and soil physio-chemical properties. We also conducted surveys with the viticulturists to characterize vineyard management practices and the disease history of each parcel.

We analysed the effects of season, soil physio-chemical properties, cover cropping type and duration, vineyard treatments, soil management practices, and GDM sensitivity of the parcel on GDM oospore concentrations in the soil. Our results provide insight into the spatial distribution of oospores in vineyard soils and into which cover cropping and soil management modalities may influence their integration into the soil. For example, our data indicate that there is a reduction in oospores between November and February when a winter cover crop is implemented compared to other cover cropping modalities. This work identifies key biophysical and agronomical drivers of P. viticola spatio-temporal distribution, contributing to a broader project to make GDM management more sustainable by finding ways to interrupt the pathogen's sexual cycle.

POSTER COMMUNICATION

Impact of pruning method on vegetative growth and yield

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Keywords: pruning practices, yield, vigour, sap flow

ABSTRACT

Over the past fifteen years or so, a number of theories have emerged on more or less new pruning practices. They promise vinegrowers better development of their vines, increased longevity, reduced esca rates and better performance. However, few scientific studies have been carried out to evaluate them. This study therefore proposes to investigate the impact of both respectful and non-respectful pruning practices on i) the vegetative expression of the vine ii) the yield iii) the expression of foliar symptoms of esca both on young vines since formation pruning and on adult vines whose usual pruning practices have been modified. So since 2020, 2 trials planted with Cabernet franc on 3309C on vines with 2m spacing between row and 1m spacing between vines have been carried out in a vineyard in south-west of France. The distribution of vegetative expression, and yield parameters between primary and secondary vegetation was quantified. The expression of esca leaf symptoms and mortality was recorded every year on a vine-by-vine basis. For the young vines, the first results show that respectful pruning provide the highest pruning weight and vigour but with higher proportion of suckers. On the other hand, the yield at the time of entry into production, is higher for the non-respectful pruning. On the adult vines there is no difference in total pruning weight, but twice as many suckers developed during the season with a higher proportion of clusters from suckers on the respectful pruning method. These preliminary results actually show differences in vegetative expression depending on the pruning methods applied. They are part of a long-term study and today, in this production context, it seems difficult to recommend the widespread adoption of a particular pruning method.

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POSTER COMMUNICATION

Approaches for estimating the age of old vineyards in Campo de Borja

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Keywords: ancient vines, age classification, georeferenced aerial photographs, Garnacha

ABSTRACT

Determining the age of a vineyard is essential for understanding its influence on wine quality and characteristics. Due to the uniqueness, production complexity, and perceived quality enhancement associated with "old vines," they are increasingly valued by the industry and consumers. Beyond the fact the OIV has recently released a consensus declaration of what an old vineyard is (at least 85% of the plants must be 35 years or older), in many contexts it is relevant to determine or, at least, to estimate, the age of a vineyard. In this context, the appellation Campo de Borja (Aragón, Spain) is developing a valorisation program of old vineyards that includes a scientific approach aimed at developing a probabilistic method that can allow classifying vineyards in age ranges based on objective criteria. To this end, 80 plots were selected and characterized through variables that encompassed the analysis of historical orthophotographs, vine spatial distribution in the field and vine arm structure (measuring the height and distance between pruning cuts, allowing the estimation of the average annual growth in each vineyard), and genetic fingerprinting of rootstocks and varieties.

The study showed that the temporality and quality of orthophotographs in this area are insufficient to precisely identify plots with a planting date prior to 1980. The analysis of the spatial configuration of vines in the field revealed that, since 1997, the predominant training system has been the trellis, whereas the oldest plots are planted using the goblet system, specifically the tresbolillo system, while the estimation of annual arm growth rates is around 1,7 cm in the plots of this study. Regarding genetic fingerprinting, rootstock identification was much more informative than scion's. Altogether, the combination of all the aforementioned parameters may be suitable to enable a probabilistic estimation of vineyard age.

POSTER COMMUNICATION

Reusable system for wine bottles: An analysis of acceptance among German wine consumers

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Keywords: reusable wine bottle system, consumer acceptance, willingness to buy, discrete choice experiment (DCE)

ABSTRACT

Consumer demands for environmentally friendly products, including wine, are constantly increasing. An important lever to improve the environmental sustainability of wine is to reduce the emission of greenhouse gases during wine production. The carbon footprint (CFP) is an indicator that measures the emissions of a product during its life cycle.

Previous work has demonstrated that the CFP of a produced wine bottle is strongly determined by the emissions caused by the single-use glass bottle. It has also been shown that the reuse of glass bottles, which has been common practice in Germany approximately 15 years ago, can save a substantial share of the greenhouse gas emissions of a bottle of wine. It is clear that, the reintroduction of a recycling chain for wine entails a number of challenges, such as the need to reduce the diversity of bottles, adapt closing and labelling technology, storage capacity for empties, and set up comprehensive cleaning logistics. However, there are already successful reuseable schemes in Germany, and consumers have a major influence on the success rate. The acceptance of a reusable system among wine consumers has only been examined to a limited extent to date. Hence, this consumer survey is intended to provide novel and up-to-date insights.

In our representative survey, conducted by an online panel provider, data of over 1000 respondents was collected. Different quotas (age, gender, place of residence) were used to control the representativeness of the sample of the German population. Minors and people who do not drink wine were screened out. In addition, factors influencing acceptance and environmental awareness were recorded using established scales. Willingness to buy and willingness to pay for wine were measured using a discrete choice experiment (DCE). For this purpose, various attributes with different options, such as origin, price, deposit price and certifications, which provide information about the wine, were defined and combined in various choice sets. The DCE was analysed with a logit model, and an exploratory factor analysis was used to identify latent variables.

We observed significant effects of price, organic certification, and the wine's origin on the likelihood of selection, while specific details about the winery had no impact. Interestingly, the attributes related to the reusable system of wine bottles, i.e., deposit and deposit label showed no significant influence on the choice probability.

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POSTER COMMUNICATION

Sheep manure: An effective regenerative practice for enhancing Plavac Mali (*Vitis vinifera* L.) wine quality in dry-farming vineyards on Hvar island

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Keywords: regenerative viticulture, Mediterranean climate, Plavac Mali, seaweed-based biostimulant, straw mulch

ABSTRACT

There is an urgent need to develop protective measures for grapevines in historically significant dry-farming vineyards, particularly on Mediterranean islands. Despite the importance, the impact of regenerative viticulture practices in severe drought agroecological conditions remains poorly understood.

The aim of this study was to explore the impact of three regenerative practices on the physicochemical and phenolic properties of Plavac Mali wines from two vineyards (Vin_A and Vin_B) on south sunny slopes of Hvar Island, Dalmatia. Vin_A, at 160 m with a 34% slope, produces lower quality grapes than Vin_B, at 350 m with a steeper 55% slope that experiences cooler conditions producing more acidic grapes. Organic sheep manure (3 kg per vine), straw mulching at 30 cm, and seactive biostimulanting organic complex applications (pre-flowering, post-fertilization, and berry coloration), were compared to an untreated control. Two vineyards showed different trends with more pronounced changes in wine composition in Vin_A situated at lower altitudes. Regenerative practices had a significant impact on the physiochemical composition of wine in Vin_A. The wines of the biostimulant treatments had a significantly higher total and volatile acidity, reducing sugars compared to all, and alcohol compared to manure and mulch treatments. The biostimulant treatment wines had a significantly higher concentration of hydroxybenzoic, gallic acid, and hydroxycinnamic, caffeic acid, and lower quercetin in comparison to other treatments. The wines of manure and mulch treatments had significantly lower concentrations of catechin-derivative, epicatechin, and ECGC, compared to control.

In Vin_B biostimulant and manure treatment wines had significantly lower concentration of gallic acid and EK in comparison to mulch treatments, and protocatechic acid and EGCG in comparison to mulch and control treatments. The regenerative viticulture practices can significantly influence the physicochemical and phenolic profiles of Plavac Mali wines, with effects varying depending on vineyard-specific factors. The manure and mulch treatment were more effective in decreasing bitter and astringent compounds in wines of VIN_A, and biostimulants and manure treatments were more effective in VIN_B. These findings underscore the potential of regenerative practices in the improvement of grapevine resilience under drought stress while enhancing the polyphenolic composition and sensory quality of wines.

POSTER COMMUNICATION

Climate regionalization of Uruguayan viticulture for ecological sustainability

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Keywords: ecological sustainability, bioclimatic indices, viticulture, regionalization, Uruguay

ABSTRACT

Ecological sustainability refers to developing viticulture in adequate environmental conditions. The first climate regionalization for Uruguayan viticulture was done 20 years ago (using a historical 30-year climate database (from 1961 to 1990). It is well known that the climate has changed in the last decades, and it is therefore imperative to update the agro-climatic regionalization of the country for grapevine growing to increase knowledge that would help to adapt viticulture to climate change. In addition, there is now a greater density of weather stations and, therefore, more data available for this purpose. This study aimed to evaluate a new agro-climatic regionalization for grapevine cultivation in Uruguay, considering the bioclimatic indices commonly used to assess spatial and temporal climate variability for viticulture. For that purpose, a 31-year climatic database stretching from 1993 to 2024 from a network of 22 weather stations (WS) of Instituto Nacional de Meteorología (INUMET) and Instituto Nacional de Investigación Agropecuaria (INIA) was used. WS are standardized with the World Meteorological Organization (WMO) norms. The daily climatic variables were minimum, mean and maximum temperatures and precipitation (mm). After a quality data control, various climatic and bioclimatic indices for viticulture were calculated, such as the Huglin Index, Growing Degree Days, Cool Night Index, and Precipitations during the growing season (Sept. to March), as well as phenological indices, i.e. Grapevine Flowering Veraison, Grapevine Sugar Ripeness. Spatial modelling of the indices was performed over Uruguay and for different periods to assess both spatial and temporal climate variability. Maps showed different climatic regions compared to the previous regionalization. Differences in time scales were established depending on the bioclimatic indices under consideration. The climate zoning well portrays the influence of the Rio de la Plata estuary and the Atlantic Ocean. These results are of great value in determining potential new terroirs and contributing to more specific decisions related to the ecological sustainability of a region (e.g. when selecting grapevine varieties). Studying climate regionalization for the future period with different climate change scenarios and time horizons can also improve current decision-making.

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POSTER COMMUNICATION

Field evaluation of biofungicides to control powdery mildew and botrytis bunch rot of wine grapes in California

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Keywords: grape, fungal disease, biofungicide, rotation

ABSTRACT

Grapevine powdery mildew caused by Erysiphe necator and Botrytis bunch rot caused by Botrytis cinerea are two of the most important fungal diseases in California grape production. Growers are increasingly interested in using biofungicides because of the tightening of state regulations and high risk of fungicide resistance in the pathogen populations. During 2023 and 2024, we conducted two biofungicide field trials on Chardonnay grapevines located in the Central Coast (San Luis Obispo) and San Joaquin Valley (Fresno) of California, respectively. At each location, two experimental blocks were selected. Weather stations were placed in the vineyards prior to budbreak to monitor powdery mildew disease pressure using the Gubler-Thomas risk index model. Fourteen treatments, including three biofungicides (Bacillus subtilis, Streptomyces lydicus, and an extract of Reynoutria sachalinensis) applied at different intervals (weekly, biweekly, or based on the powdery mildew risk index), biofungicides in rotation with synthetic fungicides, a grower standard program with only synthetic fungicides, and a non-treated control, were applied to grapevines starting at bloom time and until veraison. Disease incidence and severity were rated biweekly until veraison; yield and berry chemistry were measured at harvest. Standalone biofungicides demonstrated higher disease control efficacy when applied weekly. Biofungicides provided effective disease control under low disease pressure (2024) but were less effective when pressure was high (2023). Overall, programs rotating biofungicides and synthetic fungicides achieved the best disease control, comparable to synthetic fungicides-only treatments. No significant differences in yield or berry chemistry were observed between the biofungicide and synthetic fungicide treatments.

POSTER COMMUNICATION

Multicriteria assessment of 11 agroecological viticulture systems during six years

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Keywords: agroecological intensification, low-input systems, pesticide use, pest damage, resistant varieties, yield, organic, biodynamic

ABSTRACT

Context and purpose of the study. Modern conventional agriculture, including viticulture, relies greatly on the use of chemical inputs, especially synthetic pesticides. However, negative consequences of these practices have included unintentional impacts ranging from water pollution in streams to a decrease in biodiversity, including beneficial pest predators. A shift towards using fewer inputs in agricultural systems is critical to maintain production while improving environmental and social outcomes. As a consequence, more and more recheach is conducted to design, experiment and assess agroecological practical solutions for increasing sustainability of viticulture systems.

Material and methods. To this end, the ECOPHYTO PEPSVI (2013-2018) project designed, experimented, and assessed performances and sustainability of low-input vineyard plots under commercial conditions. Eleven viticulture systems were designed combining technical and management changes to drastically reduce pesticide use. First, the viticulture systems were designed including environmental labels with a gradient from integrated, through organic and biodynamic. Secondly, the viticulture systems inclued soil management practical solutions to avoid using herbicide: cover crop and/or tillage between row and in some systems under vine. Thirdly, fungicide spraying is reduced. Diversity of practical solutions goes from efficiency of spraying, then substitution by biocontrol products, but also to redesign spraying including other practices like addition of essential oils and blowing caps after flowering. Fourthly, some of the viticulture systems included decision aid tools in practical solution to manage the vineyard during the growing-season (e.g. reducing rate of copper and rate of sulfur). And finaly, two of the viticulture systems were redesigned with resistant varieties for both mowdery and downy mildew. The 11 new viticulture systems were ranked according to the "efficiency, substitution, and redesign" (ESR) framework. The sustainability and the performances of viticulture systems were monitored and assessed over six consecutive years. Environmental assessment was done with Treatment Frequency Index. Economical assessment was done with 3 indicators describing yield: calculated yield, ratio of targeted yield and ratio of regional yield and 2 indicators describing the ability of grapes to Protected Designation (PDO) wines powdery mildew and downy mildew severities on grapes at harvest.

Results. This study revealed that pesticide use can be reduced without decreasing absolute value of yield, targeted yield of the winegrower and also yield compared to the regional average of the studied vintage. Thus, low-input plots produced the expected yield for six consecutive years, with acceptable levels of powdery and downy mildew severities for production of PDO wines. This study can encourage the transition towards low-input vineyard systems, through organic and biodynamic managements by providing information to agricultural advisors and reassuring winegrowers who are initially reluctant to shift to such sustainable viticulture systems.

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POSTER COMMUNICATION

Tracking innovations for glyphosate-free in sloppy or terraced vineyard

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Keywords: equipment, collective action, technical system, glyphosate, redesign vineyard

ABSTRACT

Context and purpose of the study. Reducing pesticide use such as glyphosate, is a key challenge to support sustainability of viticulture systems and resilience of vineyard. However, scientists argue that in certain situations, which they describe as "dead-ends", reducing glyphosate use is particularly difficult because of structure of vineyard (Reboud et al., 2017). Then, our aim was to shed light on innovative practical solutions from winegrowers – focus on technics, equipment and collective action - to reduce the use of glyphosate in two "dead-ends" situations: sloppy and terraced vineyards.

Material and methods. We adapted a tracking on-farm innovation method (Salembier et al., 2021): (i) We identified 9 cases through exploring databases, professional viticulture press, and contacting extension agencies. (ii) We performed semi-structured interviews with winegrowers about innovation. (iii) We analyzed the systemic nature of innovation thanks to an in-depth inductive analysis of each case, relied on the concepts of coupled innovation (Meynard et al., 2017) and of action logic (Salembier et al., 2021). (iv) We built typologies through a cross analysis of the case studies.

Results. Three major results emerged: (i) First, we characterized five types of innovation on collective action that supported winegrowers' access to key levers in weed management: 1) sharing resources (e.g. equipment, land, herd); 2) sharing labor (e.g. shared employee); 3) sharing technical management decision (e.g. collective decision in a common crop rotation); 4) developing a new resource (e.g. self-building an equipment adapted to sloppy or terraced vineyards); 5) accessing viticultural services. This typology corroborates and enhances the findings of Lucas et al. (2018). (ii) Secondly, we identified three types of innovation on equipment to perform weed management: 1) flexible use of an equipment (e.g. a seed drill for sowing on straw and on cover crops); 2) combining equipment to perform two tasks at the same time; 3) designing and building a new equipment (e.g. under-vine mowing tool for terraced vineyard). (iii) Finally, we identified 3 types of coupled innovations in vineyard. i) managing perennials on moderate to steep slopes (>30%), which is based on frequent tillage, using combinations of equipment (5 cases); ii) managing perennials on steep sloppy vineyards (30%) by covering the soil in inter-rows and employing moderate tillage under vine, which involves shared equipment and/or workforce (2 cases); and iii) weed management in terraced vineyards (30-40%) while limiting erosion and mitigating the challenges associated with working on steep slopes, through the use of self-built and shared equipment (2 cases). Our findings enrich the literature on coupled innovation in weed management strategies (Boulestreau et al., 2022), and it provides evidence on how these systemic innovations work to address technical and organizational issues, which allowed winegrowers to manage weeds and cover crops in situations considered as strongly dependent on glyphosate in "dead-ends" situations. The perspective of innovations identified is their environmental, social and economical evaluations. The sustainability validation of these practical solutions would then inspire other winegrowers engaged in the redesign of their vineyard system to be free from glyphosate.

POSTER COMMUNICATION

ReGenWine: A transdisciplinary project to assess concepts in regenerative viticulture

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Keywords: regenerative viticulture, soil health, vine performance, circular economy, sustainability

ABSTRACT

Regenerative agriculture is a set of agricultural practices that focus on improving the health of the soil, increasing biodiversity, and enhancing ecosystem services. It is essentially farming in harmony with nature rather than against it. Regenerative agriculture is still a relatively new concept, but it is gaining traction as farmers and consumers alike become more interested in sustainable food production. The ReGenWine project will test the concept of regenerative agriculture in vineyards, building on a pre-trial that was instigated in 2022 on a commercial farm in the Western Cape, South Africa. A 3.69-hectare vineyard block with Merlot and Shiraz grapes, situated on Hartenberg (GPS coordinates: -33.893392° 18.795124°) will be used for the trial. The pre-trial tested the viability of grazing Dexter cattle on a mixed inter-row crop with and without fertiliser, comparing this to zero cattle and zero fertiliser. Expanding on the pre-trial, the project goals are to (i) assess the impact of regenerative agriculture on soil health, soil function, vine health and performance, wine quality, and the economic viability compared to conventional vineyard management practices; (ii) develop a comprehensive understanding of how regenerative practices can contribute to a circular economy within vineyards; and (iii) identify future regenerative practices that can be tested and adopted in the wine industry. The study is being conducted over three seasons and include five work streams: Soil systems; Animal Systems; Grapevine to Wine Systems; and Economic and material circularity analysis. This project is in all aspects practical in nature, dealing with the comprehensive evaluation of an alternative production system to evaluate the possible benefits to the environment, the producer, the maintenance of product quality, while pursuing avenues towards sustainability and circularity. Given the scarcity of quantitative data regarding regenerative viticulture in South Africa, the project will break new ground and deliver new information relevant to scientists, and producers. The project will also deliver workflows and potential guidelines in terms of the adoption of regenerative farming practices for grape and wine producers.

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POSTER COMMUNICATION

Microbial consortia as a tool for sustainable vineyard management: A study on their acceptance among Veneto region's grape-growers

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Keywords: sustainable viticulture, technology acceptance model, theory of planned behaviour, microbial consortia

ABSTRACT

In recent years, sustainability has become a key focus in agriculture, including viticulture. A major challenge is managing abiotic and biotic stresses, which requires adopting sustainable management models to combat climate change, threatening food security for billions. It also aims to address the declining health of the environment and biodiversity, further weakening agricultural systems.

Future prospects are concerning. Studies confirm that rising temperatures will cause earlier phenological phases in viticulture and increase the risk of water deficits, even with unchanged rainfall, due to higher transpiration. These stresses will reduce product quality and may jeopardize the sustainability of viticulture, especially in regions with traditional varieties more sensitive to climatic and biotic stresses (Alikadic et al., 2019; Bonfante et al., 2018). Therefore, to cope with climate change and increasing stresses, adopting novel sustainable crop protection techniques is essential to support plants and enhance viticulture resilience (Chitarra et al., 2015; Sandrini et al., 2023).

In this context, harnessing the potential of microbes to enhance crop health, resilience, and safety offers a promising solution to address climate change and ensure future food production and quality. Plant-associated microorganisms have shown great potential in helping plants cope with harsh conditions, improving agriculture's capacity to adapt to climate change. Symbiotic microorganisms organized in microbial consortia present a viable agroecological crops protection (ACP) strategy for modern agriculture, enhancing crop health and resilience without compromising quality (Marco et al., 2022; Sandrini et al., 2022).

Microbial consortia could be particularly effective in viticulture. These communities enhance plants' resilience to various stresses, ensuring i) stable yields and high grape quality, ii) reduced plant protection costs, and iii) minimized negative impacts of traditional methods on human and environmental health Sandrini et al., 2022).

From a legislative perspective, the use of microbial communities as a sustainable approach aligns with the objectives of the European Commission's Green Deal and the New Common Agricultural Policy (CAP), which aims to reduce pesticide use in the future. Additionally, the use of microbial consortia for biotic stress control is encouraged at both the community and Italian levels. Their importance and acceptance are reinforced by EU Directive 128/2009/EC and the Italian Legislative Decree n°150 of 14th August 2012, which support the adoption of sustainable alternative techniques like microbial communities to reduce reliance on traditional plant protection products, while also providing economic savings for farmers.

Despite technical studies demonstrating the positive impact of microbial communities on plant resistance and reduced chemical inputs, the success of these products largely depends on farmers' acceptance and adoption. While data on sustainable practices among farmers is limited, it is believed that wineries' sustainability levels are still insufficient and need improvement (Cullen et al., 2013; Golicic, 2021). In the literature, several demographic and socioeconomic factors have been suggested as reasons for the low adoption (Lefebvre et al., 2015; Parsa et al., 2014; Rossi et al., 2019; Zeweld et al., 2017), with studies highlighting that if the costs of innovation outweigh commercial benefits, adoption becomes economically unfeasible (Cullen et al., 2013). However, few studies have explored the role of socio-psychological factors. As a result, there is still a need for further research to understand why and how farmers adopt new technologies and sustainable practices (Yazdanpanah et al., 2014; Zeweld et al., 2017).

POSTER COMMUNICATION

Plant biostimulants in combination treatments as environmentally-friendly rest-breaking agents for dormancy release in table grapes *Vitis vinifera* Crimson Seedless

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Keywords: *Vitis vinifera*, Crimson Seedless, bud break, single-node cuttings, plant biostimulant

ABSTRACT

Context and purpose of the study. Vitis vinifera grapevine is a perennial crop which is globally cultivated, surviving cold winters in temperate zones by entering a state of dormancy. In spring, bud dormancy is released by increasing day lengths and warmer temperatures. Rapid, even bud break is vital to ensure optimal crop yield and carry out effective management practices. Hydrogen cyanamide (HC) is commonly applied to ensure optimal and uniform bud break. Due to the toxicity of HC, alternative environmentally-friendly treatments are sought by the South African Table Grape industry (SATI). This project aims to combine candidate biochemical agents (e.g., nitric oxide donors) with plant biostimulants (Lumichrome, BC204, SNH and PBXH) to enhance bud break in eco-dormant buds.

