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International Conference



Innovations for Sustainable Crop Production in the Mediterranean Region

Palermo 2024, July 11th and 12th

Department of Agricultural, Food and Forest Sciences
Main lecture hall "Gian Pietro Ballatore"
Viale delle Scienze, Edificio 4

Book of abstract

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Scientific collaborator: Simona Prestigiacomo

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University of Palermo, Italy

Prof Leo Sabatino
University of Palermo, Italy

Dr Roberto Massenti
University of Palermo, Italy

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Foreword

The Mediterranean region, with its rich cultural history and varied landscapes, represents a true treasure of biodiversity.

The agricultural sector plays a fundamental role, being the main source of food, forage, and raw materials for the production of textiles and biofuels for billions of people. However, increasing anthropogenic pressure and climate change present new environmental challenges to the sustainability of agriculture in this region. The agricultural sector holds significant potential to tackle these environmental issues by optimizing the impacts of its operations. With the aim of addressing these challenges in a collaborative and scientifically informed manner, the conference “Innovation for Sustainable Crop Production in the Mediterranean Region,” which will be held for the second consecutive year in the city of Palermo on July 11-12, 2024, will continue the discussions and dialogues initiated last year. This event represents an important moment of debate and knowledge exchange in the field of sustainable agricultural development, where the most current and relevant topics for industry professionals, scientists, students, and enthusiasts will be addressed, divided into five thematic areas.

Prof. Tiziano Caruso
Chair of the Scientific Committee

Prof. Giuseppe Di Miceli
Chair of the Organizational Committee

Conference programme

Thursday, 11 July 2024

8:30 Registration

9:30 Welcome, Opening and Addresses

- **Prof Massimo Midiri**, Rector University of Palermo
- **Prof Tiziano Caruso**, Head of the Department of Agricultural, Food and Forest Sciences, University of Palermo
- **Prof Leo Sabatino e Prof Giuseppe Di Miceli**, Conveners
- **Dr Dario Cartabellotta**, Director General of the Department of Agriculture, Sicily Region

10:00 **Session 1** - *Mediterranean Region: Biodiversity, Crop Productions, Livestock Systems and Environmental Sustainability*

Chair **Prof Tiziano Caruso**, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Keynote lecture

Strategies to support crop productions and reduce GHG emissions in the Mediterranean area

Dr Leonardo Verdi, Department of Agriculture, Food, Environment and Forestry, University of Florence, Italy

Invited speaker

Physiological and biometeorological approaches for efficient irrigation management in California olive and pistachio orchards

Prof Giulia Marino, Department of Plant Sciences, University of California, Davis

Combining nitrogen fertilization and biostimulant application in durum wheat: effects on morphophysiological traits and grain production

Prof Roberto Ruggeri, Department of Agricultural and Forest Sciences, University of Tuscia, Italy

The impact of the Environmental, Social and Governance (ESG), companies report on the agriculture activity & sustainability

Prof José Rafael Marques da Silva, Instituto de Ciências Agrárias Mediterrânicas, Department of Rural Engineering, University of Évora, Portugal.

Functional agrobiodiversity: intercropping with legumes as the most promising tool for facilitating phosphorus availability in the Mediterranean cropping systems.

Dr Emilio Lo Presti, Department of Agriculture, University of Reggio Calabria, Italy

*Feeding responses and dairy production of ewes fed dehydrated sulla forage (*Sulla coronaria* (L.) Medik) as alternative to hay*

Dr Marialetizia Ponte, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Comparison of olive oil consumers between Spain and Portugal

Prof Amparo Baviera-Puig, Polytechnic University of Valencia, Spain

13.00 Light lunch

14.30 **Session 2** - *Medicinal plants and industrial crops: towards sustainable management*

Chair **Prof Konstantinos A. Aliferis**, Department of Crop Science, Agricultural University of Athens, Greece

Keynote lecture

Sustainable management of medicinal and nutraceutical plants - a partnership for bioactive compound production?

Prof Ana Luisa Fernando, Universidade Nova de Lisboa, Portugal

Invited speaker

Intercropping systems with cardoon in mountainous Mediterranean regions: a case study from Sardinia

Prof Vittoria Giannini, Department of Agronomy Food Natural resources Animals and Environment, University of Padova, Italy

Medicinal and Aromatic Plants Cultivation and Processing in Türkiye

Prof Nazim Şekeroğlu, Department of Biology, Gaziantep University, Gaziantep, Turkey

Brassicas in the Mediterranean Basin: more opportunities than problems

Dr Roberto Matteo, Research Centre for Cereal and Industrial Crops, Bologna, Italy

Effects of sustainable agronomic management in giant reed for biomethane production

Dr Alessandra Piccitto, Department of Agriculture, Food and Environment, University of Catania, Italy

Digestate, cover crops and soil tillage management: preliminary results on soil fertility and on mais (Zea mais L.) crops

Dr Enrica Allevato, Department of Environmental and Prevention Sciences, University of Ferrara, Italy

Rapid measurement and statistical ranking of leaf drought tolerance capacity in cotton

Prof Xuejun Dong, Department of Soil and Crop Sciences, Texas A&M University, United States

17.00 Short presentation

Chair **Prof Albino Maggio**, Department of Agricultural Sciences, University of Napoli, Italy

Effect of biostimulants foliar application on yield, essential oil and chemical properties of organically grown sage

Dr Davide Farruggia, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Expression of plant-environment interaction of four groups of Vicia faba selected from a mixed population

Dr Antonella Iurato, Department of Agriculture, Food and Environment, University of Catania, Italy

Assessing the environmental impact of durum wheat in Sicily, Italy: a comparison between conventional and organic systems

Dr Monica Auteri, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Joint Action of Trichoderma atroviride and a Vegetal Derived-Protein Hydrolysate Improves Yield, Fruit Quality of Two Woodland Strawberry Cultivars Grown Under Greenhouse

Dr Pietro Bellitto, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

RIUBSAL: opportunities for expanding the use of reclaimed water for olive tree irrigation

Dr Francesco Abbatantuono, Department of Soil, Plant and Food Science, University of Bari Aldo Moro, Italy

Molybdenum biofortification as eustress factor through arbuscular mycorrhizal fungi application in a cherry tomato soilless system

Dr Lorena Vultaggio, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Trend of research on durum wheat irrigation by bibliographic mapping

Dr Noemi Tortorici, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Vegetation Analysis and Productivity Assessment of Natural Pastures in Madonie Regional Park, Sicily

Dr Nicoletta Lala, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Differential physiological activity and metabolomic signatures of lettuce plants grown under nitrogen deficiency conditions and treated with different vegetal derived biostimulants

Dr Christophe El Nakhel, Department of Agricultural Sciences, University of Naples Federico II, Italy

Effects of pasture supplemented with Aloe Vera on lamb meat production: preliminary results

Dr Simona Prestigiacomo, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Effects of biostimulants and corroborants on plant pathogenic fungi

Dr Marika Lamendola, Department of Agricultural, Food and Forest Sciences (SAAF), University of Palermo, Italy

Evaluation of Olive Oil Polyphenols' Properties on Ex Vivo Models: Results from Preliminary Studies

Dr Anna Calabrò, Department of Biomedicine, Neurosciences and Advanced Diagnostics, University of Palermo, Italy

20:00 Inauguration of the Santa Rosalia exhibition presso "Villa Niscemi", piazza Niscemi, Palermo and **conference dinner**.

Friday, 12 July 2024

9:00 **Session 3** – Food and health: how the research of well-being passes through the agri-food production system

Chair **Prof Giuseppina Candore**, Department of Biomedicine, Neurosciences and Advanced Diagnostics, University of Palermo, Italy

Keynote lecture

The importance of Diet in Health: What About the Future?

Prof Antonio Garcia Rios, Department of Internal Medicine, Maimonides Biomedical Research Institute of Cordoba (IMIBIC), University of Cordoba, Spain

Invited speaker

Functional foods for healthy aging

Dr Giulia Accardi, Department of Biomedicine, Neurosciences and Advanced Diagnostics, University of Palermo, Italy

The Nutraceutical Properties of Rhus coriaria Linn: Potential Application on Human Health and Aging Biomedicine

Dr Anna Aiello, Department of Biomedicine, Neurosciences and Advanced Diagnostics, University of Palermo, Italy

Nutraceuticals and healthy aging, implications for a positive nutrition

Prof Giovanni Scapagnini, Department of Medicine and Health Sciences "V. Tiberio", University of Molise, Italy

Non-Celiac Wheat Sensitivity: a new challenge for cereal growers

Dr Aurelio Seidita, Department of Health Promotion Sciences, Maternal and Infant Care, Internal Medicine and Medical Specialties, University of Palermo, Italy

Nutrition, epigenetic modulation and healthy ageing

Prof Giuseppe Passarino, Department of Biology, Ecology and Earth Sciences, University of Calabria, Italy

11:30 **Session 4 - Entomology and Pathology: pesticide which scenario for the next future in a contest of the new European Green Deal?**

Chair **Dr Slavica Matic**, Institute for Sustainable Plant Protection, National Research Council, Turin, Italy

Keynote lecture

Plant protection products in EU: too many or too few? A look to fungicides and related alternatives

Prof Gianfranco Romanazzi, Department of Agricultural, Food and Environmental Sciences, Marche Polytechnic University, Ancona, Italy

Invited speaker

Sustainable strategies to improve resilience to fungal diseases in berry crops

Prof Tânia R. Fernandes, Sustainable Agrifood Production Research Centre, University of Porto, Portugal

How to manage plant disease risk when implanting a new crop as sugarcane in a Mediterranean European environment

Prof Jean Heinrich Daugrois, Department Bios, Research unit Plant Health Institute

Montpellier, CIRAD, France

Coming of age: metabolomics in biostimulant research and development to combat the climate crisis and secure food supply

Prof Konstantinos A. Aliferis, Department of Crop Science, Agricultural University of Athens, Greece

Honeydew management to promote biological control

Dr Maite Fernández de Bobadilla, Centro de Protección Vegetal y Biotecnología, Instituto Valenciano de Investigaciones Agrarias, Spain

Chemical and visual cues in host-plant selection of the melon ladybird: new perspectives in biological control

Dr Valerio Saitta, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

14:00 Light Lunch

15:00 **Session 5** – *Innovative approaches for agricultural water management in a climate change*

Chair **Prof Giorgio Micale**, Department of Engineering, University of Palermo, Italy

Keynote lecture

Experimental investigation of the performance of a seawater reverse osmosis desalination system operating under variable feed flowrate pressure and temperature

Prof George Papadakis, School of Environment and Agricultural Engineering, Agricultural University of Athens, Athens, Greece

Invited speaker

Constructed wetlands as nature-based solution for sustainable wastewater treatment and reuse for agriculture: a critical assessment by experimental studies and literature

Prof Mario Licata, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy.