Material and methods. V. vinifera Crimson Seedless plant material from the 9-year-old CS block (Ramsey rootstock) at Windmeul Farm, Hoekstra Fruit, Paarl, Western Cape, South Africa was used to generate single node cuttings for forced bud break assays in the glasshouse. Combining the selected plant biostimulants with a number of biochemical agents e.g. nitric oxide donors were tested. A small-scale field trial was started on the 6 September 2022, during which the effect the two biostimulants SNH and PBXH were evaluated against HC.

Results. The molecular mode of action of HC has been well studied over the last 20 years. Several models detailing mode-of-action exist in the literature. HC inhibits catalase and induces hypoxia, activating a complex molecular cascade within bud tissues. The levels of reactive oxygen species (ROS) increase significantly, carbon flux is modulated, and phytohormone levels change. These events lead to the activation of transcription factors associated with growth resumption and cell expansion. Candidate biochemical agents (e.g., nitric oxide donors) provided useful and effective in combination with selected plant biostimulants (SNH and PBXH) in enhancing onset and final bud break % in Crimson Seedless. Further work is needed to consolidate and re-confirm these findings.

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POSTER COMMUNICATION

Ground *vs* trellis in rootstock cane production fields

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Keywords: rootstock, American species, trellis system, nursery production

ABSTRACT

Context and purpose of the study. The vine nursery sector is undergoing a transformation to meet growing environmental and sanitary demands. Several studies have highlighted the contamination risks associated with the agronomic management of rootstock cane production fields, since rootstock canes frequently show higher levels of pathogenic fungi than scion material.

A major factor that can contribute to contamination is the cultivation method of rootstocks, which in Spain and other dry climate countries traditionally involves growing plants without any trellis or supporting structure. This method requires annual pruning of head stocks close to the old wood and leaving the canes developing directly on the ground. Such practices are problematic, as aggressive pruning wounds provide entry points for pathogens, while having the vegetation at ground level promotes a humid microclimate that can facilitate the proliferation of fungal species. Moreover, from the management point of view, this cultivation method hinders the use of terrestrial vehicles for antifungal treatments, as traffic is impeded by canes growing in the inter-rows.

In wetter climates, nurseries have adopted alternative cultivation methods, transitioning from flat ground systems to vertical or horizontal trellis systems. These trellised systems aim to minimize soil-surface pathogen contamination while enhancing the quality of rootstock material. Some research suggests that these systems may yield larger quantities of good quality straight cuttings than from vines allowed to spread along the ground, though there is a lack of research in dry environments. This study aims to assess the agronomic performance and viability of three vertical trellis systems on cane production fields of 140 Ruggeri and 110 Richter rootstocks.

Material and methods. Three vertical trellis systems; elevated crown, alternate crown, and vertical axis, were implemented in two rootstock mother fields (110 Richter and 140 Ruggeri) in a commercial rootstock mother vineyard owned and managed by the Vitis Navarra nursery in Soria, Spain (41°41’31”N - 3°15’36”W, elevation: 965 m). The pruning weight was measured during the first consecutive seasons of trellis formation (2023-2024). And, a two-way analysis of variance (ANOVA; $P < 0.05$) was used to evaluate the effects of the factors (trellis system and rootstock) and their interactions on the variable measured, when the F value was significant ($P \leq 0.05$), a Tukey’s honest significance difference (HSD) test was executed.

Results. The trellis system did not affect cane production in terms of pruning weight, though there was a consistent trend in both rootstocks, the elevated crown system showing slightly higher pruning weights, followed by the alternate crown and vertical axis systems. These results are subject to validation in the following seasons and to be analysed from an operational point of view in order to determine the suitability of each system for its implementation at the nursery level.

POSTER COMMUNICATION

Investigation of the biostimulant activity of naringenin on anthocyanins biosynthesis: from an explanatory transcriptomic approach on Gamay callus towards a future vineyard application

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Keywords: *Vitis vinifera*, Gamay callus, phenolic ripeness, naringenin, climate change

ABSTRACT

Context and purpose of the study. Anthocyanins are essential phenolic compounds in red wine, contributing significantly to colour intensity, stability, and sensory quality. However, these compounds are highly sensitive to environmental stresses, such as heatwaves and droughts exacerbated by climate change. Such conditions may disrupt the balance between technological and phenolic ripeness in grapes, leading to berries with excessive sugar levels but insufficient phenolic maturity at harvest. This study explores the potential of naringenin, a natural flavonoid and an intermediate in the anthocyanin biosynthesis pathway, to stimulate anthocyanin biosynthesis and improve phenolic maturity in Vitis vinifera L. cv Gamay cell cultures.

Material and methods. Callus cultures induced from the teinturier grape Gamay Fréaux, a variant of the white-fleshed cv Gamay that produces anthocyanin in its pulp, were employed as a simplified model to study phenolic compound biosynthesis. Three-week-old calli were treated by direct application of naringenin solutions at concentrations ranging from 0.1 mM to 1.5 mM. This approach was designed to mimic potential vineyard applications and assess dose-dependent effects. Three metrics were evaluated: i/ anthocyanin content to quantify naringenin's impact on anthocyanin accumulation; ii/ callus viability to ensure no toxicity at effective naringenin concentrations; iii/ transcriptomic non-targeted analysis (RNA-seq) to explore naringenin's effects on gene expression, particularly in polyphenolic pathways and stress responses.

Results. The experiments are currently in progress, with results expected soon. Complementary analyses of anthocyanin content and callus viability will help identify the optimal treatment dose, striking a balance between maximizing anthocyanin accumulation and ensuring plant cell tolerance. Additionally, transcriptomic analyses will provide insights into gene expression changes induced by naringenin, identifying upregulated and downregulated genes. These findings contribute to a larger-scale project aimed at developing sustainable vineyard practices to resynchronize grape technological and phenolic ripening, thereby mitigating climate change impacts. Vineyard applications will also be conducted using citrus peel extracts obtained through subcritical water treatment, as these preparations are known to contain high levels of naringenin.

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POSTER COMMUNICATION

The impact of grazing by cattle on *Vitis vinifera* L. cv. Shiraz vegetative growth and metabolite profile

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Keywords: regenerative, viticulture, livestock integration, Shiraz, Stellenbosch

ABSTRACT

Context and purpose of the study. Globally, vineyard cultivation uses conventional methods to manage pests, diseases and increase yield. This cultivation practice requires the use of synthetic agrochemicals and mechanisation which results in deterioration of the soil health, biodiversity and ecosystem functioning. Over the past decade there has been an increasing demand from the consumer to know more about the origin of the product. Therefore, the use of greener methods (organic, biodynamic and regenerative practices) became a topic of interest. Regenerative viticulture integrates livestock grazing, which is based on the principals of Allan Savory's holistic management system, to enhance soil microbiology, carbon sequestration, and biodiversity. The purpose of this study was to study the effects of cattle grazing on grapevine vegetative growth, fruit quality and wine chemistry in Vitis vinifera L. cv Shiraz.

Materials and Methods. This study was conducted in the 2023-2024 growing season in a 1.13-hectare vineyard established in 1998. Shiraz clone (SH9C) grafted on 101-14 Mgt rootstock trained on a vertical shoot positioning (VSP) system vineyard with a drip system during critical phenological stages. A control – ungrazed vineyard rows and a treatment - grazed rows by Nguni and Dexter cattle breeds during August 2023. The grazing density for this vineyard was 64 cattle. Shoot lengths were determined at pea size (E-L 31), véraison (E-L 35), and ripeness (E-L 38). Individual berry weights and diameters were determined from 50 berries one week before harvest and at harvest. Bunch weights were recorded at harvest. The amino acids and tannin of the grape must and the final wine were determined. Statistica 19.0.0 were used to analyse the data statically.

Results. A significant ($p \leq 0.001$) reduction in the shoot lengths and berry weights were observed in the grazed vineyard rows compared to the control. The phenological stage and sampling stage did not have an influence in the shoot lengths and berry weights. Arginine and Gamma-aminobutyric acid (GABA) concentrations were higher in the ungrazed vineyard rows. The Hydroxy-proline concentration in the final wine were higher in the grazed vineyard rows. Higher tannin concentration in the juice and the final wine were observed in the grazed vineyard rows. Overall, while grazing decreased yield likely due to an increased nitrogen content, it appears to enhance grape quality, particularly in amino acids and tannin concentration benefiting wine qualitative properties.

POSTER COMMUNICATION

Under-row low competitive herbaceous cover: A sustainable alternative to herbicide in vineyards

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Keywords: cover crops, seedings, herbicides alternatives, weed management, sustainable vine row management

ABSTRACT

Weeds are undesirable plants in agroecosystems as they compete with the crop for essential resources such as light, water and nutrients, compromising the final yield and its quality. Herbicides remain the primary method of weed control in many vineyards worldwide due to their efficacy, economic feasibility, and ease of application. However, rising concerns about herbicide resistance, environmental impacts, health risks, biodiversity loss, stricter regulations, and the increasing adoption of organic farming are posing significant challenges to herbicide-dependent weed management. Winegrowers seek for alternatives that control weeds, and preserve yields, promotesoil health, and minimize costs and management efforts.

A preliminary field study on cover crops mixtures in Changins (Nyon, VD, Switzerland) resulted in the development of the "NoGlyphos" seed mixture. This mixture includes three low-height, low-competitive species: Medicago lupulina, Bromus tectorum and Arenaria serpyllifolia. First observations from 2023-2024 season, carried out in an experimental vineyard, showed promising results for vine row management. These species grow in winter and dry out in spring, forming a natural mulch layer. This mulch effectively reduces weed growth and thereby minimizing competition for nitrogen and water. Additionally, it requires, only one mowing intervention before the harvest. These encouraging results led to the installation of the "NoGlyhphos" mixture in three experimental plots within a private vineyard in Yvorne (VD) during autumn 2024. Three treatments were tested: I) a standard mixture of "NoGlyphos", II) a "NoGlyphos" mixture composed by Swiss ecotypes and III) a "NoGlyphos" mixture composed by Swiss ecotypes with twice the seed density. These treatments were compared with under-row herbicide control. Plant composition alongside with vine water potential, nitrogen uptake, vigour and yield were assessed.

Preliminary results show promising outcomes, leading to financial support from the Canton of Vaud to encourage winegrowers to use the "NoGlyhphos" mixture in their vineyards. Collaborations with winegrowers from different cantons will allow us to test and then adapt this mixture to different pedoclimatic conditions. By reducing weed pressure while promoting biodiversity, soil health and enhancing vineyard sustainability, the "NoGlyphos" mixture provides a practical, cost-effective, and environmentally friendly alternative to herbicide use.

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POSTER COMMUNICATION

Post-plant nematicides: too little, too late for Northern root-knot nematode management

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Keywords: nematicides, Northern root-knot nematode, integrated pest management

ABSTRACT

Context and Purpose. Management of plant-parasitic nematodes in perennial cropping systems such as wines grapes is challenging. Yet, management of these pests remains important, as some vector pathogens, while others inflict direct damage on a grapevine's root system. The study presented here evaluated different post-planting nematicide treatments in own-rooted Vitis vinifera vineyards, for their ability to reduce densities of Northern Root-knot nematode (RKN, Meloidogyne hapla). This information can be used by grape growers and crop consultants to better understand whether chemical options can play a role in long-term nematode management, or if cultural practices (use of resistant rootstocks or suppressive cover crops) are more appropriate in nematode-affected vineyards.

Materials and Methods. The products evaluated were: fluazaindolizine, fluensulfone, fluopyram, fosthiazate, and spirotetramat. Nematicides were evaluated under different application regimes (spring, summer, fall, or a combination therein), at 3 different commercial vineyards in eastern Washington State. Evaluations were conducted for 2-3 consecutive years (depending on site), between 2015-2020. Not all sites received the same treatments, but all included untreated controls. Products were applied following manufacturer's suggested rates using the drip-cup method to simulate chemigation. Treatments were applied to 9 to 20 consecutive in-row vines, replicated 4 times. Soil densities of RKN 2nd stage juveniles (J2) were determined prior to treatment, and again after treatment each year. Phytotoxicity was rated.

Results. Of the post-plant nematicides evaluated, fluazaindolizine was the only product that had sustained reductions in RKN J2 soil densities after multiple years of treatment. This reduction, however, was only after treatment 3X within a season, and at rates that now exceed label suggestions. Evaluations of fluopyram stopped after 2 years of use, due to phytotoxicity. This phytotoxicity mimicked exposure to auxin herbicides, as seen in other studies on fluopyram. Ultimately, this study showed that routine use of post-plant nematicides for the control of RKN is not the best approach for management. This means the primary focus should be on the adoption of resistant or tolerant rootstocks, and practices that either directly control nematodes (suppressive cover crops) or promote ecological diversity that may reduce RKN densities through direct resource competition or parasitism.

POSTER COMMUNICATION

Soil mineral nitrogen dynamics in cover-cropped irrigated vineyards with contrasting soil textures

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Keywords: alleyways, ammonium, ground vegetation, nitrate, nutrient cycling, undervine

ABSTRACT

Context and purpose of the study. Cover cropping in vineyards supports grape yield, quality, and soil health. This study examined alleyway and undervine cover crops' effects on soil mineral nitrogen (N) at 0-30 cm over three years in two organic vineyards with different soil textures in the Okanagan Valley, British Columbia (BC), Canada.

Material and methods. Superior cover crop species were selected through prior screening. Two organic vineyards in Oliver (loamy sand soil; S1) and West Kelowna (sandy loam soil; S2), BC, seeded to three cover crop mixtures in alleyways and undervine areas in 2021, with annual species reseeded in 2022. Undervine crops included Ladino white clover, winter lentil, and ryegrass + birdsfoot trefoil, while alley treatments included ryegrass + tillage radish + white clover, fescue + white clover, and fall rye + hairy vetch. Soil samples (0-15 cm and 15-30 cm) were collected every fall (2020-2022) and analysed for KCl extractable NH_4^+-N and NO_3^--N using a LECO 628 CHN analyser, with data processed using repeated measures in JMP v.18.

Results. NH_4^+-N and NO_3^--N concentrations were significantly higher in fine- than coarse-textured soils. End-of-season NH_4^+-N ranged from 0.08–8.96 mg kg^{-1} (S1) and 0.30–13.1 mg kg^{-1} (S2), while NO_3^--N ranged from 1.73–9.82 mg kg^{-1} (S1) and 2.30–19.04 mg kg^{-1} (S2). In S1, NH_4^+-N levels in undervine areas at both depths were significantly influenced by interactions between undervine and alley cover crops. At 0–15 cm, winter lentil with ryegrass + tillage radish + white clover produced the highest NH_4^+-N, while at 15–30 cm, Ladino white clover with fescue + white clover had the highest levels. NH_4^+-N peaked in 2020, with similar levels in 2021 and 2022. In S1, NO_3^--N in undervine areas showed significant interactions between year, undervine cover crops, and alley cover crops, with 2022 levels exceeding those in 2021 and 2020. Treatments with Ladino white clover produced the highest NO_3^--N, while winter lentil resulted in the lowest. In S2, cover crops had no significant impact on NH_4^+-N or NO_3^--N, except in 2022, when ryegrass + tillage radish + white clover increased NO_3^--N at 15–30 cm in alleys. Overall, finer soils had higher mineral N concentrations, with Ladino white clover enhancing NO_3^--N for vine nutrition and winter lentil reducing NO_3^--N to manage vine vigour.

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POSTER COMMUNICATION

Perceptions of livestock integration in South African vineyards

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Keywords: livestock integration, nature-based strategies, regenerative, sustainable, viticulture

ABSTRACT

Context and purpose of the study. Conventional viticulture relies heavily on synthetic inputs (fertilizers, pesticides), as well as mechanization to manage pests, weeds, and diseases and maximize yields. While these methods increase productivity and profitability, it resulted in biodiversity loss, soil erosion, pollution, and health risks for the workers. Growing awareness of these challenges, along with consumer demand, has driven a shift toward more sustainable practices such as organic, biodynamic, and regenerative methods. Regenerative viticulture aims to enhance soil health and restore degraded soils through nature-based strategies. Livestock integration is a key practice within regenerative viticulture. To date there are no empirical studies on the integration of livestock in South African vineyards. This qualitative study explored the perceptions and motivations of producers who employ livestock integration in South African vineyards.

Materials and methods. A qualitative research approach was followed conducting interviews with five commercial producers in Stellenbosch who integrate livestock in their vineyards. A semi-structured interview guide was compiled comprising questions of viticultural- and soil characteristics, livestock choice, social impact, economic considerations and biodiversity and ecosystem health. Ethical approval was obtained from the Social, Behavioural, and Education Research Committee at Stellenbosch University (FESCAGRI-2024-29396) prior to the commencement of the study.

Results. The study found that integrating livestock into vineyards supports regenerative, nature-based viticultural strategies by enhancing soil health, microbial activity, biodiversity, and reducing the need for synthetic fertilizers, herbicides, and mechanical mowing. Participants observed increased soil carbon, organic matter, and earthworm abundance, with longer-term livestock integration yielding more pronounced benefits. Cost savings on fertilizers and herbicides, as well as marketing advantages, were significant, with consumers and workers responding positively to the presence of animals. Challenges included the need for year-round livestock management and additional grazing areas during dry seasons, but participants unanimously recommended livestock integration as a sustainable and effective practice for vineyard owners.

POSTER COMMUNICATION

Redwine project: increasing microalgae biomass feedstock by valorising wine gaseous and liquid residues

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Keywords: CO_2, wine effluents, *Chlorella vulgaris*, vineyards, wine

ABSTRACT

Global warming due to greenhouse gases (GHG) has become a serious worldwide concern. The new EU Green Deal aims to achieve GHG emissions reduction by at least 55% by 2030 and a climate neutral EU economy by 2050. The deal strongly encourages GHG reducing measures at local, national and European levels. The REDWine project will demonstrate the technical, economic and environmental feasibility of reducing by, at least, 31% of the CO2 eq. emissions produced in the winery industry value chain by utilizing biogenic fermentation CO2 for microalgae biomass production.

REDWine project, funded by BBI-JU, has a Living Lab where it will be captured 2 ton of fermentation off-gas/year (90% of total CO2 produced in the fermenter) and 28 m3 of liquid effluent (100% of the liquid effluent generated during fermenter washing) to produce 1 ton (dry weight) of Chlorella biomass/year. This biomass is then processed under a downstream extraction process to obtain added-value extracts and applied in food, cosmetic and agricultural end-products and to generate a new EcoWine. REDWine is focused on the recovery of off-gas from a 20.000L fermenter of red wine production existing in Adega Cooperativa de Palmela (ACP, located in Palmela, Portugal).

REDWine's microalgae were tested since 2022 with 4 purposes in vineyard, improve flowering stages, contribute to high temperature resistance, biofungicide against downy mildew and increasing in nitrogen content in ripening to help fermentation and improve aromatic compoundsand, and 2 on winemaking, clarificant or anti-oxidant. New trials need to be done, but so far results have showned a light activity on raw algae. Next steps will lead us to use extracts where some literature have interesting results.

The project has already developed food solutions with Chlorella Vulgaris and it's expected to have its first cosmetics prototypes by march 2025.

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POSTER COMMUNICATION

Evaluation of field inoculation of *Kocuria rhizophila* and *Streptomyces violaceoruber* as biostimulants under water availability conditions in grapevines

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Keywords: growth-promoting rhizobacteria, *Kocuria rhizophila*, *Streptomyces violaceoruber*, drought, physicochemical properties, enzymatic activity

ABSTRACT

Agricultural productivity must promote management systems that incorporate sustainability principles, and viticulture is no exception. In this regard, several studies have shown that certain symbiotic microorganisms can enhance plant development and growth. Growth-promoting rhizobacteria (PGPR) are soil bacteria that stimulate vegetative growth and improve stress resistance. The aim of this experiment was to assess the effects of the growth-promoting rhizobacteria Kocuria rhizophila and Streptomyces violaceoruber under irrigation and drought conditions on Merlot grapevine development, physiology, physicochemical properties and enzymatic activity (urease, phosphatase, and β-glucosidase) of the rhizospheric soil. The planting was designed in blocks with a total of 30 plants per treatment (Control, Kocuria, and Streptomyces) grafted onto R110 and SO4 rootstocks. The drought treatment was based on the application of 40% of the water requirements applied in a single irrigation dose per week. For inoculation, the roots were immersed in bacterial suspensions (1x107 CFU/ml for Kocuria and 1x106 CFU/ml for Streptomyces) for 60 minutes. The control plants were treated with plain water. At the time of planting, the inoculation was reinforced by watering each plant with 500 ml of bacterial suspensions at same concentration. At different sampling times (flowering, ripening, and harvest), growth measurements (maximum height) and gas exchange parameters were taken using a portable gas exchange system. The analysis of the physicochemical parameters of the soil were analyzed by the Eurofins Agro-Environmental Laboratory. To study the enzymatic activity, the methodology described in ISO 20130:2020 was used, based on the measurement of colorimetric substrates in micro-well plates. During flowering, the bacterial treatment showed a slight increase in photosynthesis in drought-stressed plants compared to the control, while under irrigation conditions, there were significant differences between Kocuria and Streptomyces. In the subsequent sampling times, it is the irrigation treatment that shows significant differences. During the harvest period, maximum height growth showed significant differences in the irrigation treatment, with irrigated plants exhibiting greater height. In contrast, during the ripening phase, significant interactions were found between irrigation and R110 rootstock. The principal component analysis of the physicochemical properties didn't show significant differences between treatments. In enzymatic activity, urease was higher under drought conditions during flowering. At harvest, significance was observed in the bacterial treatment, with Kocuria exhibiting higher activity than Streptomyces. These results suggest that Kocuria performs better than Streptomyces as a biofertilizer in vineyards and highlight the importance of considering factors in the field such as root colonization and competition with other microorganisms.

ACKNOWLEDGMENTS

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POSTER COMMUNICATION

Modulating the phyllosphere microbiome in grapevine using plant biostimulants to enhance protection against biotic and abiotic stress

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Keywords: grapevine, microbiome, *Botrytis*, drought, plant biostimulants

ABSTRACT

Context and purpose of the study. Climate change scenarios predict ever increasing frequency of drought events and coupled with disease outbreaks poses survival risks to perennial fruit crops such as grapevine. The combination of drought and disease is becoming more widely studied in grapevine research. The use of plant biostimulants is a promising approach as these naturally occurring compounds are non-toxic and are believed to be able to modify the leaf microbiome leading to enhanced plant health and immunity. The motivation of this study is to investigate if 1; plant biostimulants can alter the phyllosphere microbiome and 2; these changes result in enhanced plant health and immunity when challenged by the dual stressors of drought and Botrytis cinerea infection.

Material and methods. one-year-old potted grafted vines Cabernet Sauvignon in glasshouse conditions as a model testing system. The biostimulant solutions prepared was sprayed onto grapevine leaves Phyllosphere microbiome studies will involve using ARISA (automated method of ribosomal intergenic spacer analysis). Control and treated plants will be further divided into those experiencing water stress (due to withholding water) and those challenged with Botrytis cinerea inoculant. Botrytis cinerea will be tested with glycine betaine a major component of the biostimulant used.

Results. Botrytis cinerea grown on glycine betaine showed enhanced sporulation at higher concentrations. In general the glycine betaine had little effect in concentration ranges tested on the necrotrophy. Potted vines were tested using detached leaf disc assays and liquid culture assays for the effects of glycine betaine pre-treatment on grapevine response to infection. To date no difference in infection severity or progression is seen between the control and glycine betaine pre-treatment. ARISA analyses of grapevine leaves pre-treated with glycine betaine is being conducted for fungal and bacterial diversity. Plant biostimulant analyses are currently underway incorporating water deficit experiments and Botrytis cinerea challenge.

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POSTER COMMUNICATION

Sustainable agriculture and food innovation: preserving agrodiversity and advancing vineyard resilience in Madeira

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Keywords: Madeira wine, climatic change mitigation, biostimulants, sustainable weed management, water stress

ABSTRACT

The ISOPlexis - Center for Sustainable Agriculture and Food Technology, University of Madeira, is a research unit that develops activities in the fields of Sustainable Agriculture, Agri-food Technology and Bioeconomy, with focus on agrodiversity monitoring and phenotyping, and supporting the regional agriculture and agri-food sector development with the goal to reach local food production system sustainability and resilience. In this domain, ISOPlexis works with local vine growers, promoting the survey and phenotyping of local grape varieties and assessing grape growth conditions. Viticulture is considered a strategic production for Madeira Island, supporting the Madeira Wine brand. Grape varieties phenotyping is essential for identification of vegetative material used in the Madeira Wine winemaking and simultaneously to support the crop genetic resources maintenance and management. Grapes varieties allowed for Madeira wine production are limited to Sercial, Verdelho, Malvasia de São Jorge, Malvasia Cândida, Tinta Negra, Caracol, Terrantez, Boal, Bastardo and Listrão. Concerning the vineyard monitoring, the agroecological and climatic conditions were assessed on short-middle temporal series with the main goal to understand and anticipate climatic changes impacts in vineyard growth and productivity, specially related to the water shortages and temperature rise. A vineyard located in Quinta das Vinhas, Estreito da Calheta, has been used as a case study, because of its production of Boal and Verdelho. Edafo-climatic data, water content, drone imaging, phenology, and grape varieties productivity data were analyzed and discussed. Additional studies are underway to evaluate the use of agroecological strategies for sustainable weed management in vineyards, using holistic strategies to control the main adventitious plants showing competitive behavior, with the main goal of reducing or eliminating the use of synthetic herbicides in agricultural crops. The use of more appropriate tools to control weeds allows for more sustainable management of them, without causing damage to the main crop, the environment or the food chain, while promoting improvements in “soil health”. They comprise crop fertilization and irrigation, mechanical and physical weed management methods (tillage, mulching, solarization, mechanical weeding, directed flame application) and vermicompost application.

POSTER COMMUNICATION

Can plant shaking reduce the incidence of *Botrytis*?

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Keywords: latent infection, Aqua-Hort, Solaris, chitosan

ABSTRACT

Wine production is expanding in Scandinavia with a focus on organic growing, and Solaris becoming the signature grape of the region. However, despite the robustness of Solaris, methods for reduction of disease pressures are still needed. A new project has been initiated in Denmark on disease control in organic growing. The main focus is on Botrytis cinerea the cause of bunch rot, the disease creating most challenges when growing Solaris. Three different methods are tested. 1) Shaking the plants with a portal harvester shortly after fruit set, to remove flower debris being a nutrient source that facilitates early stages of infection. 2) Spraying after flowering with the chitosan-based product 'Botryless' (Lallemand). 3) Spray treatments with 'AquaHort', providing micro-doses of copper. For the shaking method net bags were placed on 60 clusters prior to shaking and the amount of tissues shaken off (ovaries, anthers, caps) was quantified and B. cinerea growth from the flower parts was studied on potato dextrose agar (PDA) plates. From two different shaking intensities an average of 30 and 47mg flower parts/cluster was removed by shaking. Sclerotia (resting structures of the pathogen) was produced after 8 weeks of culture in 41 out of 60 petri dishes. Later – at pea size – latent infections of B. cinerea were investigated. Surface sterilized berries were cut in half and placed cut-side up on PDA. Based on morphological assessment, two B. cinerea infected fruits were found in the control and non from the shaking treatment. In addition, growth of Alternaria, Cladosporium and Fusarium species was identified, but also several unidentified fungal species developed. Further identification will be made based on ITS sequencing, but the initial results indicate a reduced level of latent infections. Shortly before harvest incidence of botrytis was scored based on a 12-level scale (1% - 90%) showing a clear reduction by shaking and by 'AquaHort', while only a tendency to fewer clusters with high levels of infection (>50%) was found in the 'Botryless' treatment. Finally, the effect of 'AquaHort' on the level of leaf necroses (hyperreactions to downy mildew attacks) was assessed shortly after harvest. The percentage necrotic tissue was assessed on the upper 30-40 cm of the canopy on all shoos on every 10th plant in 4 treated rows and 4 untreated (100 plants/row). The average disease score was significantly reduced from 10,6% in the control to 3,8 % necroses for 'AquaHort'.

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POSTER COMMUNICATION

High levels of copper and persistent synthetic pesticides in vineyard soils

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Keywords: pesticide persistence, soil copper contamination, viticulture management, soil health risks, microbial impact

ABSTRACT

Downy mildew (Plasmopara viticola), powdery mildew (Erysiphe necator) and bunch rot (Botrytis cinerea) are the most prevalent fungal diseases in viticulture. To protect grapevines from these diseases both synthetic chemical and organic plant protection products (PPPs) are applied, with treatment frequencies ranging from 7 to 20 times per season depending on plant protection strategy (conventional or organic). This widespread use of PPPs raises concerns about their impact on soil health. Until now a systematic and detailed assessment of pesticides and copper residues in vineyard soils is missing. In this study, we analyzed soil samples from 62 Swiss vineyards for 146 synthetic pesticides and copper. Up to 60 pesticides were detected per vineyard and almost 13 times higher sum concentrations were found under conventional compared to organic management. Additionally, long-term (>20 years) organically managed vineyards, where no synthetic pesticides are used, were found to have up to 32 different synthetic pesticides. Consequently, various pesticides had a much higher persistence in soil than expected based on reported degradation rates, indicating that risk assessment procedures by governmental agencies need further consideration. Contrary to popular belief, soil copper content was found to be comparable across both organic and conventional management strategies. A literature-based risk assessment revealed that the pesticide and copper concentrations in vineyard soils frequently reached levels considered potentially harmful to soil organisms. Initial analyses on the effects on the soil microbial community are underway. Our study demonstrates that pesticide and copper contamination in viticultural soils is high compared to other land uses. According to the risk assessment, this poses a potential threat to soil organisms that should be targeted in research and policy making.

POSTER COMMUNICATION

Linking soil C cycling and microbial diversity under regenerative management in Northern California (USA) vineyards

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Keywords: vineyard, soil management, regenerative agriculture, carbon cycling, microbial diversity

ABSTRACT

Regenerative agriculture (RA) practices aim to minimize soil disturbance, keep soil covered, maintain living roots underground, and integrate livestock to improve soil health and sustainability. Inputs from animals and living roots increase carbon (C) cycling and the associated microbial activities, which can promote C sequestration in soil. Studies have shown that RA practices, such as cover cropping, no-till, and sheep-grazing, can increase C stock and microbial diversity. Grapevine (Vitis vinifera L.) cultivation has been suggested to have a greater overall potential to store soil C than annual crops due to the vine's deep-reaching roots and C exudation. Worldwide, vineyards occupy an extensive range of soil types with distinct subsoil mineralogy and physiochemical properties that may lead to significant variability in the potential of C stabilization and accrual in the subsoil depths. Despite the promising outcomes of RA practices on soil C and microbial diversity, the role of microbial communities in C sequestration, particularly in subsoil layers, is poorly understood. In a field trial, we surveyed the vertical distribution of indicators of C pools, microbial activity, and diversity before applying tillage and grazing treatments in three Northern California (USA) vineyards. After the use of RA practices for two years, we examined the short-term effects of no-till and grazing practices on soil C dynamics at different soil depths (0-15 cm, 15-30 cm, 30-60 cm, and 60-100 cm) in one of the vineyards. Further, we investigated how soil microbial communities and soil C pools shift across subsoil layers by characterizing bacterial and fungal taxonomic composition and diversity across the four soil depths. We performed 16S and ITS amplicon sequencing to measure bacterial and fungal taxonomic abundance and alpha and beta diversities, respectively. Microbial community composition, diversity, and enzymatic activity are expected to correspond to changes in C dynamics at deeper soil depths. We expect the C pool and microbial diversity indicators to reflect trends along the vertical soil profile under various RA practices. Our long-term goal is to provide insights into how RA practices affect the linkages among microbial communities, soil C dynamics, and soil properties in California vineyards, which will help growers make management decisions to improve crop productivity and resiliency while coping with the challenges of climate change.

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POSTER COMMUNICATION

Can different green manure fertilizations affect the vine balance and grape quality? First evidence of multi-year study

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Keywords: green manure, fertilization, grape quality

ABSTRACT

In the context of sustainable viticulture that implements organic practices to maintain soil fertility, green manuring plays a crucial role due to its ability to stock carbon and nitrogen in soil while supporting biodiversity. Green manure alone is not sufficient to restock the nutrients removed with harvested grapes. Over time, this can lead to a depletion of available K in the soil and a tendency towards an imbalance in the vegetative and productive parameters of the vineyard. To assess the recovery of removed elements and the enhancement of vineyard fertility, we conducted a comparative analysis of various fertilization strategies in a Pinot blanc vineyard (clone LB18, pergola trentina trellis system).

The treatments included unfertilized green manure (GM), GM fertilized with digestate from anaerobic digestion of cattle manure (GMD), compost from digestate obtained from anaerobic digestion of OFMSW (GMC) and with mineral fertilizer (GMM). Input was standardized at 72 units of N ha^{-1}. The cover crop biomass was sampled at mowing, and C, N, P, K, and Mg, as well as the dry matter production, were analyzed. At grape's technological maturity yield, average bunches weight, composition of the berries (C, N, P, K, Mg) and musts (Brix, pH, total acidity, YAN, etc.) were determined. In late autumn, pruning wood weight was measured. The biomass analysis of the cover crop revealed that the GMM had significantly higher values for dry matter, C, N, P, and K. The C/N was significantly greater in the GMD. No significant differences were observed among the treatments in terms of yield, average weight of bunches and pruning wood, and Ravaz index. The analysis of the berries revealed the higher K content in the GMM, while no significant differences were found for C, N, P and Mg. The chemical parameters of the musts did not reveal any significant differences. In the year of fertilization, the results show that K is the distinguishing element among treatments, both in the cover crop and in the berries. The K input in mineral form is partially incorporated into the cover crop's biomass and transferred to the berries. This result suggests a balance between the cover crop's absorption and the vine's nutritional requirements. In addition to the parameters mentioned, the dynamics of soil and leaf elements, and wine quality have also been analyzed. The ongoing multi-year study will provide further insights into the medium-long term effects of fertilization.

POSTER COMMUNICATION

Grassland and patch scale diversity in supporting avian diversity and potential ecosystem services

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Keywords: birds, landscape metrics, viticulture, ecosystem services, insectivores

ABSTRACT

The composition and structure of vineyard landscapes significantly affect bird communities and the ecosystem services they provide in agriculture. In vineyards, insectivorous birds can help control insect pests, offering a valuable service. However, fruit- and seed-eating birds may cause crop losses by damaging or consuming grapes, with the impact varying by season. We conducted avian point counts and landscape analysis on 40 vineyard plots in the German wine regions of Rhinehesse and Rheingau in 2020 and 2021. We test the hypothesis that a heterogeneous viticultural landscape supports a diverse bird community rich in ecosystem services during both the breeding and non-breeding seasons, thus supporting viticultural efforts. For all response variables, our models showed better explanatory power and model fit at the patch and local scale (100 and 250 m) than at the landscape scale (500 m). Grassland and Shannon Diversity Index emerged as consistent positive predictors of species richness and diversity, while arable land had negative effects, particularly at patch scale. The Shannon Diversity Index consistently emerged as a critical positive driver of insectivore communities, highlighting the importance of landscape heterogeneity. Conversely, farmland had negative effects on species richness and diversity for insectivorous birds across seasons. Our results suggest that maintaining grasslands and promoting landscape heterogeneity are essential for supporting diverse avian communities in vineyard ecosystems, which have the potential to provide critical ecosystem services to winegrowers.

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POSTER COMMUNICATION

First application of an original methodology created to overcome conflicts between stakeholders in an important wine-growing territory: methodology, results, and perspectives in the application of sustainability EME4.1C

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Keywords: University of Venice, University of Padua, Conegliano Campus 5.1C, Interconnected Integral Global Sustainability EME4.1C and EME5.1C, Diocese, Pope Francis, Laudato Sì, Fratelli tutti

ABSTRACT

Context and purpose of the study. Considering the previous research and activities, also, on Sustainability EME4.1C which, as widely known, considers in a harmonious chain all the factors material, immaterial, moral and spiritual related to all aspects environmental, economic, social, existential, relational, ethical, technical and "MetaEthic" indexed 4.1C and 5.1C of the Great Chain Meta Ethic 4.1C of the EcoMetaEthic Algorithm4.1C or AlgorMetaEthical4.1C of the Conegliano Campus 5.1C exposed in Italy and abroad (Cargnello G, 1991÷2024; Carbonneau A. and Cargnello G, 2012÷2023; Cargnello G. and Zironi R., 2015, 2017, Boatto V., Cargnello G., Galletto L., Scaggiante S., Zironi R., Bosso A., Barisan L., Teo G., Battistella A., Dal Bianco A., 2017; Boatto V., Cargnello G., Galletto L., Scaggiante S., Bolzanella C., Zironi R., Velasco R., Bosso A., Barisan L., Teo G., 2018; Cargnello G., Ferretti C. e Perini L. 2021; Carbonneau A., Cargnello G., Torregrosa L., Ojeda H., Teo G. 2021; Cargnello G., Forest don A. e Carbonneau A. 2021; Carbonneau A. 2023; Cargnello G. e Forest don A., 2024), those exposed in the works proposed to this GiESCO 2025 (Cargnello G,, Giacomini C., Passador F., Sartor C., Teo G.; Cargnello and Coll.) and, in particular, those conducted in Lazio since 2011, (Giovanni Cargnello, Alain Carbonneau, Roberto Zironi), who, while going further, valorize the encyclicals Laudato Si and Fratelli tutti. In the territory of Prosecco DOCG, Prosecco DOC and DOCG Colli di Conegliano there has long been a lack of sharing and conflict between vine and wine producers and citizens, associations of environmental movements and with other associations in the territory. It was therefore conceived in 2017 by the corresponding author and a permanent table was then established in 2019 based on research and activities on Sustainability EME4.1C which considers in a harmonious chain all the material, immaterial, moral and spiritual factors related to all environmental, economic, social, existential, relational, ethical, technical and "MetaEthical" aspects of the Great Chain MetaEthical 4.1C of the Algorithm EcoMetaEthical 4.1C or AlgorMetaEthical4.1C of the Conegliano Campus 5.1C which also valorize the encyclicals Laudato Si and Fratelli tutti. This application was created thanks to the important contribution given by Don Andrea Forest, the Bishop's Delegate, with the activation of the "Dialogue Table" and the "Sustainability Coordination 4.1C" of this Diocese and by Pr. Paolo Cescon of the Ca Foscari University of Venice and subsequently also by Pr. Paolo Sambo of the University of Padua.

Materials and methods. In the territory of Prosecco DOCG, Prosecco DOC and DOCG Vini dei Colli di Conegliano to overcome the lack of sharing and conflict between Stakeholders, these, the Stakeholders were invited to a dialogue table not by the world of science or by the local administrations but by the religious authority to arrive not at a compromise but at a new opinion shared between them. Subsequently, this opinion was submitted to the judgment of researchers indicated independently of the stakeholders reported above so that we could move, as we did, from a shared opinion among stakeholders to a scientifically shared opinion fundamental for planning the next coordinated activities between them. Activities aimed at increasing scientific knowledge, culture, general and applied training from childhood to university, information, as well as creating demonstration activities in the territory, communication, marketing on sustainability by applying the model of "Sustainability EcoMetaEthical 4.1C".

Results. The activity carried out has already contributed and it appears that it will contribute even more in the future: 1. to increase the culture and universal basic and applied scientific knowledge, 2. to eliminate conflict between the various stakeholders, 3. to find in dialogue Sustainable EcoMetaEthical 5.1C-4.1C solutions, 4. to apply and have these Sustainable EcoMetaEthical

5.1C-4.1C solutions applied in relation to the planned next activities that concern the two sectors developed in these six years to which is added the continuation Ad Maiora 5.1C of the activities of the Conegliano Campus 5.1C planned and activated in 1996 which will receive a decisive boost and completion with regard to scientific activities, training from childhood to University, information, communication, marketing and the valorisation of the activities, productions and products of EME4.1C, 5, to avoid doing like other do, 6. to the reduction of bureaucracy, 7. to increase: 1. the preference for EME4.1C productions, 2. business profit, 3. collaborations between the bearers of knowledge, of MetaEthical 5.1C-4.1C material, immaterial, spiritual and moral interests considering that this activity is expanding elsewhere.

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POSTER COMMUNICATION

Spiders in vineyards show varying effects of inter-row management and the surrounding landscape

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Keywords: canopy spiders, ground spiders, landscape, hedgerows, cover crops

ABSTRACT

In vineyards, management and the surrounding landscape can have different effects on spiders. In temperate regions management (organic vs. conventional) may have less strong effects than for other crops. Nevertheless, spiders can benefit from a more natural landscape surrounding the vineyards. To investigate effects on spiders in vineyards beyond the general management regime, we conducted a study in 32 organically managed vineyards with different landscape configuration (vineyards adjacent to hedgerows vs. surrounded by other vineyards). Additionally, in one half of all vineyards the inter-rows were sown with a species-rich cover crop mixture and in the other half were left to spontaneous vegetation. The spider community was assessed by sampling canopy-dwelling spiders with beat-sheets and ground-dwelling spiders with pitfall traps.

Spider communities, analysed at the family level, showed significant differences between the canopy and ground stratum. The overall abundance of spiders in both strata was neither effected by the inter-row vegetation nor by the surrounding landscape. The diversity of spider families in the canopy was positively influenced by adjacent hedgerows. However, spider families responded differently to hedgerows; for example, we found more Araneidae in vineyards without adjacent hedgerows.

The ground-dwelling community was dominated by a single species (Pardosa agrestis) and no effects on the species diversity were found. Still, species also showed different reactions, for example Zodarion italicum benefitted from spontaneous vegetation. These results show that the impact of inter-row vegetation management and hedgerows on spiders in vineyards is variable and sometimes unexpected.

POSTER COMMUNICATION

Cover crops sown in the inter-rows shape the weed communities in three vineyards across Italy

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Keywords: biodiversity, cover crops, ecosystem services, functional traits, Agritech project

ABSTRACT

The use of cover crops (CCs) is widely proposed as an alternative to traditional soil management in vineyards to exploit a wide range of ecosystem services. The presence of a CC in the inter-row space is known to control spontaneous vegetation in vineyards, primarily through the biomass of the sown crop, which competes with other spontaneous species for soil resources. However, knowledge about how CCs shape vineyard weed communities remains limited. Understanding the traits associated with plant communities in different inter-row managements allows to understand the best practices to mitigate the disservices caused by these communities (such as competitive species) while promoting biodiversity.

Three different CCs (Vicia faba L., Secale cereale L., and a mix of both) were sown in autumn 2023 and compared with a tilled control. Each treatments were applied in both the vineyard inter-rows in a completely randomized design, with plots of 10–12 vines each. This experimental design was replicated in three Italian regions: Friuli Venezia Giulia (north), Tuscany (center), and Apulia (south). The CCs were terminated between April and May. At termination, the weed community composition was assessed by measuring the dry biomass of each species in two quadrats of 0.25 m² per plot. Inter-row vegetation biodiversity was assessed again at the end of the growing season through visual cover estimation of each species within the quadrats. Each species was associated with various functional traits (e.g., including family, height, and root apparatus type) which were retrieved by functional trait databases such as LEDA.

The spring and autumn surveys revealed distinct effects of the soil management treatments on the weed plant communities. The communities established alongside the CCs in spring were directly influenced by competition with the cover crops, while those that developed in late summer were affected by both soil management and CC termination. The weed community composition varied largely by geographical location. Vineyards in the region of Apulia displayed different weed compositions compared to those in Tuscany and Friuli Venezia Giulia. CC soil management showed the ability to modify functional traits of the weed communities in different locations, although some effects were consistent across all locations. These results suggest the potential to shape weed community traits through CC practices across varying vineyard environments.

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POSTER COMMUNICATION

Fungal communites diversity and functional roles of different types of *Botrytis cinerea* infected grape berries on different growing sites

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Keywords: noble rot, *Botrytis cinerea*, *Vitis vinifera*, fungal cocommunity, site specificity

ABSTRACT

Botrytis cinerea, an Ascomycota pathogen with a broad host range, infects over 1200 plant species. Grapes infected by this pathogen, which subsequently develop a noble rot, remain in the vineyard for an extended period, thus being exposed to a diverse array of physical, chemical and biological factors, which give rise to a complex microbial community. During this protracted period, a diverse array of fungi and bacteria can colonise the grapes, originating from various sources within the plant, the soil, or particles transported by wind. However, the grapes infected by Botrytis cinerea provide a unique environment that allows these microbes to modify their physiological processes. The objective of this study was to identify the characteristics of fungal communities associated with noble rot and grey rot grapes in different growing sites. In this study, we obtained ITS2-based DNA amplicon sequences from healthy, noble rot and grey rot berries in three different vineyards in the Tokaj wine region, using the cultivar Furmint. We then studied the fungal microbiome of the collected samples and identified the site based on its community. It has been established that the two types of berries are typically found in the same vineyard and even in the same cluster. It is well documented that both types of rot develop from healthy berries following the influence of a Botrytis cinerea infection. However, fundamental physical and chemical differences have been observed between the two types, suggesting that this may have an impact on the composition of the fungal community that develops on them. The two types of rot result in different berry structures, and it was hypothesised that the fungal community differs between the two types. The findings revealed significant differences in richness and beta-diversity of fungi, as well as in the dominant genera. The divergence between the mycobiomes of the plantations was found to be comparable to that observed between the berry types. The present studies have illuminated the potential role of the fungal community in defining the noble rot berry, which also suggests an emerging function of the mycobiome. However, this may also serve as a basis for many further studies and may help to inform experimental developments targeting biocontrol agents or for oenology applications.

POSTER COMMUNICATION

Influence of plant growth regulators and water deficit on cv. Krissy table grape

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Keywords: table grape quality, plant growth regulators (PGRs), deficit irrigation

ABSTRACT

Context and purpose of the study. The quality of table grape clusters significantly affects consumer perception and market value, with berry size, texture, color, and overall appearance playing key roles. In warmer climates, poor color development in red grapes is a recurring challenge, reducing production efficiency. This coloration is largely determined by anthocyanins, the pigments that give grapes their blue, purple, and red hues. To enhance color and other quality characteristics, plant growth regulators (PGRs) are often employed to promote anthocyanin accumulation during ripening.

Material and methods. This study, conducted over the 2022 and 2023 growing seasons, examined the effects of abscisic acid (ABA) and ethephon (ETH)—applied individually and in combination (ABA + ETH)—on 'Krissy' table grapes under both water deficit (SDI) and non-deficit conditions. Data on stem water potential, gas exchange, berry ripening, yield, and berry quality at harvest were collected to assess treatment effects.

Results. Results indicated significant differences in stem water potential between water deficit and non-deficit treatments. Specifically, ABA application under water deficit conditions produced distinct effects compared to non-deficit treatments. Total soluble solids (TSS) analysis in late July showed statistically significant differences among treatments. While the 2022 season's initial harvest revealed no significant yield differences across treatments, the second harvest indicated significant differences, notably between ETH under water deficit and ABA + ETH under non-deficit conditions. For the 2023 season, however, production weight was not significantly affected by any treatments.