Improving irrigation efficiency by using sensors to monitor the soil-plant-atmosphere system

Dr Vincenzo Alagna, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Use of remote sensing and modelling for crop and water monitoring in mediterranean area

Dr Dominique Courault, UMR 1114 EMMAH, INRAE, Avignon, France

Biostimulants, N level and drought stress intensity synergistically orchestrate yield, quality and physiology of greenhouse-grown basil

Dr Beppe Benedetto Consentino, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy.

Risk perception and the water crisis: a geographical approach

Prof Gaetano Sabato, Department of Psychology, Educational Science and Human Movement, University of Palermo, Italy.

Continuous monitoring of tree water potential in olive for efficient irrigation management

Prof Paula Guzman Delgado, Department of Plant Sciences, University of California, Davis

Regulated deficit irrigation to boost processing tomato sustainability in Mediterranean environment

Dr Nicolo Iacuzzi, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy.

17.00 Short presentation

Chair **Dr Giovanni Gugliuzza**, Research Centre for Plant Protection and Certification, Italy

Climate change, water scarcity and adaptation strategies in Sicily

Dr Antonino Drago, Department Agriculture Sicily Region, Italy

Medicago intertexta as a forage crop: exploring various utilizations in the Mediterranean environment

Dr Lucia Dinolfo, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Saffron “the red gold spice”: how to improve its profitability

Dr Cinzia Barbieri, Department of Agricultural, Forest and Food Sciences, University of Torino, Italy

Agronomic evaluation of 13 cotton varieties to organic cultivation in a hot arid environment

Dr Federica Alaimo, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

*Morphometric and agronomic traits multivariate analysis of sumac (*Rhus coriaria* L.) grown wild in Eastern Sicily*

Dr Valentina Formica, Department of Agriculture, Food, and Environment, University of Catania, Italy

*Comprehensive Protein-Protein Interaction Network Analysis of *Xylella fastidiosa* in Fruit Tree Crops*

Dr Aparna S. Balan, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

A Decade-Long Quantitative and Qualitative Characterization of 18 Lemon Cultivars

Dr Aurora Cirillo, Department of Agricultural Sciences, University of Naples Federico II, Naples, Italy

Composting sewage sludge with biochar and zeolite: effect on composting process and soil-sunflower system

Dr Sara Paliaga, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

*Can the combination of two apulian traditional agri-food products generate a superfood? The case of functional taralli with *Pleurotus eryngii**

Dr Fortunato Cirilincione, Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, Italy

*First report of *Sargassum muticum* in *Caretta caretta*, Sicily, Italy.*

Dr Rosalia Disclafani, Sustainability and Ecological Transition Center, University of Palermo, Italy

Impact of saline groundwater irrigation on net assimilation in Cucumis melo cv. Huanghemi in north-western China

Dr Miriam Distefano, Institute of BioEconomy (IBE), National Research Council of Italy (CNR), Catania, Italy

The potential role of hormone-related genes in controlling the olive dwarf phenotype observed in the F2 progeny of 'Koroneiki'

Prof Annalisa Marchese, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

The spearmint sector: a niche activity with strong development potential in Morocco

Dr Kawtar Mahrach, Department of Food and Nutritional Sciences, HASSAN II Agronomic and Veterinary Institute, Rabat, Morocco

Overview on the global spice and herbs market with a focus on Morocco's position

Dr Fatima Zahraa Lahsaini, Department of Food Science and Nutrition, Hassan II Institute of Agronomy and Veterinary Medicine, Rabat, Morocco.

19:30 Closing of the Conference and Final Conclusions

Dr Roberto Massenti e Prof Giuseppe Di Miceli, Conveners

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SESSION 1

Mediterranean Region: Biodiversity, Crop Productions, Livestock Systems and Environmental Sustainability

Strategies to support crop productions and reduce GHG emissions in the Mediterranean area

Leonardo Verdi^a

^aDepartment of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence

Corresponding author: Leonardo Verdi <leonardo.verdi@unifi.it>

Keywords: nitrous oxide, methane, fertilization, irrigation

In the Mediterranean, the time gap between peak irradiance and temperature (summer) and higher water availability (winter), along with the low organic matter (OM) content in most cropped soils, contributes to the low productivity of rain-fed crops. On the other hand, irrigated systems leverages solar radiation and prolonged frost-free periods to achieve high yields. The distinct soil conditions between irrigated and rain-fed crops influence soil microbial processes, which regulate the fluxes of carbon (CO₂, CH₄) and nitrogen (N₂O, NO₃⁻, NH₃) in soil. Soil water content and nutrient availability are the most influential factors affecting N₂O emissions in the Mediterranean area. Therefore, mitigation strategies targeting these emissions play a crucial role in reducing greenhouse gas (GHG) emissions in the Mediterranean. Paddy soils contribute to approximately 6% of the total CH₄ emissions from Mediterranean agriculture. These substantial CH₄ emissions result from methanogenesis under strictly anaerobic conditions and low redox potentials. Conversely, aerobic agricultural soils, whether rain-fed or irrigated, promote CH₄ oxidation, which is highly dependent on management practices i.e. nitrogen fertilization. Agricultural management strategies aimed at reducing methanogenesis in paddy soils or enhancing CH₄ oxidation in aerated soils are often overlooked in Mediterranean agriculture, despite their potential to significantly reduce total GHG emissions from these systems. In recent decades, GHG emissions from the agricultural sector have shown a continuous increase. However, the trends observed in the Mediterranean indicate a relatively stable pattern, accounting for about 5% of global emissions. At the European level, GHG emissions amount to approximately 40% of the total emissions, highlighting the importance of regional mitigation actions. The rationalization of nitrogen use, the selection of fertilizer types (synthetic, organic, nitrification inhibitors), the optimization of irrigation, and the increase of soil carbon stock are the most promising strategies for reducing GHG emissions in the Mediterranean. However, there are still open questions about the best choices to adopt in order to achieve the maximum mitigation potential of emissions in the Mediterranean.

Physiological and biometeorological approaches for efficient irrigation management in California olive and pistachio orchards

Amrit Pokhrel^a, Andre Daccache^a, Emily Santos^a, Giulia Marino^a, Paula Guzman Delgado^a, Suvocrec Kosana^a

^aUniversity of California, Davis

Corresponding author: Giulia Marino <giumarino@ucdavis.edu>

Keywords: irrigation management, evapotranspiration, plant-based monitoring, water use optimization

The future of agriculture is linked to our capability to find a way to maintain profitable production systems with limited water quantity and quality. Despite a large volume of research on irrigation, there is still a gap between research advancement and its implementation, due to a tradeoff between simplicity of use and precision of the various irrigation methods. Plant-based monitoring has stand out in the last decades for its precision; however, its practical implementation is hindered by the limited number of monitored plants, the lack of quantitative information on water needs, and the complexity of data interpretation. Empirical estimations of evapotranspiration (ET) are widely used for irrigation management due to their simplicity, although their reliance on a few crop coefficients (Kc) fails to adequately account for the diverse orchard features, thus affecting their precision. Actual ET (ETa) measurements are increasingly common thanks to new measuring and estimation methods, but they also suffer from drawbacks, including low temporal scales. In this study, we explored the potential of combining approaches spanning spatial and temporal scales to quantify irrigation needs. Specifically, we compared continuous and discrete tree-level measurements of water status and orchard-level measurements of water use using the energy balance method for olive under water limited conditions and for pistachio grown on saline-sodic soils. Overall, this study highlights the importance of adopting integrated approaches to enhance water use prediction and optimize water application in agricultural settings.

Combining nitrogen fertilization and biostimulant application in durum wheat: effects on morphophysiological traits and grain production

Angelo Rossini^a, Roberto Ruggeri^a, Francesco Rossini^a

^aUniversity of Tuscia

Corresponding author: Roberto Ruggeri <r.ruggeri@unitus.it>

Keywords: rizhobacteria, root analysis, seaweed extracts, *Triticum turgidum* L. subsp. *durum* (Desf.) Husn

Nitrogen (N) fertilization is a pivotal agronomic practice to obtain both high yields and grain quality in durum wheat. However, since the overuse of synthetic fertilizers is raising a global concern for the environment, new crop nutrition strategies are needed to accomplish the goal of “producing more by consuming less”. The use of biostimulants was suggested as a sustainable option to promote crop yield, since they are able to improve nutrient use efficiency and tolerance to stresses. Information about the relationship between biostimulant application and N fertilization of durum wheat in field conditions is still limited.

A field experiment was conducted under rainfed conditions in Viterbo (Italy), during two growing seasons, to explore the possible interaction between the effect of biostimulants application and N fertilization. A split-plot design with three replicates was used. Nitrogen fertilization level was the main treatment, while biostimulant application was the sub-treatment. Durum wheat cv. ‘Iride’ was used, and three N fertilization rates were tested: 50, 100 and 150 kg ha⁻¹. In sub-plots, three experimental products containing different biostimulants (e.g., seaweed extracts, glycine betaine, micronized vaterite and rizhobacteria) were compared among them and with the control treatment (no biostimulant application). Total N dose was split in three times: at sowing, tillering and the beginning of the stem elongation. For each plot, the following traits were recorded at different growth stages: length (cm), area (cm²), volume (cm³), and diameter (mm) of roots using WinRHIZO software; chlorophyll content (Chl) using the spad meter; grain yield at maturity.

Wheat plants treated with biostimulant products outperformed the control plants for both root development (more than doubled in length) and chlorophyll content, this latter was evident especially in late growth stages (from +75% to +82% Chl). Regarding grain yield, application of biostimulants produced a 9% to 24% increase. No interaction between treatments were observed for measured traits except for root area and volume.

The impact of the Environmental, Social and Governance (ESG), companies report on the agriculture activity & sustainability

José Rafael Marques da Silva^{ab}

^a University of Évora

^b Agroinsider Lda, Évora, Portuga

Corresponding author: José Rafael Marques da Silva <jmsilva@uevora.pt>

Keywords: ESG reporting, sustainability standards, value chain impact

ESG is all about making a difference: to the planet, to your people and to your organization. So, what is it, and how is it important to any economic activity such as agriculture? ESG stands for Environmental, Social, and Governance. It encapsulates several standards that measure how an organisation's activities contribute to sustainable, viable development, and how that organisation minimises its negative impacts on the planet, its people, and itself.

ESG is also known as the non-financial report that the largest European companies will be required to include in their annual reports starting in 2024. This practice has already been adopted by various companies globally for several years. Gradually, by 2026, it is estimated that 54,000 companies in Europe will be mandated to present this type of non-financial report, with well-defined obligations and specific characteristics. One of the requirements of ESG reporting is to monitor the value chain to understand the upstream and downstream ESG footprints of the company's activities.

Companies that are not yet required to publish this type of annual report are already anticipating this new standard within their operations, as they recognize that ESG indicators (**Environment**: Climate change, Ecological footprint, Resource use; **Social**: Health & Safety, Customer responsibility, Community impact, Labour standards; **Governance**: Risk management, Tax transparency, Anti-corruption) will influence the cost of bank credit, making it cheaper or more expensive depending on the company's scores in these three areas. Agricultural companies are not required to submit their ESG reports. However, their value chain, specifically distribution, needs to consult their suppliers, requiring a set of data that agricultural companies will need to start providing if they wish to remain operational in the market. The question remains: What type of data will be most requested from agricultural companies by their value chain, and what is the relative value of this data for their business?

Functional agrobiodiversity: intercropping with legumes as the most promising tool for facilitating phosphorus availability in the Mediterranean cropping systems

Emilio Lo Presti^a, Giuseppe Badagliacca^a, Michele Monti^a

^aUniversità Mediterranea di Reggio Calabria

Corresponding author: Emilio Lo Presti <emilio.lopresti@unirc.it>

Keywords: functional agrobiodiversity; intercropping; grain legumes; phosphorus; root exudates; root architecture; rhizosphere bacterial community.

Intercropping is proposed as one of the best practices within the agroecological approach based on functional agrobiodiversity. One of the most important functional crops that in intercropping facilitates phosphorus (P) uptake of the intercropped cereal are grain legumes. Great attention is focused on their root interactions, which are mediated by root intermingling, and the role of the rhizosphere bacterial community. Considering the low availability of P in the soil for Mediterranean crops, the improvement of the P use efficiency is an interesting way to reduce external inputs to the agroecosystem.

To shed light on the mechanisms driving P facilitation in grain legume-wheat intercropping, a series of experiments using several grain legumes were carried out at the Department Agraria of the Mediterranean University of Reggio Calabria. The main results of these studies are presented and particularly focus on: i) the effect of soil P availability on root exudation and how it influences P uptake of intercropped wheat; ii) the effects of increasing grain legume density on facilitation and competition; iii) how the roots react to P availability in intercropping due to their phenotypic plasticity and whether it affects root intermingling; iv) how grain legumes shape their rhizosphere bacterial community due to P availability and whether it can help in using the sparingly available P fraction in intercropping. The most relevant outcomes suggested that a) intercropping always facilitated P uptake of wheat at low P availability; b) the P uptake response to each legume species was affected by its density, which modified root exudates in the wheat rhizosphere; c) the root intermingling was enhanced at low P availability, which can be explained by root proliferation near the neighbour roots; d) the rhizosphere bacterial communities of the legumes and intercropped wheat were enriched with phosphate solubilising bacteria (PSB) when P was less available.

Feeding responses and dairy production of ewes fed dehydrated sulla forage (*Sulla coronaria* (L.) Medik) as alternative to hay

Marialetizia Ponte^a, Marianna Pipi^a, Riccardo Gannuscio^a, Giuseppe Maniaci^a, Marco Alabiso^a,
Massimo Todaro^a, Antonino Di Grigoli^a, Adriana Bonanno^a

^aDipartimento Scienze Agrarie, Alimentari e Forestali (SAAF), Università di Palermo, Italy

Corresponding author: Marialetizia Ponte <marialetizia.ponte@unipa.it>

Keywords: condensed tannins, feed intake, digestibility, milk yield, cheese, fatty acids profile, antioxidant capacity

Fresh sulla forage, due to its contents in protein and condensed tannins, is known to enhance the productive responses of dairy ewes, but the same effects do not emerge when it is provided as hay. With the aim to improve the quality traits of sulla forage stocks, in this research dehydration is proposed as alternative to haymaking. Thus, dehydrated and pelleted sulla forage (DSF) was compared with sulla hay (SH) evaluating their effects on efficiency of feed utilization and dairy production of ewes of Valle del Belice breed. According to a 3x3 Latin square design, 9 ewes at 60 days in milk were successively fed with 3 diets in which the forage component was constituted by SH ad libitum supplied alone (SHL) or integrated with 2 kg/day DSF derived from an early (EDSF) or a late cut (LDSF). All the ewes received also concentrate feed at level of 800 g/day. The crude protein was 8.8, 15.1 and 11.3 % dry matter (DM) for SH, EDSF and LDSF, respectively. Compared to SH, both DSF based diets significantly increased ewes feed intake (+0.6 kg DM/day), milk yield (+0.4-0.3 kg/day), and the content of polyunsaturated fatty acids in cheese, mainly due to linoleic, α -linolenic and rumenic acids. The EDSF also improved DM digestibility, ewes' milk conversion ratio and the cheese antioxidant capacity; moreover, it reduced the estimated daily methane emissions (-3 g CH₄/kg milk). These results evidence as dehydration of sulla forage can represent a suitable alternative to haymaking, especially when applied to an early-cut forage.

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Comparison of olive oil consumers between Spain and Portugal

Amparo Baviera-Puig^a, Isabel López-Cortés^a, Federico Modica^b, Nuno Rodrigues^c

^aUniversitat Politècnica de València

^b University of Palermo

^cInstituto Politécnico de Bragança

Corresponding author: Amparo Baviera-Puig <ambapui@upv.es>

Keywords: olive oil, consumer behavior, marketing, attitudes, interests.

Olive oil is an agricultural product produced mainly in the countries of the Mediterranean basin and is part of the so-called Mediterranean Diet. Olive oil consumption is growing due to more informed consumers seeking the health benefits of olive oil, in addition to the search for healthier foods. The health benefits of olive oil are well known leading to increased olive oil consumption across Europe. This study aims to analyse consumer preferences in the Iberian Peninsula by comparing, within the European Union, the country with the highest olive oil production with the country with the lowest production. Based on a survey of 376 people in both Spain and Portugal, we analyse the differences in relation to the relationship with olive oil, purchasing attitudes and the most and least important factors. It is observed that there are differences in price perception and willingness to pay between the two countries. When Best-worse scaling is used, the differences are found with respect to brand name. These results have managerial implications when designing and developing marketing strategies in the olive oil sector in one country as well as in another.

Expression of plant-environment interaction of four groups of *Vicia faba* selected from a mixed population

Antonella Iurato^a, Venera Copani^a, Alessandra Piccitto^a, Salvatore Luciano Cosentino^a & Giorgio Testa^a

^aDepartment of Agriculture, Food and Environment (Di3A), University of Catania, Italy

Corresponding author: Antonella Iurato <antonella.iurato@unict.it>

Keywords: *Vicia faba*, Mediterranean environment, plant productivity, animal feeding

Faba bean (*Vicia faba* L.) is one of the most ancient cultivated crops and, in the Mediterranean countries, it is widely used in human and animal nutrition because of its high nutritional value. This legume is also important for the positive effect on soil productivity given by its nitrogen fixation capacity. Therefore, this species can be seen as a key crop to include in crop rotation to minimise the inputs on fertilization. The genetic variability of faba bean species is large, bringing a continuous variation in productivity and morphological characteristics. Genetic resources and environmental influence can be linked to overcoming loss in productivity due to unpredictable climatic conditions and abiotic stresses in general. Among the most important *vicia faba* varieties, *Vicia faba* L. var. *minor* requires particular attention because of its potential in animal feeding and more varieties adapted to Mediterranean conditions are needed.

This study aimed to understand the interaction between the environment and the plants of 4 groups of *Vicia Faba* L. under field conditions. The trials were performed in two locations in Sicily and the productivity and the growth behaviour were assessed to understand the influence of the climatic conditions of the site. The groups studied were compared to two commercial varieties, selected by the University of Catania (Sicania and Sikelia).

Assessing the Environmental Impact of Durum Wheat in Sicily, Italy: A Comparison Between Conventional and Organic Systems

Monica Auteri^a, Giuseppe Di Miceli^a, Mario Licata^a, Rose Mankaa^b, Simona Prestigiacomo^a, Marzia Traverso^b

^aDep. of Agricultural, Food and Forest Sciences, University of Palermo

^bInstitute of Sustainability in Civil Engineering, RWTH Aachen University

Corresponding author: Monica Auteri <monica.auteri@unipa.it>

Keywords: Life Cycle Assessment, wheat, organic, conventional, environmental sustainability

Wheat production is one of the most important agricultural systems, with an estimated global area of about 219 million hectares. It has been shown that agricultural systems and the cereal industry as part of this, may potentially threaten biodiversity and ecosystem functions. This highlights the necessity to optimise the production of wheat grain in an environmentally sustainable way. The aim of this study was to evaluate and compare the environmental impacts of conventional and organic wheat grain production systems in Sicily using the Life Cycle Assessment (LCA) method. The analysis was conducted using data from 21 farms (14 conventional and 7 organic) based in Sicily in 2021 and 2022. A "cradle to gate" system boundary was specified. All wheat cultivation activities were considered. In this study, yield (t ha⁻¹) was used as the functional unit (FU). In the life cycle inventory stage, primary data was collected through questionnaires. Secondary data from Ecoinvent v.3.0 was used in instances where the necessary primary information was unavailable. The analysis was carried out using SimaPro 9.5.0.1. The CML-IA baseline impact assessment method was used, considering 11 categories. The results showed that for almost all impact categories, conventional farming had higher environmental impacts than organic farming. Normalized results suggested that, for both systems, marine aquatic ecotoxicity was the most affected impact category, with calculated values ranging from 1,30E+05 to 1,05E+06 kg 1,4-DB eq.