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POSTER COMMUNICATION

WHEY protein hydrolysates enhance grapevine resilience to abiotic and biotic stresses

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Keywords: grapevine, biostimulant, protein hydrolysate, abiotic stress, biotic stress

ABSTRACT

Context and purpose of the study. The growing need for sustainable solutions in viticulture has led to increased interest in biostimulants that can enhance plant resilience to both abiotic and biotic stresses. This study investigates the effects of whey protein hydrolysates (PHs), derived from dairy industry by-products, as biostimulants in Vitis vinifera. The goal was to assess their potential in improving plant tolerance to heat and drought stress, as well as their role in mitigating pathogen infections.

Material and methods. Heat stress experiments were conducted on potted grapevines subjected to 40°C without irrigation, with plants treated with either water or PHs. Physiological parameters such as photosynthesis, stomatal conductance, sub-stomatal CO_2 concentration and leaf water potential were monitored. In addition, the expression of key stress-related and photosynthesis-related genes was analyzed. For biotic stress, the efficacy of PHs in reducing Plasmopara viticola and Botrytis cinerea infection was assessed via sporulation assays, zoospore germination and growth inhibition assays as well as berry inoculation tests.

Results. PH-treated plants exhibited a faster recovery of photosynthetic activity and maintained normal sub-stomatal CO_2 concentration during heat stress. Expression of heat stress-responsive genes (HSP101, HSFA2) was significantly higher in PHs-treated plants. Also, PHs treatment alleviated decreases in expression of photosynthesis-related genes (LHCA3, RbcS) during heat stress. Moreover, whey PHs significantly improved grapevine drought tolerance, as indicated by higher leaf water potential values and higher expression of drought-responsive genes (NCED1, TIP2;1) compared to water-treated controls. Additionally, PHs demonstrated a direct toxic effect on P. viticola, inhibiting zoospore germination and reducing sporulation on leaf discs. Finally, PHs displayed a curative effect on B. cinerea, significantly reducing mycelial growth in vitro and infection in berries when applied 24 hours after infection. Whey protein hydrolysates serve as effective biostimulants, enhancing grapevine resilience to drought and heat stress while providing protection against fungal pathogens. This dual benefit underscores their potential as sustainable alternatives to chemical inputs in viticulture.

POSTER COMMUNICATION

Impact of Ecklonia maxima seaweed extract on the vegetative, reproductive and microbiome in *Vitis vinifera* L. cv Cabernet-Sauvignon

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Keywords: biostimulants, Ecklonia maxima, vegetative, reproductive, microbiome

ABSTRACT

Context and purpose of the study. Climate change is a major challenge in wine production. It results in erratic weather conditions which may lead to a reduction in grape yield and the subsequent grape and wine quality. Fungal disease pressures also increase because of the prevailing weather conditions. Conventional grape production relies heavily on the use of synthetic and agrochemicals and fertilisers to ensure sustained growth, yields and disease management. The application of these products poses negative impacts on human health and environment. This necessitates the move towards agricultural sustainability. Biostimulants are considered environmentally friendly and cost-effective alternatives to synthetic fertilisers and crop protection products. Seaweed extracts are the most defined non-microbial biostimulants use on commercial crops in literature. Several studies investigated the use of Ascophyllum nodosum (L.) Le Jolis. Although, positive effects were reported on the use of this specie little is known on the impact of an indigenous seaweed specie int he Cape South Coast - Ecklonia maxima specie as a mitigation strategy to abiotic stress.

Material and methods.

Site selection. An 18-year-old Vitis vinifera L.cv. Cabernet Sauvignon clone 339C grafted on 101-14 Mgt vines planted with 2.5 m x 2 m row and vine spacing and trained on a Vertical Shoot Positioning (VSP)/ 3-wire trellis system during the 2021-2022 season. The site was subjected to drip irrigation with drippers spaced at 1 m, delivering an average of 2.3 L/ha. A random block design, with two factors: Ecklonia maxima (EM) Kelpak® foliar application and water status scenario (non-irrigated and irrigated). The experimental site consisted of 120 vines, allocated to 40 mini-experimental plots (consisting of 3 vines each) which were randomly assigned throughout the vineyard.

Leaf surface area, classical parameters and grapevine yield.

Leaf area was determined at three phenological stages: véraison (E-L 35), mid-ripening (E-L 37) and post-harvest (E-L 39) using image acquisition techniques as described by Glozer (2008). MATLAB (The MathWorks, Inc., Natick, Massachusetts, United States) was used for individual image segmentation and ImageJ (Rasband, W.S., ImageJ, U. S. National Institutes of Health, Bethesda, Maryland, USA) was used to calculate the area of each leave in cm². Classical parameters (sugars, pH and titratable acidity-TA) were measured on a weekly basis from véraison until harvest. During dormancy, canes were counted, pruned and the weight measured.

Microbiome – Leaf and berry

Leaves and berries were collected at pea-size (E-L 31), véraison (E-L 35) and harvest (E-L 38) for each treatment between the morning and afternoon sun sides. Three biological replicates were sampled per vine for the leaf microbiome. Three berries were sampled from the top, middle and bottom of bunches from both morning and afternoon sun sides per vine/per treatment. Leaf and berry samples were washed with 100 mL phosphate-buffered saline (PBS) isotonic solution under gentle agitation for one hour and the wash solution containing microbial biomass was stored at -20°C until DNA extraction.

DNA Extractions & Bacterial and fungal rRNA amplicon sequencing

The ZymoBiomics DNA miniprep kit (Zymo Research, United States) was used for extraction of total genomic DNA (Papageorgiou, 2023). For the bacterial community 16S sequencing, the V2-V9 hypervariable regions, were amplified and sequenced, while for the fungal community the ITS1-5.8S rRNA gene region, was targeted. Briefly, the DNA quality was assessed with spectrophotometry to ensure an abundance ratio of 260/280 between 1.8 and 2.0 and 260/230 ratio above 1.0. For the fungi, the universal primers ITS1F (5'-CTTGGTCATTTAGAGGAAGTAA-3') and ITS2 (5'-GCTGCGTTCTTCATCGATGC–3') were used to amplify the ITS1 region.

Results. Leaf area consistently increased when treated with Ecklonia maxima from E-L 25 to E-L 41. No significant differences were seen between the treatments. Berry mass was positively influenced by the Ecklonia maxima and water regime applied. Sugar content was significantly ($p \leq 0,05$) higher in the Ecklonia maxima treated grapevines.

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No significant differences were observed in the pH and TA at harvest.

Ecklonia maxima applications increased the abundance of Staphylococcus, Lactobacillus and Alloiococcus on the leaves, berries and must, which inhibit pathogens and exhibit biocontrol properties. The presence of Lactobacillus was favouarable for the completion of malolactic fermentation and clarification of the wine. Mycotoxin producing bacteria, Penicillium and Alternaria, were more prevalent in non-irrigated berries and grape must, however, were reduced in EM-treated samples. Botrytis and Erysiphe are harmful grapevine pathogens that were diminished on the Ecklonia maxima sprayed leaves and berries.

POSTER COMMUNICATION

Developing effective physiological strategies to rejuvenate virus-infected vineyards by lowering the virus load in infected grapevines

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Keywords: girdling, leafroll, phenolics, phloem, virus

ABSTRACT

Context and purpose of the study. The wine industries face significant challenges from two highly detrimental viruses: leafroll and red blotch. These viruses pose a serious threat to grape production on a global scale, and currently, there are no effective treatment options available. The most reliable method for managing this issue is to remove infected vines and replace them with certified stock that has been thoroughly tested for virus contamination. This study evaluates phloem girdling as a strategy to reduce virus load in leafroll-infected grapevines, aiming to enhance their health and productivity.

Material and methods. Girdling involves making precise cuts in the phloem. It was performed on canes before veraison, targeting specific regions between the proximal and distal clusters of healthy and infected mature Cabernet Sauvignon vines trained onto the VSP system. Commercial laboratories employing molecular techniques measured the virus concentration and various metabolites in the healthy and infected vines before and after girdling.

Results. The vines responded favorably to this approach, creating calluses that sealed the incisions. A compelling outcome of this process was observed in the leaves above the girdled areas, which displayed a striking red color due to anthocyanin accumulation caused by sugars being trapped in the leaves. This reddening is distinctly different from the typical symptoms of leafroll infection, where the entire leaf turns red while areas near the main veins remain green, creating a recognizable visual effect. Furthermore, the study revealed a substantial reduction in virus load within the girdled canes as compared to ungirdled ones. Additionally, it assessed various vital primary metabolites, including sugars, organic acids, and nitrogen compounds, as well as secondary metabolites such as flavanols (tannins), flavonols, and anthocyanins, all crucial for high-quality winemaking. Remarkably, the levels of these metabolites showed minimal variation between clusters of girdled and ungirdled shoots, indicating that girdling does not negatively impact the overall health of the vines. In summary, this study clearly demonstrates that phloem girdling, when consistently applied over multiple growing seasons, can effectively reduce virus loads in infected grapevines. This method provides a new way to deal with viral infections in vineyards and helps restore the health and productivity of the grapevines.

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POSTER COMMUNICATION

Understanding the onset of systemic infection of red blotch virus and phenotypic studies of grapevines expressing a red blotch virus infectious clone

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Keywords: callose, chloroplast, plasmodesmata, sieve tubes, tylosis

ABSTRACT

Context and purpose of the study. Red Blotch disease, an affliction caused by the Grapevine red blotch-associated virus (GRBaV), represents a formidable challenge for grape growers and winemakers in prominent viticultural regions around the world. A critical aspect of understanding this disease lies in examining how viruses, including GRBaV, interact intimately with cellular components and produce distinctive, often anomalous structures following infection. This study embarked on a detailed investigation of symptom expression, vine physiology, fruit quality, and the ultrastructural characteristics of various tissues in Pinot Noir and Merlot, employing advanced microscopy techniques to unveil the intricate relationship between cytopathological changes and GRBaV infection.

Materials and methods. During the growing season, vine samples were collected from vineyards with a history of Red Blotch (Pinot Noir and Merlot). Shoots were sampled for microscopy analysis to determine the structure of xylem and phloem. At harvest, fruits were sampled to compare primary and secondary metabolites between healthy and infected vines.

Results. The infected vines displayed typical red blotches on their leaves, characterized by pinkish-red veins, without the leaf margins curling at the onset of ripening. These vines developed clusters of "hens and chickens" and showed changes in seed morphology. In contrast, healthy seeds were pyriform in shape with a distinct beak. The infection significantly affected both the primary and secondary metabolites essential for wine production. Since the development and ripening of berries post-veraison depend on phloem influx, the altered metabolism suggests a disruption in the phloem pathway. Additionally, the browning process associated with periderm formation was disrupted in the infected canes. However, during the cold acclimation process, the infected green stems turned brown as expected. Although the infected vines retained their primary leaf anatomical organization, the chloroplasts underwent considerable ultrastructural changes. These changes ranged from complete disassembly of the chloroplasts to a significant accumulation of starch, development of plastoglobuli, and the presence of tannins within the cytoplasm. These findings highlight the importance of structural integrity in maintaining the normal metabolism of grapevines, offering new insights for developing innovative management strategies for Red Blotch disease.

POSTER COMMUNICATION

Effect of ozone application for low-input postharvest dehydration of wine grapes

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Keywords: grape, postharvest dehydration, ozone, metabolomics, transcriptomics

ABSTRACT

The postharvest dehydration of grapes is a traditional practice to obtain wines with unique traits (e.g., sweet, dry/reinforced). The modern dehydrating rooms are equipped with systems for artificially controlling the inside environment parameters to obtain the desired dehydration kinetic and preserve the grapes from grey mold infection. However, the conditioning systems are extremely energy-demanding and the identification of practical solutions effectively controlling/reducing the postharvest decay would lower the operational costs. To this end, we explored the potential of ozone-based treatments on harvested grapes and preliminarily tested if the treatment could impact the normal behavior and metabolism/composition of grapes during the traditional dehydration practice. Harvested cv. Corvina and Sangiovese grapes were treated with ozone (ozonated water or gas at different concentrations) and partially dehydrated in a dedicated room under controlled temperature and humidity conditions. Technological, metabolomic, and transcriptomic analyses were performed on berry samples collected at different times during the post-treatment dehydration.

Weak differences regarding the dehydration kinetics and the main technological parameter dynamics were detected between treated and untreated grapes. Analyses of phenolic compound content of the cv. Sangiovese berries revealed that the treatment with the gas resulted in higher levels of phenolic acids, flavanols, flavonols and flavanones after 7 days of dehydration. Phenolic acids and stilbenes were higher in ozonated berries at the final stages (40 and 54 days) of the process. The ozone treatment induced only limited changes in the phenol compound profiles of the cv. Corvina berries. In both cultivars, the treatment modified the amino-acid pool of the berries. The transcriptomic analysis revealed that stress-response genes, including those coding for peroxidases, phytosulfokines, and pathogenesis-related proteins, were slightly upregulated shortly after exposure to the higher ozone concentration. Subsequently, modulation of transcripts related to secondary metabolism was weakly detectable.

Overall, the results will shed light on grape physiological response to ozone during the postharvest dehydration process. Sanitizing grapes using ozone will significantly increase their capacity to withstand higher temperature and humidity conditions, reducing spoilage and production losses.

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POSTER COMMUNICATION

ABA and ethephon alleviated to a different extent the impact of elevated temperatures on grape berry composition

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Keywords: ABA, ethephon, anthocyanins, amino acids, climate change

ABSTRACT

The Intergovernmental Panel on Climate Change (IPCC) forecasts an increase in global temperature and a decrease in relative humidity (RH) in the coming decades, which may have implications for berry ripening and composition. The objective of this study was to evaluate the use of two phytoregulators, abscisic acid (ABA) and ethephon (an ethylene releasing compound), to counteract the negative effects of increased temperature on the accumulation of anthocyanins in grapes. Grapevine fruit-bearing cuttings of Tempranillo (TE) and Cabernet sauvignon (CS) were grown from fruit set in two greenhouses under two temperature/RH regimes: 24 °C / 14 °C and 55% / 70% RH, day/night (T) and 28 °C / 18 °C and 43% / 58% RH (T+4), simulating the changes expected for 2100. Just before the onset of veraison the bunches of plants from both temperature/RH regimes were sprayed with ABA (400 mg L-1), ethephon (480 mg L-1), and distilled water (control). The application was repeated 7 days after the first application. T+4 conditions reduced the must acidity and the concentration of berry skin anthocyanins, increasing the proportion of malvidin, in both TE and CS. The concentration of total amino acids tended to increase under T+4 compared with T in both varieties. ABA was more effective than ethephon as a mitigation compound, increasing the concentration of anthocyanins in both TE and CS and alleviating the decrease induced by T+4. Ethephon reduced must acidity in both varieties and regardless of the temperature/RH regime. In CS, ethephon also decreased the concentration of total amino acids, but increased aromatic precursor amino acids. In conclusion, the application of ABA alleviated the negative effects of elevated temperature on anthocyanins. Ethephon was less effective than ABA, even negatively affecting must acidity.

POSTER COMMUNICATION

Shift of Nitrogen Resources by biotic interaction in grapevine

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Keywords: water stress, grapevine phylloxera, synergetic stress effects

ABSTRACT

Grape phylloxera (Daktulosphaira vitifoliae Fitch), a monophagous pest of the grapevine, induces nodosities on the roots through its sap-sucking activity. Nitrogen status is one of the most important components for plant performance and biological processes. Previous studies on phylloxera and sap-feeding have shown altered nutrient flow in the plant and enhanced accumulation in the nodosities. Additionally, the carbon and nitrogen uptakes are correlated with water availability.We studied the sink-source relationships between different plant organs under biotic (phylloxeration) and a short drought stress was studied in 72 Pinot noir/5BB plants under semi-controlled field conditions. Leaves, healthy root tips, nodosities and phylloxera aphids were sampled from each category before, during, and after the drought stress and analysed through mass spectrometry for their δ13C ratio, nitrogen and carbon concentration as percentage of their dry weight.

The phylloxeration, which was not a significant factor without the drought, significantly reduced the nitrogen content in the leaves during water stress. The healthy root tips were affected by drought only in phylloxerated plants: an exchange of behaviour between the belowground organs was observed. The well-watered individuals accumulated nitrogen in their healthy roots, but not in the nodosities. Reversely, the drought-stressed individuals decreased the nitrogen of their healthy root tips and accumulated it in the nodosities instead. The sink strength of the nodosities is enhanced under water stress. Additionally, the roots of non-phylloxerated plants showed a significantly better recovery potential in terms of nitrogen accumulation compared to phylloxerated plants. The abiotic stress appeared to be an enabling factor for phylloxeration and conversely. Generally, the non-phylloxerated plants developed more biomass than phylloxerated plants, specifically in the roots.

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POSTER COMMUNICATION

Optimizing vine pruning of Pinot noir and Müller-Thurgau after extreme hail damage

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Keywords: viticulture, hail, vines recovery, economic losses, pruning techniques

ABSTRACT

Hail damage can have a major impact on the vine's physiological growth (defoliation, wood and cane damage) and can lead to significant yield and economic losses. Economic losses may extend into subsequent years, depending on the damage sustained and the vine's ability to recover. With the expected increase in extreme weather events due to climate change, the frequency and severity of hail damage—and associated financial repercussions—are likely to rise. Effective solutions must be found to minimize economic losses and enable the vine to recover quickly. Pruning is known to play a key role for vine's recovery when damage to shoots is severe. Cordon pruning is recommended over guyot pruning, as it eliminates the risk of cane breakage and can enhance yield potential. However, the success of cordon pruning also depends on the varietal fertility of the buds.

This study, conducted between 2021 and 2024, investigates the effects of different pruning techniques following two severe hail events in Wädenswil, Switzerland (21.6 and 24.7.2021) which caused extensive damage to vines. This trial focuses on Müller-Thurgau and Pinot Noir varieties and evaluates the short-term (2022, the year after the hail event) and long-term (2023-2024 normal years) impacts of these techniques on vine recovery. One pruning variant focuses on "simple guyot" with one cane of seven to ten buds. Another variant called "double guyot" uses two canes with five to seven buds each. Two cordon variants with three or four buds per spur were implemented. Budburst fertility, yield, grape quality, and associated labor costs were measured. Labor time per vine encompasses pruning, trellising, debudding, and harvesting, providing insights into cost-per-hectare calculations. Grape quality is evaluated for must parameters as: sugar content [Oe], PH, total acidity [g/L], wine and apple acid [g/L], formol nitrogen, and yeast-assimilable nitrogen [mg/L].

It is hypothesized that increasing the number of buds (cordon variants) should increase yield in the year following hail damage (2022). However, this is expected to reduce sugar content [Oe] and nitrogen levels [mg/L]. We expect that differences in labor costs have the greatest impact in the year following the hail event. This work aligns with previous research indicating the importance of adaptive pruning strategies for vine recovery after a hail damage, particularly for low-fertility varieties such as Müller Thurgau and Pinot Noir.

POSTER COMMUNICATION

Can grapevine intra-varietal genetic variability be a tool for climate change adaptation? A case study at a hot and dry environment

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Keywords: *Vitis* stomatal conductance, carbon-13 isotope, clones, climate change, genetic variability

ABSTRACT

Climate change projections point to an increase of temperatures and changes in rainfall patterns in the mediterranean region. Grapevine is affected by extreme events, which are likely to change water-availability conditions. It is imperative, when managing future plantations, to select plant material with increased abiotic stress tolerance. It is believed that intra-varietal genetic differences can grant advantages when dealing with these events.

This study aimed to evaluate how different genotypes influence the responses to the environment. Plants of the varieties Tempranillo (TE) (8 clones), Baga (BA) (7 clones), Tinto Cão (TC) (9 clones), Touriga Nacional (TN) (5 clones) and Touriga Franca (TF) (6 clones), planted at a commercial vineyard (Montemor-o-Novo, Portugal), were monitored during the 2023 growing season. From each plant, stomatal conductance (gs) and thermal imagery measurements were performed. The difference between air and canopy temperatures (ΔT), the Crop Water Stress Index (CWSI) and the Jones Index (Ig) were calculated from the thermal and meteorological data. The carbon isotopic signatures (δ13C) were measured in leaves at veraison and in the berry juice at full maturation stage.

The results showed a differentiation between the clones. TE and BA were the varieties that showed the higher variability regarding gs. In BA, the more pronounced differences were found in the thermal indices. It was observed a tight inverse correlation between the gs values and the δ13C in the berry juice, which indicates a higher water use efficiency, a tendency also observed in TC. For all the varieties, gs was better correlated with the δ13C measured in the berry pulp, indicating that WUE can be specifically assessed during the berry formation period. In TE and BA, the clones that presented higher stomatal conductance levels also presented lower ΔT values. The gs of TF and TE presented stronger correlations with the carbon isotopic signatures, while on the other varieties, the gs correlated better with the thermal indices. TN was the variety that showed the lower intra-varietal plasticity. On the other hand, TF showed a relatively high variability of gs. These differences are also corroborated by the thermal indices.

This work shows the importance of considering the intra-varietal genetic variability when managing future plantations, and can be used with the inter-varietal variability, to overcome the negative effects of climate change.

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POSTER COMMUNICATION

Modelling leaf water potential from physiological and meteorological variables – A machine learning approach

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Keywords: water status indicators, modelling, predawn leaf water potential, remote sensing, climate change

ABSTRACT

Viticulture is a key economic sector in the mediterranean region. However, climate change is affecting global viticulture, increasing the frequency of heatwaves and drought events. Precision irrigation, supported by robust water status indicators (WSIs), is inevitable in most of the Mediterranean basin, and imperative when finding strategies to adapt to climate change phenomena. One of the most reliable WSIs is the leaf water potential (Ψleaf), which is determined via an intrusive and time-consuming method. The aim of this work was to evaluate which of the two Ψ methods (predawn water potential [Ψpd] and stem water potential [Ψstem]) better reflect the plants' water status and identify the variables with better performance when predicting Ψleaf. Finally, model the Ψ selected.

Five varieties grown in the Alentejo region (Reguengos de Monsaraz, Portugal) were selected according to their described aniso/isohydric behavior: Syrah (Sy), Touriga Franca (TF), Vinhão (Vi), Touriga Nacional (TN) and Castelão (Cs), subjected to three long-term irrigation treatments: full irrigation (FI, 100% crop evapotranspiration), deficit irrigation (DI, 50% FI), and no irrigation (NI). Plant monitoring was performed in the 2023 season, over two weeks. Measurements included stomatal conductance (gs), Ψpd, Ψstem, thermal imaging, from which we calculated the difference between air and canopy temperatures (ΔT), the Crop Water Stress Index (CWSI) and the Jones index (Ig), and meteorological data. UAV flights with a multispectral and a thermal camera were also performed.

Ψpd and gs responded differently according to the irrigation treatment. Ψstem presented lower potential to discern between treatments, when compared to Ψpd. Mid-morning (MM) measurements presented the best correlations between WSIs. gs showed the best correlations between the other WSIs and was considered the best WSI to estimate Ψpd. Machine learning regression models were trained on meteorological, thermal and gs data to predict Ψpd. The model with the best performance was the ExtraTreesRegressor, with a coefficient of determination (R2) of 0.833 and a mean absolute error (MAE) of 0.072. UAV data also showed significant differences between treatments. Regression models were trained on the UAV data, and the best model was LinearRegression with a R2 of 0.751 and a MAE of 0.114.

We concluded that gs is an excellent WSI for estimating the Ψleaf, and the UAV data showed great potential for estimating Ψleaf.