For the conventional system, most of the impact categories were mainly influenced by transport of all products and by pesticide production, especially for ozone layer depletion and abiotic depletion. The only exception was terrestrial ecotoxicity, which was mainly affected by seed production. Only eutrophication was primarily affected by the cultivation step. The production of packaging, lubricating oil and waste treatments had no significant impact. In organic system, in almost all categories, the most significant impacts were related to the production and use of diesel. Furthermore, there were no differences between self-produced seeds vs. seeds that were sourced from local producers. The findings of this study are useful in assessing solutions to reduce the environmental impacts related to wheat production.

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Joint Action of *Trichoderma atroviride* and a Vegetal Derived-Protein Hydrolysate Improves Yield, Fruit Quality of Two Woodland Strawberry Cultivars Grown Under Greenhouse

Pietro Bellitto^a, Beppe Benedetto Consentino^a, Lorena Vultaggio^a, Salvatore La Bella^a, Leo Sabatino^a

^aDepartment of Agricultural, Food and Forest Sciences, University of Palermo, Italy.

Corresponding author: Pietro Bellitto <pietro.bellitto@unipa.it>

Keywords: *Fragaria vesca* L., microbial biostimulant, non-microbial biostimulant, pot cultivation, fruit quality

The aim of current research was to appraise the potential impact of two biostimulants [*Trichoderma atroviride* and a vegetal-based protein hydrolysate (V-PH)], when applied alone or in combination, on the performance of two woodland strawberry genotypes ('Alpine' and 'Regina delle Valli'). Overall, the results showed that 'Alpine' genotype was more productive than 'Regina delle Valli', although it revealed lower fruit qualitative features. The application of *T. atroviride* or V-PH resulted in a notable increase in terms of marketable yield (+20.5% and +12.9% for *T. atroviride* and V-PH, respectively) and anthocyanins (+14.1% and +9.8% for *T. atroviride* and V-PH, respectively) compared to the non-treated control. Plants from plots treated with both biostimulants (*T. atroviride* and V-PH) had higher marketable yield (+34.8%), flavonoid (+26.3%) and anthocyanins (+29.9%) compared to non-treated plants. Furthermore, our study highlighted that the highest fruit polyphenols concentration was observed in fruits from plants ('Alpine' and 'Regina delle Valli') treated with both microbial and non-microbial biostimulants and in those from 'Regina delle Valli' genotype exposed to V-PH. Our study suggests that the joint application of *T. atroviride* and V-PH is a useful approach for improving yield and fruit quality of woodland strawberry.

Vegetation analysis and productivity assessment of natural pastures in Madonie regional park, Sicily

Nicoletta Lala^a, Giuseppe Di Miceli^a, Gianniantonio Domina^a, Mario Licata^a, Simona Prestigiacomo^a
Lucia Dinolfo^a

^a Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Corresponding author: Nicoletta Lala <nicoletta.lala@unipa.it>

Keywords: grasslands, biodiversity, grazing, agroforestry

Grasslands are an essential component of Europe's land use, accounting for more than one-third of the continent's agricultural area. They provide food for herbivores and ruminants and deliver essential ecosystem services erosion control, water regulation, water purification, carbon storage, biodiversity enhancement, and wildfire prevention. Despite their significance, permanent grasslands in Europe have been declining for over 50 years, with regional variations. The mountainous area of Madonie in Central-Northern Sicily has experienced a decline in economic activities such as hospitality and agriculture over the past decade, primarily due to climate change. Concurrently, the increase in wild ungulates like wild boars and deer has significantly pressured grazing resources, challenging small and medium-sized livestock farms, that rely on the direct use of natural pasture resources. In light of these issues, a study was conducted at Madonie Natural Park to better understand the impact of uncontrolled intensive grazing by wild animals on the environment, agricultural activities, and ecosystem services. This study is focused on floristic, vegetation, phytopastoral, and productive characterization in order to deepen knowledge, to update and to have a precise overview of mountain pastures. This will enable subsequent analysis and potentially propose sustainable alternatives within the context of agroforestry. Research activities started in October 2023 in an area within the Madonie Park, ranging from 900 to 1635 meters above sea level. Therefore, five significant sites were identified that represent the physical and vegetational variability of the study area, and exclusion cages of 3×5 meters were installed in each of them. These areas were compared with adjacent areas subjected to direct use by wild animals. Various surveys were conducted, including vegetation analysis using the Braun-Blanquet method, vegetation structure and density examination via the Daget and Poissonet linear analysis method, and pastoral value calculation using specific indices. Potential load on pastures was assessed using fragility coefficients, indicating pasture sensitivity to environmental pressures. Preliminary results from the study have shown significant differences in floristic composition between grazed and ungrazed areas. Areas not grazed by ungulates showed a greater diversity of herbaceous species, with plant formation characterized by the presence of 4 — 5 dominant and indicative species. The previous different pastoral use has led to the creation of various units of vegetation. The findings suggest that more careful and deliberate grazing management can promote biodiversity recovery and restore the original structure of pastures. This has important implications for the conservation management of Madonie Park, suggesting the need to implement an integrate management aimed at creating synergistic interactions between agriculture, forestry, and breeding.

Medicago intertexta as a forage crop: exploring various utilizations in the Mediterranean environment

Lucia Dinolfo^a, Nicoletta Lala^a, Simona Prestigiacomo^a, Chiara Maria Maggio^a, Giuseppe Di Miceli^a

^aDepartment of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Corresponding author: Lucia Dinolfo <lucia.dinolfo@unipa.it>

Keywords: forage, intercropping, legumes

In recent decades, forage production systems have become more concerned about the effects of global climate change on animal feed. Choosing forage species that thrive in adverse conditions and adopting sustainable management methods, such as intercropping, are crucial aspects in building resilient systems. Self-seeding annual legumes can benefit low-input systems by providing forage and abundant seeds in the next season. The soil seed bank, primarily composed of hard seeds acts as a crucial reserve, ensuring pasture regeneration during harsh winters or growth disturbances (Ley farming). *Medicago intertexta* L., or Calvary medick, is a relatively underexplored annual self-seeding plant that could be significant in these systems. In semi-arid areas of the Mediterranean, incorporating this species into forage systems can have beneficial effects on livestock production, nutritional quality, nitrogen fixation, and soil fertility. This is achieved by maintaining soil organic matter and enhancing soil structure. Despite these favorable factors and its widespread wild distribution in the Mediterranean region, the practical utilization and diffusion of this species in agricultural systems are currently hindered by a lack of scientific knowledge regarding its agronomic management. This study aimed to evaluate the forage production performance of *M. intertexta* in both pure stands and mixed cropping systems, simulating various utilization and management methods. Field experiments were conducted during the 2023-2024 growing season at the experimental farm "Carboj" (Department of Agricultural, Food and Forest Sciences, University of Palermo, Castelvetrano, Trapani, Italy). The experiment was set up in a split-plot design with four replications. The main plots consisted of Calvary medick (*M. intertexta*), ryegrass (*Lolium multiflorum*), berseem clover (*Trifolium alexandrinum*) in pure stands, and their mixtures arranged in alternating rows, adopting a substitutive intercropping design. Sub-plot treatments included five different utilization methods:

High-intensity utilization: first cut at 100 days after sowing at 3 cm and subsequent cuts at 35-day intervals.

Low-intensity utilization: first cut at 100 days after sowing at 8 cm and subsequent cuts at 35-day intervals.

Double high-intensity utilization: first cut at 100 days after sowing at 3 cm and subsequent hay production.

Double low-intensity utilization: first cut at 100 days after sowing at 8 cm and subsequent hay production.

Only one cut at the flowering moment for hay production.

The preliminary results highlight how different management practices affect plant behaviors and competitive abilities. For instance, *M. intertexta* demonstrated a low competitive ability. Regarding

productivity, berseem clover, renowned for its regrowth capacity, exhibited good performance under grazing simulation and double-use management. In contrast, *M. intertexta* proved more sensitive to cutting, leading to modest production in grazing and double-use systems, but it showed higher yields under hay production management. Regarding the results on intercropping, *M. intertexta* benefited significantly from intercropping with ryegrass. Under high-intensity cutting, this combination was particularly advantageous, resulting in the highest yield for ryegrass in terms of dry matter (DM). Conversely, *M. intertexta* was much more productive in hay production. Intercropping with *T. alexandrinum*, however, resulted in relatively modest yields. *M. intertexta* is less suited to intensive management but can be productive under specific cutting conditions.

Comprehensive protein-protein interaction network analysis of *Xylella fastidiosa* in fruit tree crops

Aparna S Balan^a, Giorgia Tranchina^a, Floriana Bonanno^a, Francesco Paolo Marra^a, Tiziano Caruso^a, Antonio Giovino^b, Annalisa Marchese^a

^aDepartment of Agricultural, Food and Forest Sciences, University of Palermo, Italy;

^bCouncil for Agricultural Research and Economics, Research Centre for Plant Protection and Certification (CREA-DC), Palermo, Italy.

Corresponding author: Aparna S Balan <aparna.sheelabalan@unipa.it>

Keywords: Co.Di.RO; *X. fastidiosa* strains; Olive, Almond, Medicago; putative resistant genes; meta-analysis approach.

Xylella fastidiosa, a notorious bacterium, poses a significant worldwide threat to fruit tree crops by disrupting the sophisticated mechanisms of water and nutrient transport within the xylem, crucial for plant growth and development, and its impact results in devastating symptoms such as leaf scorching, wilting, and the gradual dieback of branches or entire trees, severely compromising agricultural productivity and economic stability. A meta-analysis approach was employed to understand and address the challenges posed by *X. fastidiosa* infections in fruit tree crops by integrating and comparing multiple RNA-Seq datasets from various studies, providing a comprehensive view of gene expression dynamics across different plant species affected by the bacterium. An appropriate bioinformatics pipeline was applied to identify genes that exhibit differential expression patterns in response to *X. fastidiosa* infection. Gene Ontology analysis was performed on the identified differential gene expression data which uncovered enriched GO terms annotating genes crucial to regulatory functions that coordinate the plant's immune response. Mapping and visualizing gene expression data onto key metabolic pathways provided a clear overview of how gene activity influences metabolic processes, which helped identify pathways significantly affected by changes in gene expression and thereby pinpoint critical biological responses. Protein-protein interaction network analysis was conducted to decipher the pathogenic mechanisms of *X. fastidiosa* in these crops utilizing high-throughput sequencing data, protein interaction databases, and network analysis tools. The identification of hub proteins will aid in targeting the pivotal nodes, which have the potential to interfere with multiple pathways simultaneously offering a promising strategy for controlling the infection.

A Decade-Long Quantitative and Qualitative Characterization of 18 Lemon Cultivars

Aurora Cirillo^a, Stefano La Malfa^b, Chiara Catalano^b, Claudio Di Vaio^a

^a Department of Agricultural Sciences, University of Naples Federico II, Portici, Italy;

^b Department of Agriculture, Food and Environment (Di3A), University of Catania, Italy

Corresponding author: Aurora Cirillo <aurora.cirillo9266@gmail.com>

Keywords: germplasm, lemon fruits, *Citrus limon* (L.) Burm. f., yield production, fruits quality, essential oil

The lemon is recognized as the third most extensively cultivated citrus species worldwide, trailing only behind orange and mandarin. The enhancement in the economic value of lemons as a valuable resource in Southern Italy depends by the competitiveness of local lemons in both national and international markets. This necessitates conducting a comprehensive study that thoroughly explores the available indigenous germplasm at the local and national levels. This study aims to identify the most promising Sicilian and Campanian cultivars that are well suited for both fresh fruit consumption and the production of processed goods. The study assumes even greater importance considering the ongoing climate changes, as environmental stresses significantly impact the ripening process and the timing of fruit development. Our study has highlighted a notable diversity among the 18 investigated lemon cultivars, particularly highlighting specific cultivars that possess desirable attributes for fresh consumption. The cultivars that showed the greatest cumulative production over the 10 years of the study were Erice with 467.9 kg/tree and Femminello Siracusano 2KR with 408.4 kg. Notably, cultivars like Segesta, Erice, and Kamarina have exhibited higher percentages of juice content ranging from 27.3% to 31.1%. These cultivars show great potential for abundant juice content and optimal acidity levels for direct consumption. On the other hand, cultivars characterized by enhanced yield, such as Femminello Siracusano 2KR, Femminello Fior d'Arancio m79, and Erice, may prove to be particularly well suited to produce processed goods. The main component in the peels essential oil was limonene, accounting for 72.5-76.4%, followed by β -pinene (11.6-18.7%). Several other monoterpene hydrocarbons were also identified at appreciable contents, namely terpinene (2.88-8.26%), α -pinene (1.4-1.5%) and myrcene (0.95-1.12%). The cultivar that showed a higher content of essential oils in the peel was Femminello Adamo (2282.88 mg/100 g peel), Segesta (2215.51 mg/100 g peel) and Erice (2091.21 mg/100 g peel). Overall, our findings provide valuable insights into some qualitative parameters of lemon cultivars, important either for fresh consumption or for transformed products.

Composting sewage sludge with biochar and zeolite: effects on composting process, soil and sunflower growth

Sara Paliaga^a, Sofia Maria Muscarellaa, Luigi Badalucco^{ab}, Pedro Tomás Bulacio Fischer^a, Daniele Di Trapani^c, Giorgio Mannina^c, Vito Armando Laudicina^{ab}

^aDepartment of Agriculture, Food and Forest Sciences, University of Palermo, Italy;

^bNBFC, National Biodiversity Future Center, Palermo, Italy;

^cDepartment of Engineering, University of Palermo, Palermo, Italy.

Corresponding author: Sara Paliaga <sara.paliaga@unipa.it>

Keywords: sewage sludge compost, soil fertility, shoot/root ratio, phosphorus and nitrogen availability, circular economy

Composting is a promising process for transforming and stabilizing sewage sludge (SS) into a valuable resource. Biochar and zeolite can be used as bulking agents for composting. However, their effect on the composting process, compost quality and soil-plant system upon compost application to soil have not been tested extensively. The aim of this study was to evaluate the effect of biochar and zeolite, as bulking agents, on the composting process and compost quality from SS mixed with pruning residues. Then, compost was tested in a pot experiment to evaluate its effect on soil fertility and sunflower (*Helianthus annuus* L.) growth. Compost with biochar (CB) as bulking agent experienced temperatures and CO₂ emissions higher than those experienced by mixtures with zeolite (CZ) or only pruning residues (CC). Total organic carbon (TOC) and nitrogen (TN) were the highest in CC followed by CB and then by CZ, whereas total phosphorus (P) was the highest in CB. Thus, biochar as bulking agent, revealed a good potential to improve the quality of compost and its sanitization. Soil TN and available P were increased by CC followed by CB and then by CZ. TOC was not significantly affected by compost addition whereas extractable organic C showed the highest concentration in soil+CC and the lowest in soil+CB and soil+CZ. Such a pattern was ascribed to the ability of biochar and zeolite to absorb low weight organic substrates. This reflected also on microbial biomass C which increased only in soil+CC. Finally, CB and CZ addition to soil improved plant growth by 26% compared to the control and, particularly, increased root biomass by 85%, thus allowing plants assimilate more N and, only in the case of CB, also more P in the shoots compared to plants grown in soil not amended. Results showed that biochar, more than zeolite, is very effective as a bulking agent for composting and contributes to producing a compost able to improve soil fertility and plant growth.

First report of *Sargassum muticum* in *Caretta caretta*, Sicily, Italy

Rosaria Disclafani^{a,b}, Paola Galluzzo^a, Giorgia Schirò^a, Chiara Lomonaco^a, Salvatrice Vizzini^b, Paolo Monteverde^a & Salvatore Dara^a

^a Istituto Zooprofilattico Sperimentale della Sicilia “A. Mirri, Palermo, Italy;

^b Centro di Sostenibilità e Transizione Ecologica, Università degli Studi di Palermo, Italy.

Corresponding author: Rosaria Disclafani <rosaria.disclafani@unipa.it>

Keywords: *Sargassum muticum*, *Caretta caretta*, alien species

Sargassum muticum is native to the North Western Pacific coasts. In the Mediterranean Sea, is a noninvasive species, growing in the upper sublittoral zone, lagoons, and offshore harbors. Introduced to Europe in the late 1960s, was first recorded in the Mediterranean in the 1980s in France. Most introductions are due to anthropogenic activities, introduced through oyster farming, in Spain and Italy. Here we report the first finding in Sicily of *S. muticum*, in the gut of a dead *Caretta caretta* recovered from Porto Empedocle (AG). The sea turtle, a male sub-adult, was admitted at Regional Sea Turtle Rescue Centre in May 2024. At necropsy the subject showed presence of the alien *S. muticum*. The successful spread of *S. muticum* is also due to their ability to tolerate pollutants, temperature changes (-1°C to 30°C) and salinity. In America, *S. muticum* has become dominant, posing a threat to biodiversity and interfering with the incubation process of sea turtle eggs, altering sand temperature and negatively affecting the sex of embryos. Its presence in the gut of *C. caretta* turtles found on the Porto Empedocle coast is the first reported in Sicily, although it is common to find it dead in Florida. Still unknown are the impacts that *S. muticum* has on the Mediterranean Sea, considered, to date, a noninvasive alien species. To control the spread of exotic species, it would be necessary to monitor them. *Caretta caretta* sea turtle is a long-lived marine species widely distributed along the temperate and tropical zones of all oceans, as well as in the entire Mediterranean Sea and the only known species nesting along the Italian coast. The *C. caretta*, as a bioindicator and sentinel species, plays a crucial role in assessing the health of the Mediterranean Sea ecosystem.

Impact of saline groundwater irrigation on net assimilation in *Cucumis melo* cv. Huanghemi in north-western China

Miriam Distefano^a, Giovanni Avola^a, Anna Tedeschi^b, Ezio Raggi^a

^a Institute of BioEconomy (IBE), National Research Council of Italy (CNR), Catania, Italy,

^b Institute of Biosciences and BioResources (IBBR), National Research Council of Italy (CNR), Portici, Italy

Corresponding author: Miriam Distefano <miriam.distefano@cnr.it>

Keywords: net assimilation rate, light response curve, saline groundwater, leaf age, temperature, melon, open field

Groundwater salinization is a critical environmental problem, significantly hindering agricultural production. However, saline groundwater could represent the only available resource for irrigation in arid and semiarid regions. Thus, investigating its impacts on crops is crucial to address the challenge of maintaining agricultural productivity and sustainable development. The aim of this open field experiment was to study net assimilation in melon crop (**Cucumis melo* L. cv. Huanghemi*), cultivated in the Minqin Oasis, in response to water saline content. Effects of leaf age and leaf temperature were studied as well. Net assimilation was studied in terms of light response curve parameters (Rd dark respiration; ANmax maximum photosynthetic rate; Qapp ‘apparent’ light efficiency) obtained imposing eight light intensity levels. Two saline water concentrations were evaluated: 0.8 and 5 g L⁻¹ with a conductivity equal to 1.00 and 7.03 dS m⁻¹ respectively. The saline concentrations of the higher conductivity level were obtained reproducing the actual saline concentration in groundwater experienced in progressively expanding areas in Minqin Oasis, differing in ionic composition as well. Measurements were conducted during fruit maturation period (44 and 49 days after transplanting-DAT) when 1.708 m³ha⁻¹ have been restored in 4 applications (10, 23, 36, and 48 DAT). The net assimilation light response curve showed the typical asymptotic response and, among the function coefficients, exclusively ANmax was significantly affected by leaf age, leaf temperature and their interactions, and, in particular, it resulted higher in the younger leaves, and in the colder leaf temperature conditions. In spite of the effects of leaf age and temperature on net assimilation, dark respiration appeared not affected by the studied factors. None of the light response curve parameters were influenced by actual groundwater salinity levels, during the studied crop growth period (60% of the whole cycle).

The potential role of hormone-related genes in controlling the olive dwarf phenotype observed in the F2 progeny of 'Koroneiki'

Irene Granata^a, Aparna S Balan^a, Floriana Bonanno^a, Antonino Ioppolo^a, Tiziano Caruso^a, Francesco Paolo Marra^a, Antonio Giovino^b, Annalisa Marchese^a

^aDepartment of Agricultural, Food and Forest Sciences, University of Palermo, Italy;

^bCouncil for Agricultural Research and Economics, Research Centre for Plant Protection and Certification (CREA-DC), Palermo, Italy.