POSTER COMMUNICATION

Responses of grapevine cells to physiological doses of ethanol, among which induced resistance to heat stress

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Keywords: cell cultures, ethanol, hormesis, RNA-seq, small heat shock proteins

ABSTRACT

Grapevine naturally endures stresses like heat, drought, and hypoxia. A recent study showed very low oxygen levels inside grape berries, linked to ethanol content. Other studies have established the link between ethanol and tolerance to various stresses: heat stress, drought, and high salinity. The causes of such a tolerance are not well understood. In our study, three-week-old Gamay calli, Vitis vinifera, were characterised for their endogenous oxygen levels and endogenous ethanol concentration. Subsequently, a transcriptomic study of these cells was conducted, 6 and 24 hours after treatment with 1 mM ethanol. After 6 hours, ethanol addition led to 386 differentially expressed genes, with a notable upregulation of genes related to heat response, especially small Heat Shock Proteins (sHSPs). Further experiments showed that ethanol priming in grape cells or in Arabidopsis seedlings reduced pigment and electrolyte leakage under heat stress, respectively. This study supports the idea that ethanol priming helps protect plants against heat stress, and provides a valuable RNA-seq dataset for further research into the underlying mechanisms of this adaptive response, with sHSPs likely playing a key role.

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POSTER COMMUNICATION

Physiological response to drought and heat stress in the leaves of table grape varieties

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Keywords: grapevine, table varieties, adaptability to climate change, abiotic stress

ABSTRACT

Increasingly pronounced climate changes, including prolonged drought periods, pose a significant challenge to the cultivation of table grape varieties. These varieties are particularly vulnerable to water shortages, which adversely affect their yield, market quality, and sustainability of table grape farming. To ensure long-term sustainability, it is essential to prioritize varieties with greater resistance to drought and high temperatures. In-depth studies of table grape responses to drought conditions provide critical insights into plant adaptive mechanisms, enabling the implementation of advanced cultivation techniques in drought-affected regions. Expanding knowledge of the physiological, chemical, and genetic responses of these varieties directs to more sustainable and resilient table grape production in the future. The physiological response to drought and heat stress in the leaves of table grape varieties was investigated. The study took place in 2024 at the University of J.J. Strossmayer in Osijek, viticulture experimental station Mandićevac, within a collection of table grape varieties. No differences among grape varieties were observed in the concentration of chlorophyll a, chlorophyll b, chlorophyll a+b, carotenoids, and total phenols. A significant difference ($p < 0.05$) was observed in proline concentration and ferric-reducing antioxidant power (FRAP). The highest proline concentration was observed in the “Sindikat” variety, while the lowest was identified in “Sonja”. However, the significantly highest FRAP was determined in the “Sonja” variety, while the lowest activity was in “Suzi”. Regardless the cultivar Sonja is not prone to accumulate free proline, considered one of the key regulators of osmotic potential in drought stress conditions, the elevated antioxidant activity indicates that other physiological mechanisms, such as increased phenol synthesis, may be involved in defence against high temperatures and drought.

POSTER COMMUNICATION

A multidisciplinary approach to assess the impact of future drought scenarios on vineyard ecosystems

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Keywords: drought stress, vineyard ecosystem, plant species composition, soil quality, soil microbiota

ABSTRACT

Drought events can strongly affect grapevine and berry physiology and subsequent wine quality, as widely demonstrated in controlled experiments. However, the potential impacts of summer drought on the whole vineyard ecosystem, combining vegetation, soil and its microbiota, remains poorly explored, especially in cooler climate regions.

To fill this gap, we set up a multidisciplinary drought simulation experiment in a Chasselas vineyard in Yvorne (Switzerland). Four rainout shelters were installed to prevent natural rainfall in April 2024. Under these shelters, the experimental plots were subjected to three different water supply regimes: 1) a control regime representing the 20-year average local rainfall; 2) a high-water stress regime, based on RCP 8.5 climate projections for 2085; 3) an extreme water stress regime, with water supply reduced to 50% of the 2085 projections. Additionally, an external control was setup for each replicate.

Vine physiology (such as water potential, photosynthesis, δ13C, vigour, fertility, yield), berry composition (organic acids, sugars, amino acids), wine quality, plant species composition, soil properties and soil microbial diversity were monitored throughout the 2024 growing season. These measurements will be repeated in 2025 and 2026. Below and aboveground temperature and humidity are continuously recorded at various heights and depths.

Preliminary results from the first year revealed that the extreme water stress regime reduced vine fertility, berry weight, yield and most assimilable nitrogen by one-third compared to the control treatments. Water stress also altered soil cover composition. In the drought-induced plots, soil cover predominantly consisted of mulch and plant species composition shifted towards more drought-resistant species.

Altogether, this study will deepen our understanding of summer drought impacts on vineyard ecosystems and provide further insights into the interactions between soil, vegetation and vines under different water conditions. This study will also contribute to develop innovative vineyard management practices better suited to future climatic conditions.

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POSTER COMMUNICATION

The drought, the temperature, and the time: drivers of osmotic adjustment?

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Keywords: Grapevine, Pinot noir, drought, osmotic adjustment, osmoregulation

ABSTRACT

Context and purpose of the study – Leaf osmotic adjustment (i.e., active accumulation of osmolytes in the cells) has been reported in grapevines in response to drought and as a natural process throughout the growing season (seasonal osmotic adjustment). However, the seasonal progression and associated temperature changes were not separately considered in previous studies. Therefore, we investigated the capacity of Pinot noir leaves to modulate their osmotic potential in response to (i) time (seasonal osmoregulation), (ii) growing temperatures, and (iii) drought events. Additionally, we analyzed the contribution of key compounds acting as osmolytes (e.g., sugars and cations).

Material and methods – Trials were conducted under semi-controlled field conditions and in greenhouse chambers set to three distinct temperature regimes: cool (20/15 °C), warm (25/20 °C), and hot (30/25 °C) day/night conditions. Potted Vitis vinifera plants, cultivar Pinot Noir grafted onto SO4, were subjected to two water treatments for at least 30 days: well-watered (WW) and water deficit (WD). Leaf osmotic adjustment was assessed using an osmometer, while sugars and cations were quantified through ion chromatography (HPIC).

Results – Seasonal osmoregulation was observed throughout the growing season, with osmotic potential at full turgor decreasing by an average of -0.30 MPa in 70 days. Temperatures affected the intensity of osmotic potential at full turgor but not its seasonal trend. Surprisingly, osmoregulation wasn't triggered by the lower water potentials in WD vines. The absence of osmotic adjustment in response to drought observed in this cultivar suggests Vitis genotypes exhibit a wide range of drought responses, with drought-coping strategies varying significantly by cultivar. The total contributions of sugars and cations covered up to 60% of the measured osmotic potential. Glucose and fructose were the predominant sugars, while cations were the main contributors to the seasonal osmotic adjustment.

POSTER COMMUNICATION

Phylloxera root infection drives vineyard water

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Keywords: drought, grapevine phylloxera, WUE, synergetic

ABSTRACT

Most of the rootstocks used in viticulture today are partly resistant against grape phylloxera (Daktulosphaira vitifoliae Fitch) and host phylloxera on the root system without conspicuous negative impacts on fruit production). Therefore, any decrease in this resistance and/or synergistic interaction with abiotic stresses could exacerbate the impact of phylloxera and have direct consequences on viticulture worldwide. Phylloxera root feeding produces root damage and subsequent gall formation. Root galls affect the whole plant physiology through the impairment of water and nutrient uptake. Recent work demonstrated that phylloxera root feeding modulates plant water use by directly affecting stomatal conductance and transpiration, which may induce a synergistic interaction between phylloxera and drought where premature stomatal closure could have substantial negative impacts on photosynthesis and productivity.

The goal of our work is to understand the biotic x abiotic stress interaction between grape phylloxera and drought and study which of the components of the interaction are synergistic drivers.

The experiment was conducted on the phenotyping platform at the BOKU University in Tulln, Austria. Thirty-two potted 3-year-old vines (Pinot noir | 5BB) were kept under semi-controlled conditions for the full summer season and underwent the treatments: root phylloxeration (by a defined collection of phylloxera root-feeding strains), drought (two subsequent drought cycles with defined recovery phase) and compared to respective non-treated & non-infested control plants in the season 2024. Physiological measurements on water uptake, stomatal regulation and carbon assimilation have been performed on a 2-weekly basis throughout the experiment.

We present first results describing the effects of the single vs. combined stresses as monitored through eco-physiological measurements and grape growth parameters. As one of the main results we show that the water use efficiency (WUE) is affected by the biotic x abiotic stress interaction.

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POSTER COMMUNICATION

Exploring between- and within-vineyard variability of "Malvasia di Candia aromatica" vineyards from Colli Piacentini

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Keywords: geraniol, monoterpenes, selective harvesting, profitability, *terroir*

ABSTRACT

Several studies demonstrated how climate and soil may be key drivers of variability at different scales. Zoning studies identified sub-regions leading to distinctive wines, while precision viticulture recently focused on within-vineyard scale. Different vigor zones may show differential canopy growth, yield and fruit composition depicting diverse enological potentials. Despite several studies addressed differences in technological and phenolic maturity of widespread red varieties, few works have explored how within- and between- vineyard variability affects varietal odorous compounds (VOCs) in terpene-based aromatic white cultivars.

The study aims to: describe the aroma profile of "Malvasia di Candia aromatica" (MACA) grapes depending on vineyard and vigor, assess if and how between- and within-field variability affects VOCs during ripening, and identify harvest zones for selective picking (SH) at the estate scale.

The study was performed in 2018 in four variable MACA blocks (V1,2,5,7) where two vigor zones were identified by visual assessment. Per each vineyard a CRB design was considered and 9 vines per treatment identified to assess growth, yield and fruit composition. Per each vineyard technological ripening was monitored weekly; similarly, grapes samples were collected pre-veraison, pre-harvest and at harvest to quantify free and bounded monoterpenes and their derivatives by head space solid phase microextraction (HS-SPME) coupled with gas chromatography–mass spectrometry (GC-MS).

The results show differences among vineyards and diverse enological aptitude. Low vigor zones (LV) had lower pruning wt. and yield vs. high vigor (HV) characterized by heavier tight bunches. LV grapes had higher TSS, pH, phenolics and tartrate compared to the less ripe grapes from HV. Regardless zones, V5 had lower pruning wt and yield vs. the other blocks; however, the less vigorous V5_LV achieved highest TSS, pH, K+ and phenols than V5_HV. Between- and within-field variability influenced grape VOCs at harvest; LV had higher free and bounded VOCs than HV while the lowest spatial variability was observed in V5. Regardless of vineyard and vigor zone the study confirmed that MACA has a monoterpenic profile dominated by geraniol. The results support adoption of SH for exploiting between- and within-field differences of grape aroma potential through production of different wines. The panel confirmed different sensory profiles and aging potential of derived commercial wines.

POSTER COMMUNICATION

A stratified sampling approach to investigate the impact of climate and maturity on the aroma and phenolic composition of grenache grapes and wines within the poctefa area

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Keywords: *Vitis vinifera* L. cv Grenache, maturity, climate change, aroma, phenolics

ABSTRACT

Context and purpose of the study - Climate change is affecting wine production and induces a large variability in wine composition between vintages. In most cases, this may take the form of altered precipitation regimes and higher temperatures during maturation which may induce a decoupling between technological and phenolic maturations involving a delay, high sugar concentrations and aromatic defects at harvest. This is particularly observed for Grenache, a cultivar well represented in France and Spain within the POCTEFA Pyrenean foothills. The aim of this study was to investigate during two consecutive seasons the impact of climate and maturity on the aroma and phenolic composition of wines made from this cultivar.

Material and methods – For the main PDO located in Pyrénées-Orientales, Aragon, Navarra and La Rioja growing Grenache, normal climatic data (1981-2010) were collected and used to calculate several bioclimatic variables. Data were treated through k-means clustering analysis to determine three homogenous climatic areas. A stratified sampling approach was used to select 30 Grenache vineyards across Spain and France (20/10), and the three climatic area previously identified (10/10/10). For each site, grape samples were harvested at three time points during maturation, the first one corresponding to a sugar concentration of 21.0 ± 2.0 °Brix (P1), the second one (P2) to 10-14 days after P1, and the third one (P3) to 10-14 days after P2. These grapes were used to determine classical enological parameters, to monitor phenolic composition according to the Cromoenos® method, to obtain a berry volatile fingerprint through SIFT-MS analysis and to produce hydrolyzed mistelle – a model to predict the aroma potential of grapes. At P1 and P2, experimental wines were produced under minivinification techniques to analyze wine aroma composition using gas chromatography techniques and to perform descriptive sensory analysis.

Results – The samples obtained in 2024 are presently being analyzed and the results will be available soon. The findings should emphasize the relative importance of climate and maturity on aroma composition, and enable to determine optimal climatic conditions to avoid the appearance of aromatic defects. They shall also be useful to identify new viticultural regions, especially at higher elevation, more suitable for the future production of faultless wines in a context of changing climate.

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POSTER COMMUNICATION

Pedicel lenticel diversity of cultivars and their influence on cell death and berry shrivel

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Keywords: lenticels, cell death, oxygen, shrinking berries

ABSTRACT

Shrinking berries are the common symptoms of Berry Shrivel (BS) and Late-Season-Dehydration (LSD) in grapevine cultivars. The causal events leading to the induction of both ripening disorders are still unclear, although our knowledge increased substantially in the last years. In Shiraz, berries showing shrinkage symptoms, have been associated to a mesocarp cell death, especially near the seeds. Vitality staining of BS affected berries also showed enhanced cell death near the brush region. In general, mesocarp cell death is a natural process during grape berry ripening, but a wrong timing or an enhanced intensity could result in a loss of cell compartmentation followed by an increased quantity of dead tissue. One factor inducing cell death could be hypoxia, a lack of oxygen. One hypothesis state that oxygen is supplied to berries by lenticels on their skin and on pedicels, as berry transpiration is limited after ripening start. In our study, we hypothesize that lenticels ensure the oxygen transfer to berries and that BS affected berries show an enhanced cell death near the brush region due to a lack of oxygen. Specifically, we addressed the following questions a) is there a diversity of lenticel coverage on pedicels between cultivars, b) which categories of lenticels can be observed, and c) could the number of lenticels and their structure be related to cell death and BS. Microscopic methods were used to study these questions. Our results confirmed that lenticels develop over time and cultivars diver in numbers and lenticel areas. Vitality staining of berries showed minor differences between cultivars and currently we are analyzing the structure of lenticels. With this study we hope to provide an additional piece of information to decide on the contribution of cell death to the induction of BS.

POSTER COMMUNICATION

Influence of thermal stress on Malbec, Syrah, and Bonarda (*Vitis vinifera* L.) anthocyanin content and evolution in growing seasons with heatwaves in semi-arid climate (Argentina)

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Keywords: temperature, climate indexes, overhead spray water treatment (OSWT), climate change, principal component analysis

ABSTRACT

It is known that high temperature influences the synthesis, transformation and degradation of grape anthocyanin (ANT) threatening the quality of grapes and coloured wines. The increasing temperature, due to climate change, is expected to negatively influence the metabolism of ANT. Moreover, heatwaves that are related to global warming are growing in length and frequency worldwide, exacerbating the thermal stress on plants. Specifically, in the semi-arid condition of Mendoza viticultural area, heatwaves have been intensifying, giving opportunity to study in depth the effect of the thermal stress on ANT accumulation during growing seasons. The aims of this biannual study on three varieties were: i) evaluating the relationship between thermal accumulation and the ANT seasonal dynamic; ii) evaluating whether an evaporative cooling treatment over the canopy may alleviate the impact of the thermal accumulation during heatwaves on ANT; iii) identifying if any thermal indexes can be related to ANT profile and concentration helping growers to adapt the vineyard management preventing grape damage.

During heatwaves, the vine canopy of three cultivars (Malbec, Bonarda and Syrah) were treated in an experimental vineyard, with the Overhead Spray Water Treatment (OSWT) in two growing seasons. Within the canopy iButton sensors were used to record the temperature. Two (2 and 8 day-length) and one (10 day-length) heatwaves were identified in the two growing seasons, respectively. Four to six berry samples were collected from veraison to harvest to assess soluble solid content and ANT concentration and profile. From the beginning of veraison to the date of each sampling, thermal accumulation indexes were calculated. ANOVA and PCA were carried out.

The OSWT lowered canopy and berry temperature, modified ANT profile by decreasing their acylation, without changing the total concentration. Treatments and cultivars were differentiated by the calculated thermal indexes on the basis of ANT concentration and/or profile. In the presence of thermal excesses, plant management can include systems for temperature control at microscale level. Among these, the OWST, tested in this study, showed reproducible impact over the years, together with an effect on the ANT profile. The technique can be of valuable help in different circumstances but its application must depend on the oenological aims. Other aspects still under analysis will be discussed.

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POSTER COMMUNICATION

Ethanol reduces grapevine water consumption by limiting transpiration

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Keywords: drought acclimation, ethanol, Gamay cuttings, hormesis, transpiration

ABSTRACT

Studies suggest that ethanol (EtOH), triggers plant adaptation to various stresses at low concentrations (10 µM to 10 mM). This study investigates whether EtOH induces drought acclimation in grapevine, as demonstrated previously in Arabidopsis, rice, and wheat. Preliminary results with bare root Gamay cuttings showed that those pre-treated with 10 µM EtOH aqueous solutions lost fewer leaves when deprived of water compared to controls. Subsequently, we ran a potted-cutting experiment with progressive soil water deficit. Plants pre-treated with 250 mM EtOH solutions exhibited slower depletion of the fraction of transpirable soil water (FTSW), compared to controls. While 250 mM EtOH decreased transpiration in early days, these EtOH pre-treated plants maintained higher leaf transpiration than controls after 10 days of soil water depletion. The transpiration response to FTSW was affected by EtOH application. EtOH pre-treatments limited plant leaf expansion without increasing leaf senescence. Interestingly, plants primed with EtOH followed typical hormesis curves. These results suggest that EtOH improves grapevine acclimation to drought, leading to potential water-savings in wine growing regions prone to high water shortages, linked to climate change. These should encourage further testing under various vineyard conditions.

POSTER COMMUNICATION

Assessing the impact of defoliation on grape volatiles profile and wine odor characteristics in four Greek red varieties (*Vitis vinifera* L.) using multivariate chemometrics

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Keywords: Greek red grape varieties, defoliation, volatile profile, sensory descriptive analysis, volatile fingerprints

ABSTRACT

Context and purpose of the study. Cultivation techniques are widely recognized for their significant impact on the aroma profile of grapes and wines. Among them, defoliation is a crucial practice for viticulture management to modify the microclimate of the fruit zone, and by extension, to improve the quality of the produced wine. In the context of climate change, characterized by rising temperatures and altered precipitation patterns, defoliation might lead to excessive light incidence and heat stress on the exposed berries, thereby its necessity as a vital strategy should be reevaluated, especially under semi-arid conditions. In the present study, the impact of defoliation on four different Greek red varieties (Agiorgitiko, Xinomavro, Mandilaria and Limniona) was assessed to establish defoliation's impact on grape and wine aroma and their sensory attributes and possible differences in their respective repsonses.

Material and methods. Vitis vinifera L. cvs located in an experimental plot in Southern Greece, were subjected during three consecutive and climatically distinct years (2021, 2022, and 2023) to two defoliation tretaments: full removal of basal leaves and laterals at veraison and non-defoliated control vines. At the stage of optimum maturity, grape samples of each variety and treatment were harvested and analysed. Experimental wines were produced in small-scale batches according to the same protocol. The volatile compounds of the red grapes and wines were analyzed through HS-SPME couples to GC-MS, while descriptive sensory analysis was conducted by a trained panel consisting of fifteen judges.

Results. Differences between defolation treatments across the four cultivars and possible interactions were assessed using multivariate statistical analysis, including ANOVA, principal component analysis (PCA) and orthogonal partial least squares discriminant analysis (OPLS-DA) models. Variant Importance in Projection (VIP) algorithm was used to calculate the VIP scores of the determined volatiles and distinguish the most important chemical markers among them that affect the discrimination, including only the variables with VIP > 0.8. In summary, despite of some common responses to sunlight exposure found within varieties, in the most of the cases, the application of the treatment and the differentiation between varieties generate a fingerprint including volatile compounds and sensory aroma characteristics.

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POSTER COMMUNICATION

Grapevine under nutrient stress: exploring the adaptive mechanisms in response to iron deficiency conditions

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Keywords: Fe deficiency, chlorosis, morphology, biochemical, transcriptomic

ABSTRACT

In plants, stress due to nutrient deficiency can significantly impair their development and productivity. Although iron is abundant in most soils, factors such as high pH and lime content affect Fe solubility, resulting in a remarkable reduction in plant growth and yield. In vineyards, several strategies have been used to prevent the occurrence of Fe deficiency chlorosis, including the use of Fe-chlorosis tolerant rootstocks. In response to low Fe availability, grapevine rootstocks adapt on several levels to maintain the required Fe level, however, the mechanisms underlying such changes are still unclear. Therefore, we sought to identify the key adaptive responses evolved by tolerant grapevine rootstock to cope with Fe limitation and to understand how different pathways interact to regulate Fe acquisition and transport in response to Fe shortage stress at the transcriptional level. Rooted woody cuttings of Fercal (tolerant) and 3309C (susceptible) rootstocks were used to study plant responses to i) direct Fe deficiency

(-Fe) and ii) bicarbonate-induced Fe deficiency (+Fe+BIC) compared to iii) sufficient Fe supply (+Fe). Plants were grown in sand-filled pots for 30 days and watered daily with a modified half Hoagland nutrient solution according to the treatments applied. Our results revealed a difference in the response mechanisms evolved by both rootstocks, which further differed by the cause of Fe deficiency. Most severe symptoms of chlorosis were observed with the susceptible rootstock 3309C on young leaves, which was related to the significant decrease in chlorophyll content. Fercal plants showed higher ability to increase root biomass compared to 3309C plants under bicarbonate stress. This observation was confirmed by the increased expression of several genes involved in root growth and development such as (VvSAUR66, VvZAT6). In addition, Fercal roots were able to maintain constant level of ferric chelate reductase activity under both applied stress treatments compared to +Fe roots, while 3309C roots suffered a decrease in its activity under the same stresses. Moreover, under both Fe deficiency treatments, Fercal showed high efficiency in Fe transport and translocation through enhanced expression of related genes (e.g. VvOPT3, VvFRD3) compared to 3309C. The outcomes of this study will strengthen the current understanding of Fe deficiency induced adaptation, which can be used as an approach to develop Fe deficiency tolerant plants.

POSTER COMMUNICATION

Guard cell metabolism – A key for regulating drought resilience?

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Keywords: drought stress, guard cells, priming effects, metabolic acclimation, sulfate

ABSTRACT

In view of increasing drought frequencies due to climate change, enhancing grapevine resilience to water scarcity has become vital for sustainable viticulture. This study examines drought adaptation strategies in grapevine guard cells, which regulate water loss. We compared the grapevine guard cell metabolome with maize guard cells under comparable controlled drought conditions. Physiological and metabolomic analyses were conducted using mesophyll and guard cells under single and repeated drought stress conditions. Guard cells were isolated using a blending technique. An untargeted metabolic profiling was performed by using GC-MS.