Corresponding author: Annalisa Marchese <annalisa.marchese@unipa.it>

Keywords: *Olea europaea*, in vitro culture, RNA-seq, dwarf genotypes, breeding

The olive (*Olea europaea* L.) is one of the Mediterranean's most representative and cultivated fruit crops, due to its numerous advantages on human health and ecological plasticity. Over time, many breeding programs have been conducted to select valuable genotypes with desired traits. However, one of the most important agronomic characteristics that remains a challenge is the identification of low-vigor genotypes suitable for high-density orchard systems. The Department SAAF of the University of Palermo raised an F2 progeny from the selfing of the Greek self-fertile cultivar 'Koroneiki' segregating for a wide range of phenotypes showing low vigour traits, including the dwarf phenotype. The transcriptomic analysis of two genotypes exhibiting contrasting plant height and vigour traits (dwarf vs. tall) was performed. The analysis provided a clear and valuable insight into the understanding of the pathways associated with olive plant vigour and juvenility, confirming that phenotypic differences observed both in the field and in vitro are caused by significant genetic differences. The potential involvement of hormone-related genes, in modulating the dwarf traits was observed and this represents a compelling avenue for further exploration. These findings offer great promise for future olive tree breeding programs.

SESSION 2

Medicinal Plants and Industrial Crops: Towards Sustainable Management

Sustainable management of medicinal and nutraceutical plants - a partnership for bioactive compound production?

Ana Luisa Fernando^a

^a Universidade Nova de Lisboa

Corresponding author: Ana Luisa Fernando <ala@fct.unl.pt>

Keywords: medicinal plants, nutraceutical plants, bioactive metabolites, abiotic stress, biotic stress, anticancer, antimicrobial, antioxidant, antidiabetic properties

Medicinal and nutraceutical plants are plants with medicinal or nutritional properties or both. Medicinal plants are plants that exert beneficial pharmacological effect on the human or animal body or possess therapeutic properties and some of them have been used in traditional medicine practices since prehistoric times. Nutraceutical plants are plants rich in nutrients and substances that show pharmaceutical properties, that confer health benefits. Indeed, plants synthesize hundreds of chemical compounds, following a reply mechanism against biotic and abiotic stresses. And those compounds have several functions, e.g. defense and protection against insects, fungi, diseases, and herbivorous mammals, or as a defense against heat stress or water stress. The majority of the bioactive compounds are known for their anticancer, antimicrobial, antioxidant, antidiabetic, and anti-tubercular properties, among others. Plant health and productivity are greatly affected by abiotic and biotic stresses. However, studies on the relationship between plants and living beings: e.g. fungi, bacteria and plants and factors such as temperature or irradiation, offer an option of altering the biosynthetic pathways that produce diverse bioactive and new compounds of economic significance. Therefore, the aim of this work is to present current knowledge on how biotic and abiotic stresses can affect the synthesis of plant secondary compounds in certain medicinal and nutraceutical plants and to provide hints on how a sustainable crop management can contribute to a higher production of plant metabolites of economic significance with limited yield loss.

Intercropping systems with cardoon in mountainous Mediterranean regions: a case study from Sardinia

Pietro Todde^a, Pier Paolo Roggero^a, Vittoria Giannini^b

^aUniversity of Sassari

^b University of Padova

Corresponding author: Vittoria Giannini <vittoria.giannini@unipd.it>

Keywords: serradella, forage radish, weeds, biomass

Cardoon (*Cynara cardunculus* var. *altilis*) is a versatile Mediterranean crop used in marginal land both for food and energy production. This study focuses on I) verifying the adaptability of this crop to Mediterranean mountain environments and II) testing cardoon intercropping with forage species (*Ornithopus sativus* - serradella and *Raphanus sativus* var. *oleiformis* – fodder radish), in the perspective of reducing weed competition and assuring useful production also in the first year of the crop growing cycle, usually unproductive when cardoon is grown as a single crop. Phenological and biometric data were collected systematically. At the end of the first-year field experiment, the results showed that the species chosen for intercropping influenced the cardoon density, their height and biomass production levels. At the end of the third year (2023), the observed cardoon density was significantly higher (6.8 plants m⁻²) in the plots cultivated with fodder radish than in the control or serradella plots (2.1 and 2.2 plants m⁻² respectively). The cardoon seed yield was significantly higher in the plots intercropped with fodder radish (2.73 t ha⁻¹) than in the serradella and control plots (0.904 t ha⁻¹ and 0.372 t ha⁻¹, respectively). The biomass production obtained from the inter-row showed sufficiently high production levels and a floristic composition of high pastoral value, making this intercropping management a suitable option to cope with the first unproductive year of the cardoon in mountain pastoral communities.

The intercropping with serradella influenced the weed species composition by favouring indirectly some Poaceae via the nitrogen fixation. These results offer promising agronomic options for the management of arable agricultural land in the Mediterranean mountains by integrating fodder production with alternative crops to enhance local agro-biodiversity.

Medicinal and Aromatic Plants Cultivation and Processing in Türkiye

Nazim Şekeroğlu^a

^a Gaziantep University, Turkey

Corresponding author: Nazim Şekeroğlu <nsekeroglu@gmail.com>

Keywords: Medicinal and Aromatic Plants, rural developments, sustainable production, domestication, wild harvesting of MAPs

Medicinal and Aromatic plants (MAPs) have become a rising value all over the world in the last decades. These distinguished crops classified under industrial plants are of important raw materials in order to develop novel natural products especially in food, medicine, cosmetic, perfumery, textile industries. Although the main source of MAPs, around 80%, is wild collection from flora, standardized sustainable raw material needs make some of them made main cultivated plants. Türkiye is one of the most important suppliers for medicinal and aromatic plants (MAPs) worldwide. Medicinal and aromatic plants exported from Türkiye have mostly been obtained from wild harvested from the rich flora of the county with more than 13.000 plant taxa, even today. However, the number of cultivated MAPs and their harvesting area is increasing day by day. The Turkish government manage sustainable wild harvesting of the MAPs with applicable rules and support these plants in situ cultivation and processing, especially in the rural areas. Cultivation of the MAPs started with limiting tobacco production and replacing novel crops with government financial and technical support in the beginning of 2000's. Oregano, one of the most exported MAPs and mostly wild harvested, was the first novel crop from wild to field in Türkiye. After the successful domestication and cultivation story, nowadays, almost 80% of the exported Oregano has been obtained from field production. After Oregano many plant species which have economic importance started to cultivate on the fields. Orchids (*Orchis sancta* and *Serapias vomeracea*) for salep have been produced on the field cultivation, recently. Mountain tea (*Sideritis spp.*) cultivation studies are successfully going on and many other wild collected MAPs are about to cultivate on the fields in Türkiye. Turkish authorities are supporting medicinal and aromatic plants cultivation and more than 70 different MAPs species have been financially supported nowadays. We believe that many different MAPs species would be produced on the fields in the near future in Türkiye and rural development could be achieved by these plants' cultivation.

Brassicas in the Mediterranean Basin: more opportunities than problems

Bruno Parisi^a, Eleonora Pagnotta^a, Laura Righetti^a, Lorena Malaguti^a, Manuela Bagatta^a, Massimo Montanari^a, Nerio Casadei^a, Roberto Matteo^a, Ugolini Luisa^a

^a Research Centre for Cereal and Industrial Crops (CREA), Bologna, Italia

Corresponding author: Roberto Matteo <roberto.matteo@crea.gov.it>

Keywords: Isothiocyanate, myrosinase, bioactive molecules

Beside the approximately 40 million hectares of rapeseed for oil production, the cultivation of other Brassicaceae for agri-food and industrial applications is not very widespread. In fact, the plants belonging to this family grown in the Mediterranean environment are mainly horticultural that derive from an ancient heritage and productions are relatively limited. Interestingly, though, the huge botanical biodiversity of this plant family, made of almost 4000 species and more than 300 genera, opens possibilities to many research and innovations, in particular considering the wide spectrum of plants potentially suitable for the Mediterranean climate area. This biological variety also translates into an incredible diversity of active compounds that can be exploited for the creation of innovative value chains. Some products are already on the market, such as the ones exploiting Brassicaceae in the so-called biofumigation technique for plant protection in agriculture. More recent research focuses on applications of products derived from their defatted seed meals, such as the protein hydrolysates with potential biostimulant properties on plants growth or extracts with nutraceutical properties for human health and honeybee protection. Another interesting example of applications in a Mediterranean environment concerned the cultivation, rainfed and with minimal agronomic inputs, of *Eruca sativa* and *Camelina sativa* for the production of biomasses enriched in bioactive molecules, in particular glucosinolates. Certainly, compared to rapeseed, agronomic yields remain low, but these plants fit better in Mediterranean climate and the work of varietal selection, breeding, and the study of the best cultivation techniques are still in their infancy. For these reasons, in the next future the opportunities given by these plants may overcome the problems related to their cultivation.

Effects of sustainable agronomic management in giant reed for biomethane production

Alessandra Piccitto^a, Antonella Iurato^a, Barbara Rachele Ciaramella^a, Giorgio Testa^a, Salvatore Luciano Cosentino^a

^aUniversità degli Studi di Catania

Corresponding author: Alessandra Piccitto <alessandra.piccitto@phd.unict.it>

Keywords: *Arundo donax* L., lignocellulosic biomass, long-term plantation, anaerobic digestion, biomethane, white rot fungi, fungal pretreatment

In recent years, lignocellulosic perennial grasses have been increasingly attracted as a feedstock to produce biomethane through anaerobic digestion, considered a sustainable energy solution for reaching the RED II directive's aims. *Arundo donax* L., commonly known as giant reed, is a lignocellulosic perennial rhizomatous grass, diffused in the Mediterranean area. Among different perennial grasses, *Arundo donax* L. is a promising candidate for bioenergy production because of its ability to thrive in a wide range of environmental conditions, also in marginal areas with low agronomic inputs (use of irrigation, fertilizers, and pesticides). Lignocellulosic material from perennial grasses can be converted into several biofuels and by-products through different biochemical or thermochemical processes. Anaerobic digestion is one of the most environmentally friendly technologies to produce biomethane from lignocellulosic material, however adopting lignocellulosic biomass as substrate a pretreatment is necessary to break down the tough structure, weakening cellulose crystallinity and increasing the surface area for enzymatic attack. Among pretreatment methods, the biological one is the most sustainable since it is a mild process that doesn't use chemical reagents and doesn't require high energy, cost, and equipment inputs.