Grapevine guard cells exhibited stable amino acid and sugar profiles, while maize guard cells showed dynamic sugar accumulation. These responses illustrate two contrasting strategies, namely a muted acclimation of grapevine and a vigorous acclimation of maize in mesophyll and guard cells. In both crops, metabolite concentrations were less impacted by drought stress in guard cells compared to mesophyll cells, suggesting the emphasis of plants to maintain stable guard cell metabolomes for functional integrity. Furthermore, supplemental sulfate promoted enhanced metabolic adjustments in mesophyll cells under drought conditions, while the effect of supplemental sulfate in guard cells was markedly diminished. Despite their contrasting drought strategies, grapevine and maize exhibited similar responses to supplemental sulfate. This suggests that sulfate fertilization could be a viable strategy to improve the resilience of grapevines to drought stress. In conclusion, this study identified the contrasting drought adaptation strategies of grapevine and maize, highlighting the critical role of guard cell metabolic stability in maintaining functional integrity under drought conditions.

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POSTER COMMUNICATION

Drought stress shapes the fungal microbiome of grapevine leaves: insights from DNA metabarcoding

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Keywords: grapevine, microbiome, drought stress, ITS metabarcoding

ABSTRACT

Drought stress is an increasingly prevalent environmental challenge with implications for grapevine physiology and productivity, as well as for the microbiomes associated with grapevine tissues. Environmental conditions that impact plant health and development are closely intertwined with the structure and function of their associated microbial communities, creating a dynamic interplay between host and microbiome.

Grapevine leaves are a transient and seasonally variable niche for fungal colonization. The chemical and physiological properties of these tissues, combined with environmental stressors such as drought, demand a high degree of adaptation. Understanding the response of fungal communities to such stresses is essential for managing vineyard ecosystems and ensuring sustainable production under changing climatic conditions.

In this study, we investigated the impact of drought stress on the diversity and composition of fungal communities inhabiting the leaves of grapevine cultivars typical of the Eger wine region in Hungary. Using DNA metabarcoding, we assessed fungal richness, relative abundance, and community composition, with a focus on functional groups relevant to plant health and stress adaptation. Statistical analyses highlighted significant shifts in fungal community structure under drought conditions, providing insights into the ecological resilience and adaptability of these microbiomes.

Our findings contribute to a deeper understanding of the interplay between drought stress and grapevine-associated fungal communities, offering a foundation for exploring potential strategies to support plant resilience through microbiome management.

POSTER COMMUNICATION

Grapevine Shiraz disease-associated viruses lead to yield losses by altering transcription of genes

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Keywords: grapevine virus A, grapevine leafroll virus, systemic acquired resistance, transcriptomics, pathogenesis-related proteins

ABSTRACT

Context and Purpose of Study. Grapevine Shiraz disease (SD), which is associated with Grapevine Virus A (GVA), is one of the highly destructive diseases affecting Australian and South African vineyards. However, virtually nothing is known about the transcriptional modifications in grapevine phloem tissues induced by SD as well as its impact on vine physiology, yield and fruit composition. We therefore conducted an evaluation of SD on mature Shiraz grapevines in the warm climate region of Riverland, South Australia.

Materials and methods. Physiological parameters, including vine water status, leaf gas exchange and PSII chlorophyll fluorescence, as well as yield components and fruit composition of SD-infected Vitis vinifera L. cv. Shiraz vines grown in a commercial vineyard in the Riverland region of South Australia were assessed over two growing seasons, 2020/21 and 2021/22. Viruses present in symptomatic SD-affected and asymptomatic vines were investigated using serological (ELISA) and molecular tests (PCR and Illumina next generation sequencing (RNA-seq)). Phylogenetic and differential transcript expression analyses were done on the RNA-seq data.

Results. SD did not alter plant water status over the growing season, however significantly decreased canopy size, leaf gas exchange, PSII chlorophyll fluorescence, and yield. Differential gene expression analysis revealed significantly higher expression of genes associated with systemic acquired resistance (SAR) and downregulation of defence- and photosynthesis-related genes in phloem tissues of SD vines. This is the first report of the physiological and transcriptomic effects of SD on grapevines.

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POSTER COMMUNICATION

isUP-AgrO European project – unlocking the potential for agricultural research on an EU outmost region: boosting ISOPlexis center

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Keywords: sustainable food production, agrosystem functional diversity, training schools, vineyards, Madeira wine

ABSTRACT

The isUP-AgrO project aims to enhance the capability of ISOPlexis - Centre of Sustainable Agriculture and Food Technology, a research unit from the University of Madeira, an outermost region of Portugal. Networking, training and research activities will be implemented between the partners in the consortium, which includes the Università Degli Stdi Di Parma (UNIPR) in Italy, the Institute of Natural Resources and Agrobiology of Seville (IRNAS - CSIC) in Spain, and the company SATURNTECH from Portugal. The objective of this project is to transform the ISOPlexis Centre into a reference research unit in the specific domains of agrodiversity and bioresources, with the goal of comprehending the functional agrodiversity of agrosystems and its role in the promotion of sustainable food production. The specific goals are: I) To complement a network to foster the activities and expertise exchange in life sciences, domains related to agriculture, and food, with the organization of training schools and staff exchange on specific research topics and with the participation of recognized specialists; II) To promote workshops and webinars aiming to accelerate knowledge transfer, prepare joint scientific publications and proposals writing, improving research management, and implement post networking and consortium able to compete at the international level; III) To implement a research project with the consortium partners, which aims to apply the competencies and skills, acquired during the isUP-AgrO realization. The vineyard will be the model crop used in the research project because it's an important agricultural production, associated with the internationally recognized Madeira Wine brand, which suffers the pressure of ongoing climate and global changes. On the other hand, it generates by products and waste that can be valuable raw materials to develop new biological solutions and products for the local bioeconomy. In detail, an initial survey and characterization of the vineyards in the Madeira Region will be realized by targeting an important variety for Madeira Wine production, Verdelho. From this information, two vineyards will be chosen for the project. In these vineyards, traditional irrigation (farmer's irrigation) will be compared with plots under precision irrigation to check the variations in the crop ecophysiology, phenology, productivity and soil microbiome during two crop cycles.

POSTER COMMUNICATION

The impacts of simulated heatwaves on the induction and maintenance of bud cold tolerance in cultivated and wild-type *Vitis* species

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Keywords: global warming, heatwaves, cold tolerance, budbreak, cold acclimation

ABSTRACT

Low temperatures are required for the acquisition and maintenance of bud cold tolerance, which are necessary for grapevines to survive freezing temperatures in winter. Heatwaves during cold acclimation could undermine the induction and maintenance of bud cold tolerance, but this was untested. Over two studies, we explored how simulated heatwaves applied during grapevine cold acclimation impacted bud gene expression, metabolites, and cold tolerance during and after heat exposure in addition to phenology the following spring. In Study 1, we evaluated the impacts of heat on a cultivated grapevine, Vitis vinifera cv. Cabernet Franc, and in Study 2, between a cold-sensitive grapevine species (V. vinifera cv. Cabernet Franc) and a cold-tolerant wild grapevine species (V. riparia).

Each study was conducted at The Pennsylvania State University in Pennsylvania, USA, a cool-climate region, and was a 2x2 factorial design performed on young, potted grapevines. Four treatments were evaluated in Study 1: 1) "Early Heat," a 10-day heatwave at approximately 5 °C above ambient temperatures in September, 2) "Late Heat," a seven-day heatwave at approximately 10 °C above ambient temperatures in November-December, and 3) "Early + Late Heat" both September and November-December heatwaves, and 4) "Control," vines grown under ambient vineyard conditions. In Study 2, responses were contrasted between V. vinifera or V. riparia when treated as a control (no heat exposure) or with a two-week simulated heatwave of 7 °C above ambient temperatures in October.

For both studies, heat application significantly impacted bud gene expression of pathways hypothesized to play a role in bud dormancy and cold tolerance (e.g., soluble sugar gene pathways) compared to buds from control vines; however, the impacts of heat on bud gene expression were transient for both heat applications (Study 1) and for both Vitis species (Study 2). Despite significant changes in the transcriptome during each heatwave, there were no significant impacts of heat on bud cold tolerance phenotypes for V. vinifera cv. Cabernet Franc when measured four times between November and January for Study 1 or for V. vinifera or V. riparia when measured once in December for Study 2. The "Early" heatwave, but not the "Late" heatwave, significantly delayed budbreak by four days in the following spring in Study 1, and there were no impacts of heat application in October on spring budbreak for either Vitis species in Study 2.

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POSTER COMMUNICATION

Effectiveness of "curettage" and rootstock over-grafting in the control of esca

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Keywords: curettage, overgrafting, survival curves, GTD

ABSTRACT

Context and purpose of the study - The grapevine domestication requested the need of pruning, which expose the vines to trunk pathogens, leading to the spread of vine trunk diseases. (GTD). Among these, Esca disease, primarily caused by Phaeomoniella chlamydospora, Phaeoacremonium aleophilum, and Fomitiporia mediterranea, bring significant challenges to European viticulture. Nowadays, no curative techniques are available to counteract the development of GTD. The possibility to adopt surgical techniques such as "curettage" to remove unhealthy wood from the grapevine tissues has been reevaluated as a promising technique to recover plants after Esca infection. A log-term experiment have been set up in different vineyards to examine the effects of curettage and rootstock over-grafting as potential methods for containing Esca.

Materials and method – Three trials were carried out in Italy (two in Tuscany and one in Veneto regions, respectively). For each site, a completely randomized block design was set, with 4 replicates of 150-200 vines each. For several years, symptomatic vines were treated with curettage (removal of decayed wood) or over-grafting, and the manifestation of symptoms, recurrence, and mortality rates were compared with untreated controls. A GIS database was created to store data collected during field visits. Furthermore, survival curves (Kaplan-Meier) were created, updating the year of symptom onset to year zero, and then observing the number of death events over time. These curves were compared using the statistical test of logarithmic ranks.

Results - The results revealed that both techniques reduced the symptoms of Esca. The survival analysis showed that the treated vines had a significantly higher probability of survival compared to the untreated ones. While curettage aim to reduce the fungal inoculum of F. mediterranea, maintaining the vigor and productivity of the plant, the effectiveness of overgrafting varied depending on the health status of the rootstock. Overall, both methods offer promising but conditionally effective alternatives for managing GTD, suggesting the need for integrated and site-specific approaches in vineyard disease control.

POSTER COMMUNICATION

Strigolactones as possible elicitors in sunburn defense mechanisms in grapes: preliminary results

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Keywords: abiotic stress, phytohormone, priming, antioxidant capacity, climate change

ABSTRACT

Due to altered climatic conditions, grape berry sunburn has become one of the main challenges in contemporary viticulture. This disorder results from a combination of excessive direct exposure to sunlight and high temperatures, leading to brown and necrotic patches on the fruit skin, potentially reducing vineyard yield and grape commercial value. Despite its prevalence, winegrowers lack effective and economically viable strategies, in line with sustainable agriculture principles to mitigate sunburn beyond the use of shade nets, temporary protection with kaolin and zeolite, or the avoidance of defoliation practices.

We explored the use of phytohormones, particularly strigolactones, as potential agronomic tools to enhance plant stress responses. Specifically, we investigated the potential benefits of multiple in-field strigolactone (racGR24, a synthetic analog of natural strigolactone) applications on "Muscat blanc" clusters during the green developmental phase to enhance stress response mechanisms. At veraison, berries were then subjected to artificial sunburn in a laboratory setting, utilizing a "UV Test Box".

Clusters were treated with a 5 µM rac-GR24 solution twice during the green growth phase. The solution was sprayed to facilitate absorption into fully shaded berry tissues. This approach was aimed at mitigating the risk of sudden sun exposure, as severe sunburn damage typically occurs when berries are abruptly subjected to high light and temperature conditions without prior acclimation during early development. Both control and rac-GR24-treated berries underwent artificial sunburn testing under identical conditions to assess the protective effects of strigolactones.

Analyses included berry color assessment using a colorimeter (CIEL*a*b system), spectrophotometric measurements of total polyphenols, polyphenol oxidase activity, and the skin's antioxidant capacity, both pre- and post-artificial sunburn treatments. racGR24 application revealed significant differences in all the parameters investigated, indicating a protective effect against oxidative stress. Further research is needed to decipher the molecular role of strigolactone applications in grape berry metabolism, in order to characterize the strigolactone's induced mechanism.

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POSTER COMMUNICATION

Climate change impacts on grapevine leafroll disease and its transmission by mealybugs

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Keywords: ted temperature, grapevine, GLRaV, plant-vector-virus interactions

ABSTRACT

Climate change impacts crop plants, plant pathogens, and their insect vectors and hence adds abiotic stress to the triangle of plant-virus-vector interactions. Grapevine is among the most widely grown fruit crops worldwide and grapevine leafroll disease (GLRD) is probably the most widespread viral infection in vineyards. It is transmitted through infected propagation material and insect vectors, such as the vine mealybug Planococcus ficus (Signoret). Knowledge of climate change impacts on mealybugs in general or as virus vectors, in particular, is scarce. Similarly, we lack information on grapevine plant defence against pathogens under climate change conditions. Plant-virus-vector interactions are usually very species-specific hence conclusions cannot be derived from other pathosystems. It is therefore unclear how climate change influences the plant-virus-vector interactions of GLRD. We exposed potted grapevines to elevated temperature (eT) and elevated CO2 (eCO2) and inoculated them with mealybugs carrying GLRD viruses. After 4 months transmission rates, defence-related plant metabolites, and gene expression patterns were analysed. Our results show higher virus transmission under ambient climate scenarios, while defence parameters were influenced by climate rather than virus infections. These findings will close knowledge gaps on plant-virus-vector interactions, and the disease they cause in current and future climate scenarios. Enhancing the knowledge of the impacts of climate change on economically important plant diseases and their insect vectors is crucial to strengthen the adaptive capacity of crop production and ensure sustainable viticulture.

POSTER COMMUNICATION

Effects of auxin treatment on compositional and molecular ripening dynamics in grape varieties of northern Italy

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Keywords: grape ripening, climate change, ripening delay, auxin, NAA

ABSTRACT

Context and purpose of the study. The temperature increase related to ongoing climate changes is causing a progressive anticipation of the ripening time, negatively affecting grape quality at harvest. Various short-term adaptation strategies have been proposed to mitigate these effects. In this study, we collected data from multi-year auxin treatment trials aimed at delaying the ripening of some of the most important grape varieties cultivated in Valpolicella (Veneto, Italy). We evaluated cultivar-specific responses in terms of ripening dynamics and berry composition. Additionally, we analyzed the effects of auxin on berry transcriptome rearrangements.

Material and methods. The trials were conducted over several years in Guyot-trained vineyards located in Valpolicella. Clusters of cvs. Corvina, Corvinone and Rondinella were treated with 1-naphthaleneacetic acid (NAA) before veraison. The dynamics of the main technological parameters were monitored from the time of treatment until harvest. An RNAseq analysis was performed on berry samples collected throughout the ripening period, and the genes modulated by the treatment at different time points were identified.

Results. The treatment of grape clusters with auxin strongly impacted the ripening dynamics, postponing sugar and anthocyanin accumulation and slowing the decrease in acidity, albeit with marked differences related to the grape variety. In some years, a positive re-balancing between sugars and anthocyanins was observed for cv. Corvina. However, for cv. Corvinone, the delay in ripening was consistently excessive, resulting in treated grapes failing to achieve acceptable maturity levels. Molecular analyses showed that the entire ripening program was postponed, and the longer stay of NAA-treated clusters on the vine appears to have had some effects on berry secondary metabolism. Moreover, we observed a strong modulation of numerous auxin-related genes, as well as genes related to gibberellin, ABA, ethylene, and brassinosteroids. This modulation began a few days after the treatment, confirming previous indications that grape ripening initiation is controlled by a crosstalk of multiple hormone signals. These results provide valuable insights for vineyard management strategies aimed at adapting viticulture to climate change in those areas where the grape varieties are part of the terroir paradigm.

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POSTER COMMUNICATION

Dissecting the dual role of light regarding the plasticity of grape physiology and gene regulation through daylength simulation in a semi-arid region

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Keywords: *Vitis vinifera*, sunshine duration, phenolic compounds, volatile compounds, molecular biology

ABSTRACT

Context and purpose of the study. Daylength is a key climatic factor within the terroir concept. However, the complex interplay of multiple variables in regions with varying daylengths makes it challenging to isolate and investigate this specific factor. To address this, a three-year experiment (2021-2023) was conducted in a semi-arid region of China with the longest natural daylength (CK).

Material and methods. To simulate the daylengths of central (20% reduction, MD) and eastern (30% reduction, SD) regions, daily artificial shading was applied to entire grapevines from anthesis to harvest. Microclimatic conditions at the grapevine scale, gas exchange parameters, targeted grape metabolites, and RNA-seq data were collected and analyzed to investigate the physiological and metabolic responses of the grapevines.

Results. The results revealed that shading reduced incident light by 80%, leading to a decline in net assimilation rate, stomatal conductance, and transpiration rate. Phenological stages were delayed, and the main shoot leaf area increased in MD and SD treatments, as evidenced by slower accumulation of total soluble solids and delayed degradation of total acidity. However, these differences in phenological stages and physicochemical parameters diminished before harvest. Compared with CK, MD and SD grapes exhibited delayed anthocyanin accumulation, significantly lower flavonol levels, and higher concentrations of C6/C9 compounds, terpenes, and norisoprenoids. Notably, compensation effects were observed, as the significant differences in metabolites disappeared by harvest. RNA-seq was performed on grape berries sampled at four time points during the day during three key phenological periods. The differential expressed genes were more abundant at veraison and pre harvest, especially half an hour after shading and half an hour after net removing. The regulated pathways included carbon metabolism, amino acids, starch and sucrose metabolism, and phenylpropanoid biosynthesis. The WGCNA and network analysis revealed the key genes and transcription factors (TF) responsible for the daylength changes including VviWRKY3, VviNF-YB3, and VviNF-YC9. The binding sites of these candidate TFs were identified through DNA affinity purification sequencing, and the Dual-luciferase reporter assay was applied to investigate the transactivation of these TFs.

POSTER COMMUNICATION

Guard cells and stomatal movement reveal early molecular interaction between grapevine cells and esca-associated pathogens

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Keywords: cellular model, interaction, plant-cell defense, stomata, grapevine trunk disease

ABSTRACT

Esca is one of the major grapevine trunk diseases that cause vineyards decline and important economic losses in vineyards. Studies have shown that wood differently recognizes Phaeomoniella chlamydospora (P.ch) and Phaeoacremonium minimum (P.min), two esca associated pathogens, at tissular, metabolomic and transcriptional levels. However, the characterization of molecular events occurring throughout the first hours of interaction between grapevine cells and esca-associated pathogens is difficult to perform directly in the trunk. To overcome this difficulty, we proposed a cellular model based on stomata . Stomata are specialized structures consisting of two guard cells surrounding a pore, that perceive stimuli and respond by inducing their opening/closing, which can be quantified. The aim of this study is to decipher the early interaction between esca-associated pathogens and the grapevine cells by using guard-cells model. Epidermal peels of V.vinifera and A.thaliana are observed and the ostiole aperture is measured before and after immersion in a bathing solution containing either complete cell wall of P.ch or P.min, their parietal proteins or their parietal polysaccharides. Our first results suggest that P.ch's parietal proteins are recognized by grapevine and A.thaliana cells, whereas it is the polysaccharide part of P.min's cell wall is recognized. In addition, the use of 1-methylcyclopropene, a competitive inhibitor of ethylene, blocked the stomatal closure in response to P.ch, suggesting an involvement of the ethylene cell signaling in grapevine response to this pathogen. We develop further this topic by the use of mutants involved in the ethylene signaling. Reactive oxygen species (ROS) production and calcium accumulation are signatures of molecular plant response to pathogens. By using fluorescent dyes, we are determining the kinetics of ROS and calcium accumulation on guard cell protoplasts inoculated with pathogens. Overall results showed that guard cell and stomatal responses are efficient and promising tools to establish a cell pathosystem model for characterize and explore molecular events that occur during grapevine and esca-associated pathogens. In addition to these results, other cellular contexts will be explored the most complete vision of these interactions.

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POSTER COMMUNICATION

Grapevine nitrogen dynamics as a function of crop thinning

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Keywords: isotope labelling, uptake, partitioning, carry-over effect, amino-acids

ABSTRACT

Context and purpose. Nitrogen (N) is crucial for plant development but is used inefficiently, with only 30–40% of the fertilizer assimilated by crops, leading to significant environmental losses. In viticulture, N metabolism is influenced by genetics, soil management, vineyard practices, and environmental factors. Understanding these influences is key to optimizing grape composition and production sustainability. Yeast assimilable nitrogen (YAN) in grape must is critical for fermentation and wine bouquet. Levels below 140 mg N/L can cause fermentation issues and sensory deviations, especially in white wines. As wine sensory profiles depend primarily on grape composition, managing N at the vineyard level is crucial. Previous studies demonstrated that canopy size (with different trimming height) negatively correlates with YAN concentration. However, the effects of crop thinning on N partitioning remain unclear.

Material and methods. This study evaluated the impacts of crop thinning on N uptake, mobilization, and allocation in grapevines using isotope 15N-labelling method. Conducted over two years on the white cultivar Vitis vinifera Chasselas, the study employed a gradient of crop loads and N fertilization (20 kg N/ha as 15N-labelled urea applied at veraison stage). Vines were destructively sampled over eight periods and the organs separately analyzed to monitor N dynamics. Musts were analyzed for soluble sugars, acids, NH4+, and amino acids.

Results. Crop thinning did not affect grape N concentration, which remained constant in the grape must at harvest, to the detriment of N content in the roots. Both N uptake and root N mobilization were reduced in response to crop thinning. Fertilization efficiency was higher under high-yield conditions in terms of N uptake and grape N accumulation. Therefore, without affecting plant vigor, urea supply efficiently increased YAN concentration in the must (+55 mg/L) only under higher-yield conditions. Carry-over effects of crop regulation in the following year were highlighted. Grapevine seemed to compensate higher N demand from the grapes with higher N uptake from leaves and roots and higher N reserve mobilization. Urea supply limited N mobilization from the roots, thus preserving N reserves for the following year. Depending on the yield, musts were discriminated about their amino-acid profiles, hinting at potential wine aroma modifications.

POSTER COMMUNICATION

The chain of effects between sunburn necroses and rot infestation in the context of climate change

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Keywords: *Botrytis cinerea*, 'Calardis blanc', defoliation, 'Riesling', *véraison*

ABSTRACT

Climate change will increasingly challenge future viticulture due to long-enduring and extreme weather conditions, jeopardizing yield and wine quality in various ways. Elevated air temperatures, intense solar radiation and drought favour the occurrence of sunburn necroses, while high levels of precipitations lead to more severe rot infestation on grapes. Previous damages or injuries of berry skins facilitate the infection of secondary pathogens such as Botrytis cinerea, Penicillium expansum, Acetobacter spec. and wild yeasts.

In order to analyse the relationship between sunburn necroses and rot pathogens, a defoliation experiment was carried out using 'Riesling' as a susceptible cultivar. Bunch zones were completely defoliated on both sides of the canopy between the end of flowering and fruit set or prior to forecasted heatwaves at bunch closure and at véraison, respectively. The maximum extent of sunburn necroses was observed when defoliation was conducted at bunch closure. Conversely, the highest level of rot infestation was recorded in the non-defoliated approach. Defoliation at véraison caused a double risk to grapes leading to the second-highest severity of sunburn necroses and rot infestation, respectively. However, defoliation between the end of flowering and fruit set was able to reduce both types of damages in comparison to the respective maximum extents.