This study aimed to evaluate the long-term yield of *Arundo donax* in the semiarid Mediterranean environment in relation to harvest time and nitrogen fertilization and its biomethane production using a fungal pretreatment.

Digestate, Cover crop and different soil tillage management: preliminary results on soil fertility and on maize (*Zea mays* L.) crop

Enrica Allevato^a, Valentina Quintarelli^a, Morthada Ben Hassine^a, Daniele Borgatti^a, Maria Ianiri^a, Emanuele Radicetti^a, Silvia Rita Stazi^a

^aUniversità degli studi di Ferrara

Corresponding author: Enrica Allevato <enrica.allevato@unife.it>

Keywords: soil quality, crop production, conservative agriculture, sustainability

Excessive industrialization in agriculture, with high mineral fertilizer use and intensive soil tillage, reduces soil fertility and crop production. Conventional tillage determines heavy soil disturbance up to 0–25 cm depth. In contrast, no-till and minimum tillage practices, based on minimal soil disturbance, improve soil quality by preserving structure, supporting biological processes and increasing microbial biodiversity. Alternative agronomical practices are needed to minimize negative impacts while maintaining yields. This study compared the effects of different tillage practices on soil health and maize cultivated for biomass production. Part of a long-term experiment started in 2017 at Fondazione per l'Agricoltura F.lli Navarra (Ferrara, Italy), it includes sustainable practices like digestate application and cover crops. The treatments were: Conventional tillage (CT), Minimum tillage (MT), Long-term no-tillage (ONT, 7 years), Newly implemented no-tillage (NNT, started in 2023). Each treatment was replicated three times in a completely randomized block design. The current data reported is part of the DICO_SOS project (Digestate, Cover Crops and Crop Operations to Increase Soil Organic Matter; Req. no. 5517300; PSR 2014-2020 Reg. Emilia Romagna — 16.1.01 — Focus Area 4B). Soil quality has been assessed, focusing on biochemical properties. Results highlighted that soil biochemical properties varied with soil management practices: MT and ONT showed higher microbial respiration rates than NNT and CT; NNT showed higher soil microbial biomass (SMB) and soil enzyme activities data. Reduced soil disturbance, the use of digestate and crop residues, likely increased available organic matter for decomposition, thereby boosting SMB and altering its activity. Regarding the mais crop, the highest values of mais biomass was observed in CT, even if the biomass production observed in MT resulted like CT (-8%). Although the mais seed germination resulted negatively affected in both no tillage treatments (ONT and NNT), in these plots, mais plants showed higher values of ear weight and length. Preliminary results suggest that conventional agricultural techniques, while increasing production, tend to degrade soil quality. Further research is needed to close the yield gap in maize biomass production.

Rapid measurement and statistical ranking of leaf drought tolerance capacity in cotton

Xuejun Dong^a, Dale Mott^b

^aTexas A&M AgriLife Research

^b Texas A&M University

Corresponding author: Xuejun Dong <xuejun.dong@ag.tamu.edu>

Keywords: Bayesian hierarchical linear model, drought tolerance ranking, fiber quality, leaf dry matter content, leaf osmotic potential at full turgor, lint yield

With the predicted future climate change, the impact of drought stress on the production of agricultural crops can only be expected to become more severe in many parts of the arid and semi-arid regions. Thus, there is an urgent need to rapidly determine the drought tolerance capacity of agricultural crops. Leaf osmotic potential at full turgor as measured using osmometry has widely been regarded as a fast measurement of plant leaf drought tolerance capacity in the past decade. Based on extensive data collected under the field condition, we found that the measurement can be made ten times faster using leaf dry matter content, the ratio of leaf dry mass to saturated mass. This provides an opportunity for more efficiently calibrating remote sensors for indirectly estimating plant water status. We also developed a Bayesian statistical modeling method for cotton drought tolerance ranking and the results were corroborated with measured leaf carbon isotope ratios. Our work highlights the broad linkages between drought tolerance traits and cotton yield/quality indicators, which has implications for obtaining a deeper understanding of drought stress responses cotton and other crops being cultivated in arid and semi-arid regions.

Effect of biostimulants foliar application on yield, essential oil and chemical properties of organically grown sage

Davide Farruggia^a, Mario Licata^a, Johannes Novak^b

^aDepartment of Agricultural, Food and Forest Sciences, University of Palermo, Italy

^bClinical Department for Farm Animals and Food System Science, University of Veterinary Medicine, Vienna, Austria

Corresponding author: Davide Farruggia <davide.farruggia@unipa.it>

Keywords: Biostimulants, sage, yield, Monoterpenes, Antioxidants, Phenolics

Sage (*Salvia officinalis* L.) is a medicinal and aromatic plant (MAP) belonging to the Lamiaceae family. The morphological, productive and chemical characteristics of this species are affected by abiotic and biotic factors. The application of biostimulants seems to be one of the most interesting innovative practices due to the fact they represent a promising approach for achieving sustainable and organic agriculture. Despite a large application in horticulture, the use of biostimulants on MAPs has been poorly investigated. On this basis, a field experiment in a 2-year study was done to assess the effect of foliar treatments with different types of biostimulants (containing seaweeds, fulvic acids and protein hydrolysates) on the main characteristics of sage organically grown in a Mediterranean environment. Morphological, productive, and chemical parameters were significantly affected by biostimulants. The application of three biostimulants produced higher values of plant height, chlorophyll content, relative water content, biomass yield and essential oil yield compared to those of control. In treated-plants with fulvic acid and protein hydrolysates, the highest total fresh yields (between 3.9 and 8.7 t ha⁻¹) and total dry yields (between 1.3 and 2.5 t ha⁻¹) were found. The essential oil yield almost doubled with protein hydrolysates application (33.9 kg ha⁻¹) compared with control. In this study, 44 essential oil compounds were identified. The highest percentage of the most representative monoterpenes (1,8-cineole, α -thujone and camphor) were observed in biostimulated plants, with an average increase between 6% and 35% compared to control. The highest values for total phenolics, rosmarinic acid, antioxidant activity were, instead, obtained in the control. This study emphasizes how the application of biostimulants may be exploited to improve the yield performance of sage, and the essential oil quality. At the same time, biostimulants caused a decrease in total phenolic, antioxidant activity and rosmarinic acid values.

Agronomic Evaluation Of 13 Cotton Varieties To Organic Cultivation In A Hot Arid Environment

Federica Alaimo^a, Davide Farruggia^a, Nicolò Iacuzzi^a, Noemi Tortorici^a, Teresa Tuttolomondo^a

^aDepartment of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Corresponding author: Federica Alaimo <federica.alaimo02@unipa.it>

Keywords: cotton, yield, genotypes, *Gossypium*, semi-arid areas

Cotton (*Gossypium* spp.), belonging to the Malvaceae family, is a semi-xerophytic species native to central-northern America and Mexico. It is one of the most relevant species for the production of natural fiber. Unlike most agricultural raw materials, cotton fiber is not produced from one but from 39 species of *Gossypium*. In the last few years, the growing interest in natural fibers around the world has led to a revival of cotton cultivation in the Mediterranean area as well. With the aim of its possible re-establishment in Sicilian environment, this work has set the objective of evaluating the agronomic response of 13 different genotypes, belonging to the species of *Gossypium hirsutum* L., *Gossypium barbadense* L. and hybrids of *G. hirsutum* × *G. barbadense*, grown under organic regime.

The test was carried out in 2023 in Sicily (Italy), adopting an experimental design with randomized blocks with three replicates. Regarding to production data, the raw fiber yield, the lint fiber % and the seed % showed highly significant differences ($p \leq 0.001$). The highest raw fiber yield was obtained in the variety PRG 9811 (5.99 t ha⁻¹), while the lowest yield in Olivia C1 (2.0 t ha⁻¹). Both varieties belong to the species of *G. hirsutum* and come from Greece. The highest percentage of lint fiber was found in the variety Concha (48,45 %) of *G. hirsutum*, that comes from Spain; while the lowest was found in the variety HA1432 (37,37 %), a hybrid of *G. hirsutum* and *G. barbadense* that comes from the US.

The results of this study are promising, revealing the possible reintroduction of cotton in the cultivation systems of the semi-arid areas of Sicily. All the 13 varieties have shown a specific capacity to adapt to Sicilian climatic conditions and some of them stand out in terms of productivity.

Morphometric and agronomic traits multivariate analysis of sumac (*Rhus coriaria* L.) grown wild in Eastern Sicily

Valentina Formica^a, Antonio Favara^a, Silvia Zingale^a, Sebastiano Infantino^a, Orazio Riccardo Fisicaro^a,
Carola Di Giovanni^a, Paolo Guarnaccia^a

^aDepartment of Agriculture, Food, and Environment, University of Catania, Italy

Corresponding author: Valentina Formica <valentina.formica@phd.unict.it>

Keywords: medicinal and aromatic plants, biodiversity, environment, ecotypes, conservation

Sumac (*Rhus coriaria* L.), belonging to the Anacardiaceae family, is a Medicinal and Aromatic Plant (MAPs) native to the Asian continent. Thanks to its wide adaptability, it has since spread to many Mediterranean countries, such as the Canary Islands, the Azores, Madeira, and other East Asian countries. Despite its beneficial aromatic, medicinal, and anti-cancer properties due to several active ingredients in its leaves and drupes, sumac in Sicily is considered a naturalized plant that grows spontaneously in various areas, from arid to calcareous soils, potentially acquiring different properties. Indeed, from the interaction of genotype and environment, new phenotypes develop that vary in chemical profiles, morphometric, and agronomic traits. This study investigates the morphometric and agronomic diversity within different wild samples collected in 17 locations in Eastern Sicily. The hypothesis was to verify the variability within the different ecotypes using multivariate analysis. In each site, five branches bearing infructescences were collected during the maturity stage in 5 sample areas during autumn 2022. Infructescences height above ground, number per unit area, length, diameter, and dry weight; leaves number and dry weight; branches length, diameter and dry weight; drupes number and dry weight were measured. StataSE 18 software was used for hierarchical cluster analysis, grouping samples based on morphometric and agronomic traits and geographic locations. Initially, 10 clusters have been found, which were later reduced to 7. A one-way ANOVA and Sidak's post-hoc test were performed to identify significant differences between the clusters for all parameters and locations. The results show a highly significant difference among the clusters for all parameters ($p < 0.0001$); the clustering analysis also indicates a significant variability among the examined locations ($p = 0.0062$) indicating a phenotypic difference of sumac growing spontaneously in Sicily. Deepening the analysis through genetic and chemical characterization could provide valuable insights into the adaptability of sumac in different environmental conditions, potentially offering new opportunities for its enhancement and cultivation.