Furthermore, grape susceptibility of 'Riesling' and the fungus-resistant cultivar 'Calardis Blanc' to sunburn necroses and rot infestation was analysed. Similarly, bunch zones of the two cultivars were completely defoliated on both sides of the canopy prior to forecasted heatwaves at bunch closure over two contrasting seasons. Grapes of 'Calardis Blanc' were less susceptible to sunburn necroses within each year than those of 'Riesling'. Samples of uninjured and damaged berries affected by sunburn necroses at bunch closure as well as at véraison were taken from each cultivar and inoculated with a spore suspension of B. cinerea. 'Riesling' berries damaged at véraison showed the highest level of B. cinerea infestation compared to the other berries of both cultivars. Additionally, 'Riesling' revealed a positive correlation between sunburn necroses severity of berries damaged at véraison and the resulting B. cinerea infestation. However, 'Calardis Blanc' was less susceptible to both, sunburn necroses as well as B. cinerea, in comparison to 'Riesling' and was thus able to limit this amplifying effect.

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POSTER COMMUNICATION

The influence of irrigation and crop load management on berry composition and yield in Chardonnay

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Keywords: Chardonnay, crop load, irrigation level, berry quality

ABSTRACT

Australian grape producers are facing a difficult wine market, therefore a reduction of vineyard production costs is critical. This experiment was carried out on Chardonnay under field conditions in the Riverina wine region (NSW, Australia) and included two experimental factors: irrigation and crop load. Irrigation treatments (full, reduced and low irrigation) were implemented over the whole growing season, amounting to approximately 500, 350 and 300 mm, respectively. Crop load (50% and 100%) was adjusted one week after bloom by removing clusters manually. During berry maturation berry weight and composition was assessed (TSS, YAN and phenolics), at harvest must composition and yield was determined. In addition, anatomical measurements were undertaken on the rachis from the various treatments.

Both irrigation and crop load significantly affected all berry parameters during grape maturation and harvest. Increased irrigation was associated with higher yield, bunch and berry weight as well as elevated juice acidity. On the other hand, the high-water availability resulted in lower berry sugar content, as well as lower total flavonoids and hydroxycinnamates. Crop load reduction resulted in higher berry weight, sugar content and phenolic compounds, but also lower acidity and YAN. Rachis anatomical parameters were significantly affected by seasonal water availability, with higher rachis diameter and area of conductive tissues in coming from bunches that received the increased irrigation levels. No significant differences between the two crop load treatments were found.

This study highlights the interaction between source-sink manipulations and water availability, especially in white cultivars, where the understanding of the relationships between two factors is still limited.

POSTER COMMUNICATION

Exploring the contributions of terroir factors on berry quality of cvs. Cabernet-Sauvignon and Merlot (*Vitis vinifera* L.) at the Eastern Foothills of the Helan Mountains region of China

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Keywords: *terroir*, grape quality, anthocyanins, aroma

ABSTRACT

Terroir leaves its mark on the accumulation of flavours in grape berries, triggering biochemical re-actions and ultimately shaping wine styles. However, the complicated relationship between terroir and grape quality remains not fully understood. We investigated biochemcial profiles of ripened berries in two major grape cultivars Cabernet Sauvignon and Merlot during two consecutive vintages across the Eastern Foothills of the Helan Mountains at Ningxia region, which is a blooming wine region in China. The corresponding terroirs and the fruit carbon stable isotopes ($\delta^{13}C$) were measured. Results indicated that organic acids and anthocyanins exhibited a strong vintage effect, with the cooler vintage exhibiting higher levels of these compounds relative to the warmer vintage. The Mantel test identified several critical factors influencing berry biochemical compositions, including total soil phosphorus (Tp), total soil potassium (Tk), soil thickness (Thickness), precipitation (April-September precipitation, Pre4-9), temperature diurnal range (May, July, August, September, DR-5 and DR 7-9), and δ13C. These results contribute to a scientific foundation for grape cultivation in the Eastern Foothills of the Helan Mountains region and can help growers to better understand and control the production of fruits that maximize their grape typicity.

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POSTER COMMUNICATION

Long-term flooding effects on the physiological and productive performance of Montepulciano and Sangiovese cultivars

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Keywords: flooding, root hypoxia, epigenomic response, climate-resilient viticulture

ABSTRACT

Extreme climatic events, such as prolonged drought followed by intense flooding, increasingly impact viticulture, affecting vine physiology, productivity, and grape composition. This study examines the effects of long-term late-season flooding on two Vitis vinifera L. cultivars, Montepulciano and Sangiovese, grafted onto 1103 Paulsen rootstock. The experiment was conducted in the summer 2024 at the University of Perugia (central Italy), where six potted vines (60 L), three per cultivar, were submerged in 1000 L of tap water within a controlled flooding system. Plants underwent two treatments: flooded and non-flooded (control) from July 1st (day 0) to July 31st, followed by a one-week recovery. Gas exchange parameters were measured using an ADC-LCA3 system on days 1, 4, 7, 14, 21, 28 (flooding), 35, and 42 (recovery), while leaf water potential was assessed on days 11 and 22. Basic ripening parameters were analyzed, and sugar and starch content quantified in roots, shoots, and leaves immediately after flood removal. Leaf and root samples were collected during flooding and recovery to assess reactive oxygen species (ROS) and carotenoid content as stress indicators and to determine whether intracellular root fermentations occurred due to severe oxygen deprivation. Additionally, an epigenomic approach identified differentially methylated genes (DMGs) potentially linked to flooding stress. Flooding significantly impacted photosynthetic performance from day 15, causing a fivefold decrease in Montepulciano and a threefold decrease in Sangiovese after 20 days. However, Montepulciano recovered more efficiently, whereas Sangiovese did not, suggesting greater sensitivity to prolonged soil saturation. Interestingly, transpiration rates remained unchanged in both cultivars. Regarding phenology and ripening, veraison occurred 17 days earlier in Montepulciano and 15 days earlier in Sangiovese. Montepulciano grapes showed lower soluble solids and pH, along with higher titratable acidity, likely indicating incomplete ripening due to prolonged root hypoxia. These findings underscore the importance of cultivar-specific responses in selecting grapevines for climate-resilient viticulture. Further analyses are ongoing to deepen our understanding of biochemical, genetic, and physiological adaptations to submersion and assess intracellular root fermentations under severe hypoxia.

POSTER COMMUNICATION

Grapevine, berry and soil Indicators to manage minimal irrigation strategy in semi-arid conditions: example of Grenache noir (*Vitis vinifera* L.)

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Keywords: precision irrigation, soil moisture, water deficit indicators, berry growth, sugar accumulation, malic acid degradation

ABSTRACT

Context and purpose of the study. Climate change in many Mediterranean wine-growing regions is resulting in lower rainfall and higher reference evapotranspiration, generally leading to reduced water availability for vines. This necessitates rethinking cultural practices, including the use of irrigation. This article aims to present the key soil-climate and vegetative-berry development variables that should be considered for effective minimal irrigation management, ensuring yield consistency and acceptable berry quality that meets market demand.

Material and methods. The experiment was conducted over two successive years (2022–2023) on cv. Grenache N. (Vitis vinifera L.) grafted onto 110R in a commercial vineyard located in the Pyrénées-Orientales wine region, in the south of France. A minimal irrigation treatment (50 mm/year), supplementing the limited rainfall (less than 250 mm/year), was compared to a rainfed treatment.

Results. Among the key findings of this study, the relationship between soil water content, measured using a capacitive probe, and vine water status, assessed through predawn leaf water potential, differed between drip-irrigated and rainfed treatments. This highlights the practical need, given the current stage of knowledge, for proper parameterization of the curve linking these two variables when implementing drip irrigation.

In addition to soil and/or plant water assessments, tracking berry volume (or fresh mass) and primary metabolites, including sugars and malic acid, from véraison onwards, appeared essential to identify potential plant water and carbon imbalances. This information is crucial for adjusting both the timing and amount of minimal irrigation during ripening.

A methodology incorporating a reduced number of measurements of soil and/or plant water status and berry development variables at key phenological stages is proposed to help winegrowers achieve predefined yield and wine quality targets while minimizing their water footprint.

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POSTER COMMUNICATION

Studying heat waves effects on berry composition: first outlooks and challenges

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Keywords: climate change, drought, heat waves, harvest quality, metabolites

ABSTRACT

Extreme climatic events, such as prolonged drought followed by intense flooding, increasingly impact viticulture, affecting vine physiology, productivity, and grape composition. This study examines the effects of long-term late-season flooding on two Vitis vinifera L. cultivars, Montepulciano and Sangiovese, grafted onto 1103 Paulsen rootstock. The experiment was conducted in the summer 2024 at the University of Perugia (central Italy), where six potted vines (60 L), three per cultivar, were submerged in 1000 L of tap water within a controlled flooding system. Plants underwent two treatments: flooded and non-flooded (control) from July 1st (day 0) to July 31st, followed by a one-week recovery. Gas exchange parameters were measured using an ADC-LCA3 system on days 1, 4, 7, 14, 21, 28 (flooding), 35, and 42 (recovery), while leaf water potential was assessed on days 11 and 22. Basic ripening parameters were analyzed, and sugar and starch content quantified in roots, shoots, and leaves immediately after flood removal. Leaf and root samples were collected during flooding and recovery to assess reactive oxygen species (ROS) and carotenoid content as stress indicators and to determine whether intracellular root fermentations occurred due to severe oxygen deprivation. Additionally, an epigenomic approach identified differentially methylated genes (DMGs) potentially linked to flooding stress. Flooding significantly impacted photosynthetic performance from day 15, causing a fivefold decrease in Montepulciano and a threefold decrease in Sangiovese after 20 days. However, Montepulciano recovered more efficiently, whereas Sangiovese did not, suggesting greater sensitivity to prolonged soil saturation. Interestingly, transpiration rates remained unchanged in both cultivars. Regarding phenology and ripening, veraison occurred 17 days earlier in Montepulciano and 15 days earlier in Sangiovese. Montepulciano grapes showed lower soluble solids and pH, along with higher titratable acidity, likely indicating incomplete ripening due to prolonged root hypoxia. These findings underscore the importance of cultivar-specific responses in selecting grapevines for climate-resilient viticulture. Further analyses are ongoing to deepen our understanding of biochemical, genetic, and physiological adaptations to submersion and assess intracellular root fermentations under severe hypoxia.

POSTER COMMUNICATION

Bud fruitfulness in *Vitis vinifera* L. cv. Chardonnay in cool climate regions in South Africa

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Keywords: Chardonnay, bud fruitfulness, bud necrosis, reserves

ABSTRACT

Bud fruitfulness is a key determinant of the potential and the actual yield. The formation of the grapevine yield spans over a period of two consecutive growing seasons (Ferrara & Mazzeo, 2023). Flower induction and differentiation take place in the first season, followed by floral initiation and differentiation, development of the clusters until the physiological maturation of berries and seeds in the following season (Monteiro et al., 2021). Bud fruitfulness varies depending on intrinsic (scion cultivar, rootstock, node position and shoot orientation, hormones - gibberellins and cytokinins) and extrinsic parameters (light intensity, air temperatures, nutritional status, water supply and carbohydrate reserves) (Cox et al., 2012; Li-Mallet et al., 2016).

Grapevine buds comprise a primary bud, secondary and tertiary bud (May, 2000). The primary bud is the most fruitful, but the secondary bud takes over the role of the primary bud if it is killed or damaged. Generally, secondary and tertiary buds are less fertile compared to primary buds (Dry, 2000 & May 2000). Primary buds can also become necrotic, which is detrimental for grapevine yield. Primary bud necrosis (PBN) is strongly correlated to the level of carbohydrates in the grapevine tissue (Collins et al., 2006; Holzapfel et al., 2018). Smith and Holzapfel (2009) reported reduced fruit set and fruitfulness in Semillon grapevines with lower carbohydrate reserves. Chardonnay is an early ripening variety that is subjected to extreme temperatures during spring. The cultivar is versatile and used to produce still and sparkling globally. In the South African context, most Chardonnay plantings are found in Robertson, Stellenbosch and Paarl wine regions. Recently there has been a shift from these traditional wine regions to cool-climate areas like the Walker Bay and Elgin wine regions. However, a lack of knowledge about the relationships between fruitfulness, bud necrosis and carbohydrate reserve levels on canes in Chardonnay in these cool-climate regions is stated. Through this knowledge, it is possible to better manage the most appropriate management techniques in these production areas.

The aim of this study was to determine the fruitfulness with cane elemental analysis in Chardonnay over two seasons 2021-2022 and 2022-2023 in cool climatic conditions. Additionally, the correlation between primary bud necrosis, elemental analysis (carbon %, hydrogen%, nitrogen % and sulphur %) and yield components was determined.

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POSTER COMMUNICATION

Grapevine responses to *Botrytis cinerea* infection: noble rot versus grey rot

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Keywords: *Botrytis cinerea*, noble rot, grey rot, transcriptomics, plant pathogen interaction

ABSTRACT

The intricate relationship between the necrotrophic pathogen Botrytis cinerea and grape berries (Vitis vinifera spp.) can lead to the development of either the desirable noble rot (NR) or the unfavourable grey rot (GR), depending on the prevailing weather conditions. In this research, the focus is on the functional gene set of V. vinifera by conducting multidimensional scaling, which is then followed by differential expression and enrichment analyses. The aim of this study is to identify the variations in gene expression among grape berries during the phases of grey rot, noble rot, and developing rot (DR, in its initial stages). The grapevine transcriptome during the NR phase showed notable differences compared to that at the DR and GR stages, which revealed strong similarities. Likewise, various pathways associated with plant defence, such as hypersensitive responses to plant-pathogen interactions, were discovered to be enriched. The analysis results revealed a possible plant stress response pathway (SGT1 activated hypersensitive response) that was overexpressed in the GR berry while being downregulated in the NR berry. The research indicated a reduction in defence-related V. vinifera genes during the NR phases, exhibiting significant variability in functions, especially in enriched pathways. This suggests that the plant is not actively protecting itself against Botrytis cinerea, which is otherwise found on its surface with significant biomass. This finding underscores the hypothesis that during the NR phase, the grapevine and the pathogenic fungi engage in a balanced interaction, in contrast to the early phases of botrytis infection, which appear to be an aggressive interaction between fungus and plant, irrespective of whether the result is grey or noble rot.

POSTER COMMUNICATION

Distribution of fungicide-resistant *Botrytis cinerea* mutations in the Tokaj and Eger wine regions

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Keywords: *Botrytis cinerea*, grapevine, grey rot, noble rot, resistance

ABSTRACT

Botrytis cinerea is one of the most widespread host-specific fungal pathogens, causing significant yield losses and economic damage to vineyards every year. As a widespread, polyphagous fungal pathogen, it is capable of living a saprophytic or parasitic lifestyle. The successive use of active substances belonging to the same chemical family to protect vineyards may result in an increase in fungal resistance to chemicals, which is reflected in the amplification of point mutations in the genomic regions coding for proteins involved in the mechanism of action of different pesticides. The aim of our study was to compare the fungicide susceptibility of Botrytis cinerea populations in two wine regions with different pest management practices: in Tokaj, where the presence of Botrytis cinerea is necessary for the production of noble rot wines, and in neighbouring Eger, where a comprehensive strategy for the prevention of Botrytis cinerea is followed. This study is the first presentation in Hungary of some previously documented resistance mutations in the ERG27 and SDHB protein coding genes. Our results revealed the presence of point mutations in the transmembrane domain of ERG27 that have not been previously described in the literature. These mutations may potentially influence the development of resistance to specific fungicides. Our studies show that the Botrytis cinerea population in the Northern Hungary region consistently shows an increase in fenhexamid resistance.

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POSTER COMMUNICATION

An effective method for extracting high-quality RNA from grapevine

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Keywords: RNA extraction, CTAB, *Vitis vinifera*

ABSTRACT

Grapevine (Vitis vinifera L.) is one of the most important economic crops in the world. Because of this importance, one finds widespread molecular genetic research on this species, an important element of which is high quality RNA. However, in woody plants, isolation of this molecule is often rather difficult, as the tissues of the various organs may contain significant amounts of secondary metabolites (polysaccharides and polyphenols). These compounds can be removed only with great difficulty during extraction. Our aim was to describe an accurate and usable method for RNA isolation from old leaf tissue starting with a small sample volume (up to 50 mg) to make RNA extraction possible even when younger, developing leaves and shoots are not available. Unlike most related studies, we have also tried to provide a highly detailed methodology to avoid lengthy fine-tuning procedures and thus, to save time and money. The advantages of isolation from leaves include the fast and easy collection of samples and the possibility to study both molecular-genetic changes in physiological processes and plant-pathogen interactions. Our version of the so called CTAB method proved to be efficient in extracting grapevine RNA, which is indicated by the A260:A280 and A260:A230 ratios measured between 2.05 and 2.06 and between 2.06 and 2.09 using an UV-VIS spectrophotometer (NanoDrop 2000, Thermo Fischer Scientific, Massachusetts, USA). The integrity analysis of the RNA was carried out using Agilent RNA 6000 Nano LabChip® (Agilent 2100 Bioanalyzer Califronia, USA). The RIN value (RNA Integrity Number) of the samples was between 7.7 and 8.1, which indicated that small degree of RNA degradation occurred during extraction. The efficiency of the RNA isolation was determined by transcriptional analyses of six housekeeping genes (CYSP, YSL8, Actin, SAND, EF1-α, GAPDH) using quantitative real−time PCR (qrt-PCR), which was carried out in three biological and two technical replicates applying SYBER Green technology (Qiagen Ltd, Germany). The presence of a single peak in the melt curve and amplification curve analyses and low standard errors between the Ct values indicated the specificity of the primers to bind to the cDNA, with no interference of PCR inhibitors.

REFERENCES

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POSTER COMMUNICATION

Foldable lyre as an alternative to improve yield and oenological potential of grapes for a sustainable viticulture

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Keywords: Merlot noir grapes, *Vitis vinifera* L., wine; sustainability, phenolic compounds

ABSTRACT

Actually, many countries around the world are studying different strategies for adapting winegrowing regions to climate changes, focusing on a sustainable viticulture. There are many ways trying to mitigate the effect of global warming on wine sector, including the use of disease-resistant varieties, new clones of cultivars, new rootstocks, new enological protocols for winemaking, such as autochthonous yeasts producing lower alcohol content. Other possibilities are changing grapevine canopy architecture, the vineyard orientation, and new training and trellising systems. Serra Gaucha is the most important Brazilian winegrowing region, located in Southern in a humid temperate climate. In 2023, the country produced around 300 million liters of wines, composed by 80-85% from Vitis labrusca grapes, and15-20 % from Vitis vinifera L. In 2002, the first Geographical Indication of the country (as Protected Indication of Origin-PI) was recognized, named Vale dos Vinhedos, including more than twenty varieties authorized. In 2012, this PI became a Controlled Designation of Origin-DOC, and Merlot Noir was the only variety allowed for red wines. This study aimed to evaluate and compare the impact of vertical shoot positioning (VSP) and foldable lyre training systems, using three different angles (20°, 30°, and 40°), on vine development, physiology and yield, as well as on oenological potential of Merlot Noir grapes at Serra Gaucha, in two vintages (2022 and 2023). In 2022 season, the cycle between pruning and harvest was 161 days; while in 2023 was 193 days. The leaf and yield of the lyres systems were around 50% higher as compared to VSP, but no significant differences were observed for physiological parameters. The oenological parameters of grapes presented significant differences, except for total soluble sugars. In 2022, total anthocyanins was higher in the treatments VSP, 30º and 40º than 20º, while in 2023 vintage, 20º was higher than other. For tannins, foldable lyre at 40º presented the highest values. Foldable lyre showed that can be an alternative to wine sector in the region, increasing the yield and improving oenological potential of Merlot Noir grapes. The system proposed can be easily transformed in VSP, by using an adjustable closure mechanism. It allows mechanization of all vineyard management, including winter pruning, shoot topping and mechanical harvesting, thus reducing production costs and going to a sustainable viticulture.

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POSTER COMMUNICATION

The impact of vine pruning methods on physiological development and health condition of *Vitis vinifera*

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Keywords: pruning, Guyot, cordon, trellis, sap-flow

ABSTRACT

This project aims on monitoring the plant development and comparison of the effects of various training systems on vine fertility and physiological processes. It seeks new approaches to enable vines to adapt to the continuous evolution of climate conditions. Proper establishment and development of cordon training systems are key to ensuring the sustainability of vineyard conditions. Several options have been explored, including newly established cordon vineyards, converted old cane-trained vines, and original cane-trained vineyards.

Research objective of this project is to reflect and develop procedures for changing the conditions of vine cultivation in region of South Moravia, Czechia. One of the main purpose is to integrate the know-how of branched Guyot and Spurred Cordon pruning methods within our working practices. Main purpose is to boost durability of our vineyards using the basic manual work as a tool of improvement. Based on these outlined goals, I attended the Simonit & Sirch pruning academy to reach maximum of education about correct prunign know-how. Based on these skills and knowledge, I decided to elaborate few methodologies for Czech viticulturists, in which I applied Simonit & Sirch methodology in our vineyards of different age and life stages. These models should help to transform the vineyards into funcional and sustainable structures with well preserved vascular tissues and higher durability against weather conditions.

Materials and methods. Evaluated varieties: Pinot blanc, Riesling, Zweigeltrebe, Chardonnay, Pinot noir. Evaluated pruning styles/trainings; Guyot versus Transformed cordon. Methods: comparative analysis of analytic compunds, uvology of grapes and Ravaz index of plant vitality.

As one of the results I produced article about changes within pruning practices and adjustment of grapevine canopy structures within so-called Cool climate regions, using climate-responsive techniques of pruning and cultivation as a part of Precision viticulture.”

POSTER COMMUNICATION

Seasonal variations and climate interactions with phenolic extractability of Pinot noir across the whole winemaking process

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Keywords: seasonal variation, micro-scale winemaking, pomace, lees, mass allocation

ABSTRACT

Context and Purpose of the Study. A deeper understanding of the relationship between weather conditions and wine quality is essential for assessing the impact of climate change and developing effective adaptation strategies. This study introduces a novel approach, utilizing data from a single vineyard under controlled conditions to analyze phenolic extraction. Results on berry phenolics were combined with a micro-scale winemaking technique to produce wines under consistent conditions for each vintage over 11 years (Blank et al., 2019). The aim of this second part of the study was to deepen insights into the climatic influence on phenolic extractability by incorporating data from pomace and lees to perform a component allocation mass balance analysis.

Material and methods. Grapes of Vitis vinifera L. cv. Pinot Noir, grafted onto rootstock SO4 and cultivated in a vineyard at Hochschule Geisenheim University (Germany), were studied over the 2005–2015 period. The phenolic composition was analyzed across four field replicates of Pinot Noir, both before and after fermentation, in various co-products (berries, wines, pomace, and lees).

Results. Only 9% of tannins present in the grapes were extracted into the wine, while 56% remained in the pomace and 13% bound to the lees. Using a component allocation method, phenolic profiles were successfully linked to seasonal climatic conditions. Warmer temperatures, particularly before véraison, combined with low precipitation, were associated with increased tannin accumulation in fruit and wine, with a stronger accumulation in skins compared to seeds. Heat accumulation between flowering and veraison ([ΣGDD10°C]) increased the proportion of seed-derived tannins in the wine. However, higher temperatures during this period negatively affected tannin extraction efficiency, resulting in a larger proportion of tannins being "unaccounted for."

Conclusion. This study presents the first comprehensive component allocation approach for tannins throughout the entire winemaking process, correlating phenolic profiles to seasonal climatic variations, allowing for adaptation strategies to mitigate the impacts of climate change on wine quality.

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POSTER COMMUNICATION

Evaluation of viticultural measures to delay ripening of *Vitis vinifera* 'Grüner Veltliner'

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Keywords: viticulture, ripening delay methods, Grüner Veltliner

ABSTRACT

Context and purpose of the study. `Grüner Veltliner´ is the most important Austrian white quality wine variety, which is mainly used to produce primary fruity wines. The climatic changes lead to significantly earlier grape ripening, often resulting in wines with undesirably high alcohol levels and low acidity with little primary fruit. Therefore the aim of the present study was to delay the ripening of `Grüner Veltliner´ by means of three different viticultural measures.

Material and methods. The vines were planted in 2008 at a spacing of 3.0 x 1.0 metres and raised in a mediumhigh trellis training system with a tying wire pair (h = 0.75 m) and three stitching wire pairs. Pruning was carried out as follows: two fruit canes with six buds each and two spurs with two buds each (= double Guyot). Thus, the number of buds per vine was 16 or the equivalent 5 buds per m². The trial vineyard was located on a steep slope (gradient: 36 to 39 %) facing southeast. The soil type was a carbonate-containing brown soil on flysch marl. In order to delay the development of ripening the methods "Three applications of the antiperspirant Vapor Gard® (2 % concentration) in the period after flowering", "Total defoliation above the grape zone at the end of the development stage bunch closure" and "Keeping the canopy short at a height of 70 cm" were applied over two growing seasons in the form of four replicates per method. In the two years of trial the Huglin index was 1915 and 2105 respectively, the annual precipitation was 453 and 386 l/m² and the precipitation from April to September was 314 and 287 l/m². In the second year, the vines were irrigated by drip irrigation on the 14th , 20th and 27th of July and on the 10th of August with 33 litres per vine. In order to evaluate the effects of these maturity delay measures, selected generative and vegetative parameters were collected and analyzed and sensory wine evaluations were performed after microvinification.

Results. "Three applications of the antiperspirant after flowering" resulted in a year-dependent reduction of the sugar content in the must by 1.9 and 1.2 °KMW and of the acid content in the must by 0.8 and 0.4 g/l, respectively. Total defoliation above the grape zone at development stage "Bunch closure" also led to a reduction of must weight in both years, by 1.2 and 1.0 °KMW, respectively, without affecting acidity. In 2021, keeping the canopy short at a height of 70 cm reduced cluster weight and thus also yield compared to the control variant (-17 g per cluster and - 0,7 kg/vine). Thereby, must weight was only reduced by trend (-0.4 °KMW) and acidity was not affected. In 2022, however, the effects on the yield parameters were not significant, even though there were trends towards a reduction in yield (-0.65 kg/vine) and in cluster weight (-33 g). Neither in 2021 nor in 2022 the contents of nitrogen, potassium and total phenols in the musts were influenced by the ripening delay methods. Extra-polated pruning defoliation above the grape zone at bunch closure" (1600 kg/ha) and "Canopy height = 70 cm" (1073 kg/ha). The values of the other two variants were 1308 kg/ha and 1313 kg/ha, respectively. In 2021, the wine of the variant "Canopy height = 70 cm" was evaluated sensorially significantly worse. However, in the evaluation of the wines of the 2022 vintage, there were no significant sensory differences.

POSTER COMMUNICATION

Enhancing the color traits of 'Nebbiolo' and 'Dolcetto' grapes: the role of abscisic acid during ripening

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Keywords: plant hormone, climate change, anthocyanin, texture

ABSTRACT

The red Italian variety Nebbiolo (*Vitis vinifera* L.), used in the production of the prestigious Barolo and Barbaresco wines, is renowned for its aromatic and structural complexity but also for its low color intensity. This lack of pigmentation and the prevalence of oxidizable disubstituted anthocyanins, compounds responsible for the red color, are intrinsic characteristics of the grape variety, resulting in wines with lighter color compared to other red varieties. Firthermore, the impacts of climate change, particularly rising temperatures, are likely to exacerbate this issue by further decreasing anthocyanin concentrations. 'Dolcetto' grapes exibit higher anthocyanin content compared to 'Nebbiolo' however, they are equally susceptible to the adverse effects of heat waves. One potential solution is the application of abscisic acid (ABA), which can not only increase total anthocyanin content but also modify the anthocyanin profile towards trisubstituted forms, thereby enhancing color stability and intensity. A trial was conducted on cv. Nebbiolo and Dolcetto grapes to evaluate the effect of ABA in an experimental vineyard located in Alba, Piedmont (Italy). A 1.5 mM ABA solution was sprayed on the grape clusters at two stages: at 30% veraison and 20-25 days after this stage. Four clusters per plant received the treatments for each of four replicates. Three samplings were carried out: before ABA application, and after the first and second ABA applications. In each sampling, the weight of 100 berries, berry diameter, Brix degree, pH, total acidity, tartaric acid, malic acid, citric acid, glucose, and fructose were determined. Additionally, anthocyanin concentration and profile are being evaluated by HPLC. Whole berry and skin texture analysis was done at harvest. Data were analyzed by one-way ANOVA and Tukey test. Results showed that the treatment did not affect any variables such as berry weight, pH, Brix degree, total acidity, or texture parameters for 'Dolcetto'. However, an increase in the anthocyanin content have been found in the treated berries compared to the control. Contrary, 'Nebbiolo' showed a significant increase in berry weight, Brix degree, and pH, while total acidity decreased with the treatment. Anthocyanin content in 'Nebiolo' is being evaluated.

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POSTER COMMUNICATION

Insulative effects of vine shelters may impact growth potential and cold hardiness of young vines

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Keywords: grapevine, vineyard establishment, cold hardiness, heat stress, dormancy

ABSTRACT

Context and purpose of the study. The seasons immediately following planting are key growth stages where young vines are particularly susceptible to various forms of damage. Although vine shelters provide protection, with erratic temperature swings becoming more common, certain vine shelter types may directly or indirectly harm vines. The greenhouse effect provided by the insulative properties of shelters may increase heat injury potential during summer months. Conversely, the insulative effects of the shelters may increase the risk of cold injury during winter months. Vines acclimate at the start of winter into a state of dormancy and deacclimate entering spring, thereby providing protection from cold injury in a process that could be disrupted by shelter properties. The warmer environment provided by certain vine shelters may disrupt acclimation or promote deacclimation prematurely.

Material and methods. Five commonly used shelters were installed on a newly planted research vineyard block in Lubbock, Texas in April 2024. Investigated shelter types included waxed cardboard of two heights (18" and 30"), solid recyclable plastic (15"), opaque corrugated plastic (30"), and transparent blue polyester (30"). Watchdog 1000 series micro stations (Spectrum Technologies, Aurora, Illinois) were installed in each shelter type to measure temperature and relative humidity. Eichorn-Lorenz phenological stages were surveyed to assess growth rate. Beginning in November 2024, samples will be collected for measuring bud cold hardiness using differential thermal analysis (DTA).

Results. Waxed cardboard shelters had lower daytime temperatures than all other shelter types. Transparent blue polyester shelters had the highest daytime temperatures, followed by corrugated plastic shelters. Differences in recorded growth rate did not correlate with differences observed in temperature between shelter types. On the final date of assessment, vines housed in the blue polyester shelters, which provided the warmest growing environment, were the least developed. The question of whether shelter type may impact vine acclimation, dormancy, and deacclimation will be addressed using DTA from collected bud samples beginning in November 2024. This information will be of particular value as extreme and unpredictable late winter and early spring temperature swings become more common, increasing the risk of early vine deacclimation and susceptibility to cold damage.

POSTER COMMUNICATION

Drip irrigation and precision cooling reduce impact of extreme heat events during berry ripening

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Keywords: heatwave mitigation, drip irrigation, advanced cooling, yield and quality, grape chemistry

ABSTRACT

Context and purpose of the study. Heatwaves have become more frequent and intense in several winegrowing regions. Supra-optimal temperatures (≥ 35 °C) reduce vine physiological activity and increase water stress. Yield is negatively affected by extreme heat, with average losses of 20% or more. Grape quality is also impacted, as color, mouthfeel and aroma compounds become more prone to degradation over 35 °C. Drip irrigation is a useful tool for heatwave mitigation. Berry dehydration and quality losses were reduced by increasing irrigation during heatwaves, even more so when irrigation was increased prior to the event. Advanced cooling techniques may also provide added benefits by directly improving vine microclimate. In the present study, drip irrigation and precision cooling systems for heatwave mitigation were evaluated in California.

Material and methods. Experimental treatments were applied to Cabernet Sauvignon vines grown commercially in the Sonoma AVA, CA in 2024. Six drip irrigation and four canopy cooling treatments were compared to control vines drip-irrigated at 80 % of crop evaporanspiration (ETc), with four replicates each. Drip irrigation treatments were a combination of amount (120 % or 160 % ETc) and timing (0, 1 or 2 days prior) of supplemental irrigation. Precision cooling treatments varied by the emitter location (above, in or below the canopy), flow rate and distribution. Canopy cooling was applied automatically at Tambient ≥ 35 °C. Fruit zone temperature and vine water status were monitored during heatwaves, yield components and fruit composition were assessed before and after each heatwave and at harvest.

Results. The 2024 season was characterized by unprecedented levels of heat, mostly concentrated pre-veraison. All cooling treatments were able to reduce fruit zone temperature, ranging -1.5 to -6 °C. The effect of drip irrigation on fruit zone temperature was negligible. Both drip irrigation and precision cooling led to higher yield at harvest, up to +50% with the highest volume of irrigation. Grape composition at harvest was improved by means of drip irrigation and canopy cooling, with a prevailing effect of cooling techniques. Cooler fruit zone temperature was linked to greater berry anthocyanins, moisture content and lower off-note volatiles, namely 1-octen-3-ol and acetic acid. These results highlight how different irrigation techniques may be used to prevent yield and quality losses caused by extreme heat events.

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POSTER COMMUNICATION

Grapevine rootstock field evaluation under drought and saline condition in California

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Keywords: drought, salinity, rootstock, scion

ABSTRACT

Climate change impacts grape production worldwide and in California drought and salinity became increasingly challenging for grape growers to maintain sustainable production and fruit quality. Four rootstocks, Freedom, 1103 Paulsen, 140 Ruggeri, and RS 3, were field tested under the drought and saline conditions in the San Joaquin Valley of California. Two scions, Barbera and Colombard, were grafted on those four rootstocks along with their own rooted vines in 2020. Soil and irrigation water were sampled annually to confirm the salinity level, and irrigation B was found consistently at 1.7 ppm which is considered toxic for grapevines. A two-way split block experimental design was conducted in 2024: two irrigation regimes and five rootstocks were repeated four times. 50% ETc and 80% ETc through the growing seasons were applied as the irrigation regimes. Petioles were collected at bloom and veraison to measure the plant nutrients. Mid-day leaf water potential (ψ) and fruit-zone photosynthetic active radiation (PAR) were collected biweekly after fruit set until harvest. Rootstock had a significant effect on grapevine nutrient uptake, berry pH, TA and lowered water stress compared to own-rooted vines when the water deficit was high. Higher water deficit resulted in lower leaf ψ, higher PAR, lower nutrient uptake, smaller berry size, and higher berry anthocyanins content for Barbera. No yield difference was observed from irrigation regimes or rootstocks. Interestingly, a significant difference of petiole nutrient contents between two scions on the same rootstock and irrigation regimes was observed. Data collection will resume in 2025.

POSTER COMMUNICATION

Impact of grapevine rootstock genotypes on nitrogen status of the scion and phenolic composition in Pinot noir berries and wine

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Keywords: grapevine rootstock, N-status, phenolic composition, micro-scale winemaking

ABSTRACT

Context and purpose of the study. Nitrogen (N) limitation enhances the production of phenolic compounds in grapes due to the downregulation of the flavonoid biosynthesis pathway. Grapevine rootstocks influence the N status of the grafted scion through variations in their uptake and assimilation efficiency. However, the extent to which rootstocks regulating the vegetative growth of the scion have an impact on fruit and wine composition remains poorly understood. This study aimed to determine whether the effect of rootstocks on the phenolic composition of Pinot Noir berries and wines is related to the N status of the scion.

Material and methods. A rootstock trial, was planted 2003 in a vineyard of Hochschule Geisenheim University (Germany). The investigation was carried out on Pinot Noir vines grafted onto 17 rootstocks across four field replicates over three vintages (2012–2014). The rootstocks included Riparia Gloire, 5C, 8B, SO4, Binova, 125AA, 420A, Kober 5BB, 110 Richter, 140 Ruggeri, 1103 Paulsen, 41B, 101-14, Schwarzmann, Georgikon 28, Börner, and Rici. Yield, vigor, together with scion N status were recorded using an optical sensor and juice yeast-assimilable nitrogen. Phenolic composition in Pinot Noir berries was analyzed, and micro-scale fermentation was performed to produce wines for each replicate.

Results. While rootstock had no significant effect on Pinot Noir fruit yield ($p=0.181$), it significantly influenced both vigor and the N status of the scion. Berries from Pinot Noir vines grafted onto rootstocks such as 5C, 420A, 41B, 1103 Paulsen, SO4, and 140 Ruggeri exhibited significantly higher tannin concentrations in both skins and seeds compared to those grafted onto Georgikon, Riparia, 8B, 125AA, and Schwarzmann. However, these differences were not observed in the wines. Anthocyanin concentrations were higher in berries from vines grafted on 8B, 420A, 5C, 41B, and 110 Richter, with this trend translating into wines, showing an inverse relationship with the scion's N status.

Conclusion. This study highlights the critical interaction between rootstock-driven N uptake efficiency and scion phenolic composition in berries and wines. These findings provide a foundation for selecting rootstocks that align with desired wine profiles and vineyard management objectives.

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POSTER COMMUNICATION

Global geo changes, including climate: viticulture result on new viticulture-viticolture in a territory both further north of the region and at high altitude

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Keywords: EME4.1C sustainability, bioMetaVersoEcoMetaEthic 4.1C and 5.1C, new table and wine grape at nord end high altitudes, in the mountains, tolerant and resistant grape varieties, EME4.1C district, Academy of the Diffused Vineyard, non-invasive

ABSTRACT

Context and purpose of the study. In relation to global geo changes, including climatic ones, the following research has been conducted: 1. In Europe's highest vineyard (1395 m.a.s.l.) (Cargnello, 2014÷2021; Cargnello & Col. 2019÷2021), 2. Previously conducted studies in viticulture-viticolture and winemaking according to the "Great Chain MetaEthic 4.1C" framework of thought, applied philosophy, methodology, and the "MetaEthicAlgorithm4.1C" or "AlgorMetaEtico4.1C" from the "Conegliano Campus 4.1C" (Cargnello, 1985÷2021; Cargnello e Col. 1988÷2021) and to the EME4.1C viticultural ones presented at this GiESCO2025, 3. Studies in the plains within the "BioMetaVersoEcoMetaEthic 4.1C Districts" (Cargnello, 2017÷2024; Cargnello & Col. 2020÷2024). In 2022, the corresponding author extended the research to mountainous areas between 900 and 1250 m.a.s.l., starting with the viticultural-viticoltural and winemaking sectors for an oenology ME5.1C and therefore for a "BioMetaVersoEcoMetaEthic 5.1C-4.1C" wine-making activity and therefore for a ME5.1-4.1C wine-making activity harmoniously inserted into the territory. This work will present the very innovative oenological results obtained thanks also to the foresight, sensitivity, passion and precious collaboration of those who had requested and obtained the authorization to cultivate the vine in this land. This work presents the highly innovative results achieved in winemaking, thanks to the foresight, sensitivity, passion, and valuable collaboration of those who requested and obtained authorization to cultivate vines for vines on this land. A separate study submitted to this GiESCO2025 will focus on the resulting multi-productive vines, including table grapes.

Materials and methods. The vineyard is located in the Ampezzo Valley at 940 m.a.s.l. It was established and managed to ensure that the vineyard, as a beautiful and multi-productive entity in a strategic position for communication and marketing (Cortina and Olympics 2026), along with the grapes and wine, can be effectively highlighted with this logoand certified EME4.1C (Cargnello, 2014÷2024; Cargnello e Col. 2018÷2024). Therefore these specific oenological activities have been designed and conducted according to the "Sustainability EME4.1C" protocol of the "MetaEthicAlgorithm4.1C" or "AlgorMetaEthical4.1C" of the "Conegliano Campus 5.1C" and in particular for bioMetaVersoEcoMetaEthic5.1C-4.1C (Cargnello, 1985÷2024; Cargnello & Col. 1988÷2024) relating to: These specific activities were designed and conducted following the "EME4.1C Sustainability" protocol of the "MetaEthicAlgorithm4.1C" or "AlgorMetaEtico4.1C" from the "Conegliano Campus 5.1C" (Cargnello, 1985÷2024; Cargnello & Col. 1988÷2024) with particular emphasis on: 1. as a beautiful and multi-productive entity in a strategic position for communication and marketing (Cortina and Olympics 2026), 2. On the "Well-being of psychophysical existence 5.1C-4.1C" of all resources, including human ones, 3. on the identification, conservation, improvement, and enhancement Ad Maiora 4.1C of the existing, of everything that exists, including the landscape, 4. on the application of originality in process and product (Cargnello, 1986÷2011) for the production of a "sur le lit" sparkling wine from white Solaris and a rosé, using "health-promoting" yeasts, 5. oenochemical analysis of the wine, 6. evaluation of the wine according to: 1. the EnoConegliano-AssoEnologi evaluation sheet (Cargnello, 1996÷2023), 2. the EME4.1C115.6T sheet from Conegliano Campus 5.1C (Cargnello, 2011÷2024), which summarizes in 15 aspects over 5000 elements of the "EME4.1C Sustainability" of the "MetaEthic Algorithm 4.1C" or "AlgorMetaEthico4.1C" of Conegliano Campus 5.1C (Cargnello, 2011÷2024). To this EME4.1C sustainability evaluation, the assessment of the wine has been added concerning: 1. buyer satisfaction, on a scale of 1 to 100, 2. and the price the buyer is willing to pay for the wine, based on the De Rosa sheet (De Rosa, 1977), modified by Cargnello to include these two factors (Cargnello, 1981÷2017). This De Rosa-Cargnello evaluation sheet was recently used in a thesis at the University of Padua (Boatto, Cargnello, Lunardelli, 2018). Furthermore, these two wines were compared with the Prosecco produced by the winery. Results – For obvious reasons, only the most important results are presented here in a very summarized form: 1. Oenochemical Analyses: White sparkling wine:

Alcohol: 11.2%, Residual sugars: 13 g/l, Total acidity: 5.73 g/l, pH: 3.13, Malic acid: 2.0 g/l, tartaric acid: 1.69 g/l; Rosé sparkling wine: Alcohol: 11.3%, Residual sugars: 13 g/l, Total acidity: 5.73 g/l, Malic acid: 1.97 g/l, Tartaric acid: 1.75 g/l, pH: 3.13, 2. Wine Evaluation Based on the Following Criteria: EnoConegliano-AssoEnologi Sheet: White sparkling wine: 91 points out of 100, Rosé sparkling wine: 96 points out of 100; 2. EME4.1C115.6T from Conegliano Campus 5.1C: Both wines were positively assessed across all 15 aspects of "EME4.1C Sustainability," allowing the use of the EME4.1C logo; 3. De Rosa Sheet Modified by Cargnello: A higher buyer satisfaction compared to Prosecco: +8 points out of 100 for the white sparkling wine, +14 points out of 100 for the rosé sparkling wine; A greater willingness from buyers to pay more: +116% for the white sparkling wine, +129% for the rosé sparkling wine. These results are attributed to the innovative and sustainable EME4.1C features of these new productions in the region. **Conclusions and perspectives.** These initial results are very encouraging, especially considering the context of the 2024 production.

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POSTER COMMUNICATION

Vitivoltaics: overview of the impacts on grapevine performance, wine quality, design features and stakeholder perceptions

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Keywords: vitivoltaics, grapevine shading, berry and wine quality, sustainable viticulture, renewable energy

ABSTRACT

This multidisciplinary study investigates "Vitivoltaics," where photovoltaic (PV) panels are integrated into vineyard systems to generate renewable energy while providing partial shade to grapevines. With climate change pressures, such as rising temperatures and water scarcity, vineyards increasingly need strategies that support both sustainable grape production and decarbonisation. Vitivoltaics could meet this need by combining energy generation with agricultural resilience. In trials conducted at the University of Adelaide's Waite Campus, alongside virtual and commercial vineyard simulations, researchers evaluated the impact of PV-induced shading on vine physiology, grape quality, wine chemistry, and consumer perceptions.

Experimental trials used mock PV panels to simulate shading and examined responses in grapevine growth, canopy structure, photosynthetic performance, and berry composition. Findings showed that vines adapt to partial shading by expanding leaf area and internode length, with modest reductions in CO2□ assimilation but no loss in yield or quality. Shaded grapes exhibited slower but complete ripening, and berry acidity and nitrogen, beneficial for winemaking, were higher under PV panels, with consistent sugar and flavonoid levels across treatments. Sensory analyses confirmed that wines from shaded grapes matched the quality of those from unshaded vines, suggesting that partial shading does not impact sensory attributes when grapes are allowed to reach target maturity.

In addition to physiological effects, the study explored modular PV designs to optimise mechanical and electrical efficiency with minimal vineyard disruption. Feedback from stakeholders and consumers was positive, indicating a favourable view of integrating renewable energy into viticulture, which is especially beneficial in Australia's challenging climate, where water resources are limited, and sustainability efforts are highly valued. These findings suggest that Vitivoltaics could be a viable, climate-adaptive solution for vineyards, supporting consistent grape production and wine quality while enhancing environmental sustainability.

POSTER COMMUNICATION

Impact of agrivoltaics on berry ripening: preliminary results for the white cv. Viosinho

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Keywords: adaptation measure, agrivoltaics, slower ripening, canopy shading, *Vitis Vinifera* L.

ABSTRACT

Climate change poses significant challenges for viticulture, particularly in Mediterranean regions like Portugal, where extreme heat and drought conditions are becoming more frequent. In parallel, the growing global demand for energy has intensified competition for land between agricultural use and solar energy production. Agrivoltaic systems offer a potential solution by combining crop cultivation with photovoltaic energy generation on the same plot of land. In viticulture, the shade provided by these systems can potentially reduce heat stress, avoid early ripening, and reduce berry sunburn while generating electricity for local consumption or sale to the grid. The objective of this study was to evaluate the effects of an agrivoltaic system as a multifunctional climate change adaptation strategy for viticulture, focusing on the berry ripening period of the Portuguese white grape variety Viosinho at the Lisbon winegrowing region.

An agrivoltaic system was installed in May 2024 over an adult N-S oriented vineyard, trained in a vertical shoot positioning system. Within the agrivoltaic setup two treatments were considered depending on panel position, PVI (panels over the interrow) and PVR (panels over the row) which were compared against a control (C) in full sun conditions. As the panels were installed at pea-sized berries phenological stage, in this work, only the results related to berry ripening are presented. Grape composition analysis was conducted weekly between full veraison and harvest, based on four randomized samples of 200 berries per treatment.

The shading promoted by the panels induced a significantly lower °Brix on the PVI and PVR treatments as compared to the C, at the first sampling date. These differences were maintained until harvest mainly for the PVR treatment. Regarding the relative differences in titratable acidity and pH among treatments, a similar trend was observed but without significant differences. The shaded treatments reached the target maturity (~20° Brix) with a delay of 12 days compared to the C. These preliminary results indicate that the Agrivoltaic system induced a slower ripening, hinting that it might be considered a potential adaptation measure for climate change. Further studies are ongoing to confirm these effects.



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