Saffron -“the red gold spice”: how to improve its profitability

Cinzia Barbieri^a, Valentina Scariot^a

^a Department of Agricultural, Forest and Food Sciences, University of Torino, Italy

Corresponding author: Cinzia Barbieri <cinzia.barbieri@unito.it>

Keywords: saffron, profitability, sustainability, low-input crop, MAP

Saffron (*Crocus sativus* L.), which is also known as "red gold", is one of the most expensive spices. It was traditionally mainly used as a condiment and natural dye in foods and as a medicinal plant in folk medicine. It has several nutritional and therapeutic properties (antioxidant, anti-inflammatory, anxiolytic, and antidepressant). Its cultivation is characterized by an extensive use of labor, since most crop management techniques (e.g., sowing, weeding, flower picking, and stigma separation) are performed manually all over the world. Many different environments are suitable for the cultivation of saffron. Saffron can tolerate a wide variety of pedo-climatic conditions; it can survive frosts to temperatures of -10°C and short periods of snow cover, but it performs best in a Mediterranean climate (hot, dry summers and mild winters). Unfortunately, there is a lack of statistical and economic data on this spice. The market value of saffron was equal to 390 million US\$ in 2017 and it will rise to 555 million US\$ by 2026. The leading production countries in 2019 were: Iran (430 t, 91%), India (22 t), Greece (7.2 t), and Afghanistan (1.27 t). The main exporting countries in 2022 were Spain, the United Arab Emirates, the Netherlands and France, with values of 51.83, 13.8, 3.26 and 2.98 million US\$, respectively. Italy produces about 1 t, and has an export value of 1.17 million US\$. Cardone et al. indicated a global production of 418 t y⁻¹ in 2018. Iran, which has ca. 90% of the world's production (108,000 ha and 376 t in 2017, mostly in the Khorasan province), is the main producing country, and it is followed by Afghanistan (the Herat Province, 7,557 ha), India (the Jammu and Kashmir regions, 3,674 ha), Greece (mainly around Kozani, 1000 ha), Morocco (mainly around Taliouine, 850 ha), Spain (Castilla-La Mancha, Albacete, Toledo, Cuenca, and Ciudad Real, 150 ha), and Italy (70 ha), where saffron is traditionally produced in Sardinia (about 40 ha in San Gavino, the Cagliari province), Abruzzo (6 ha in Altopiano di Navelli, L'Aquila province), and Sicily (5 ha in the Enna province); small cultivations can be found throughout almost the entire Italian Peninsula, including the north-western Italian Alps, where its cultivation has recently been introduced to diversify agricultural production. The saffron yield is influenced by soil and climate conditions, agronomic practices, and by the corm size. Its yield –dried stigmas– can vary to a great extent, ranging from 2 to 30 kg ha⁻¹. Indeed, 5.4 kg ha⁻¹ was recorded in Iran, 15 kg ha⁻¹ in Spain, and 29 kg ha⁻¹ in Navelli, Italy in 1999. Finally, informal sources (producers and utilizers) have indicated that the price of saffron on the Italian market varies from 7-8 €/gr (imported production) to 20-30 €/gr (domestic production).

In general, saffron production in European countries has been seriously challenged in the last few decades because of increased manual labor costs, climate change, soil contamination and the spread of diseases. Saffron production has decreased by around 98% in Spain (where the saffron cultivation area was about 6,000 ha in 1971), 38% in Greece (1,600 ha in 1982), and 98% in central Italy, Abruzzo (300 ha in 1910). Conversely, production has increased in Iran, although the yield per unit area has fallen significantly (from 5.1 kg ha⁻¹ in 1982 to 3.5 kg ha⁻¹ in 2017). The aim of this work, which is currently underway, has been to investigate how the adoption of sustainable cultivation techniques can improve the profitability of saffron at the primary level. Thus, economic and technical data have been collected directly (all the data referred to 1 ha) on farms in a marginal area in the North West of Italy. It was considered the effects on the productivity of: a) sustainable practices, used as inoculants of beneficial microorganisms, such as arbuscular mycorrhizal fungi (AMF); b) optimized agrotechniques. As far as the utilization of AMF is concerned, an increase in replacement corms and in the corm weight, which are important aspects for the production of its flowers, has been observed. Such results will allow a comparison to be made with recent economic data¹ which indicate that saffron² was the most profitable spice, in terms of Gross Margin (GM)², in Italy in the 2015-2020 period, a result that reflects

the profitability of each farm's production activities and the Operating Margin (OM)³. Moreover, the human labor cost (HLC), that is, 83% of the total Farm labor cost⁴ has had an incidence of approximately 54% on the GM. Our study has excluded the effects of the utilization of the violet tepals of the flower on profitability, as they have long been considered a floral waste of Formattato: Non Evidenziato saffron, although they have health-promoting properties (e.g., antioxidant and antidepressant) and could generate a new source of income from saffron.

The spearmint sector: a niche activity with strong development potential in Morocco

Kawtar Mahrach^a, Saadia Zrira^b, Idrissia Janati Idrissi^c

^a Department of Food and Nutritional Sciences, HASSAN II Agronomic and Veterinary Institute, Rabat, Morocco;

^b Department of Food and Nutritional Sciences, HASSAN II Agronomic and Veterinary Institute, Rabat, Morocco;

^c Department of Food and Nutritional Sciences, HASSAN II Agronomic and Veterinary Institute, Rabat, Morocco.

Corresponding author: Kawtar Mahrach <k.mahrach@iav.ac.ma>

Keywords: Aromatic and medicinal plants, Spearmint, valorization, diagnosis, market.

The rich biodiversity of the Mediterranean region offers great opportunities, particularly for Aromatic and Medicinal Plants (AMP). Morocco, as part of this eco-region, has been a traditional user and exporter of these valuable resources. The cultivation and trade of AMP have deep cultural roots and economic importance for local communities. For instance, the Moroccan AMP sector produces approximately 140,000 tons (T) annually, generating a revenue of around 1.2 billion dirhams and providing employment for over 500,000 people. Among the 600 to 800 aromatic and medicinal species found in the kingdom, spearmint is among the most consumed and used AMP. In Morocco, spearmint is grown in the green belts surrounding the country's major cities and in rural areas. It is grown on small areas of up to 4 ha. The total surface area is around 3,000 ha, spread over several areas of the country. The four regions known for spearmint production at national level are : Casablanca-Settat, Fès-Meknès, Marrakech-Safi and Souss-Massa. The know-how to produce quality spearmint and its valorization through the various technologies could be used to organize the mint sector in the Moroccan domestic market. Spearmint essential oils, in particular, are highly sought after for use in pharmaceuticals, confectionery, and aromatherapy, enjoying significant demand both nationally and internationally. The objectives of this work were to update the data concerning the evolution of the indicators of the Moroccan spearmint value chain, namely area, production, valorization, exports and imports. Morocco exported an average quantity of 10,407.00 tons of various mint species, with an average value of 21,000 MAD per ton. Specifically, between 2015 and 2019, the average quantity of green mint exported was 6,186.2 tons, with an average value of 132,625.08 million dirhams. Green mint is marketed in various forms: conventional fresh mint, organic fresh mint, and dried mint. Additionally, it is available in different shapes: broken mint (dried mint sprigs), mint bouquet (a bunch consisting of 10 to 12 branches), cut mint (branches cut into fragments), and powdered mint.

Since the spearmint sector is non-structured and informal, a national diagnostic was carried out to help promote it. The diagnosis was made by carrying out the surveys with the relevant sector stakeholders, in order to examine its socio-economic role, identifying the constraints and opportunities encountered and drawing up an action plan for the development of the sector. On the basis of the results obtained, we have concluded that the mint market is highly fluctuating, subject to the law of supply and demand, and tightly related to the nature of the product which is rapidly perishable and very sensitive to climatic changes. Spearmint in Morocco is valued in several forms: 1) the fresh plant, widely used to flavor mint

tea, 2) The dried plant in bulk or in the form of sachets, 3) The essential oil, which is generally used in perfumery, cosmetics and aromatherapy.

In conclusion, the use of these plants not only supports local economies but also preserves traditional knowledge and practices. This with the ongoing interest and global demand for natural products further highlight the importance of conserving this biodiversity and promoting sustainable practices. Continued research, innovative cultivation methods, and sustainable practices will be paramount in harnessing the full potential of the AMP sector generally and the mint sector particularly in Morocco and across the Mediterranean region.

SESSION 3

Food and Health: How the research of Well-being passes through the Agri-food Production System

The importance of Diet in Health: What About the Future?

Antonio Garcia Rios^{abc}

^aDepartment of Internal Medicine, Maimonides Biomedical Research Institute of Cordoba (IMIBIC);

^bReina Sofia University Hospital, University of Cordoba, Cordoba, Spain Centro de Investigación Biomédica en Red Fisiopatología de la Obesidad y la Nutrición (CIBEROBN);

^cInstitute of Health Carlos III, Madrid, Spain

Corresponding author: antonio Garcia Rios <angarios2004@yahoo.es>

Keywords: Diet, Metabolism, Cardiovascular, Sustainability

Food habits and preferences of our population are continuously changing throughout the world. In an era with more evidence about the importance of diet for health, there is increasing abandonment of heart-healthy diets such as the Mediterranean diet. The direct consequence of this is an increase in metabolic diseases such as obesity, dyslipidemia, and diabetes, leading to a rise in cardiovascular disease. In order to combat this pandemic, the agri-food sector is essential, which must use education, new technologies and research as weapons to improve the health of society in a sustainable way for the planet. To achieve this it will be key to establish alliances between professionals in the agri-food sector and health professionals, perhaps through research and evidence.

Functional Foods for Healthy Aging

Giulia Accardi^a, Anna Aiello^a, Anna Calabrò^a, Calogero Caruso^a, Giuseppina Candore^a, Rosa Zarccone^a

^a

^a Laboratory of Immunopathology and Immunosenescence, Department of Biomedicine, Neurosciences and Advanced Diagnostics, University of Palermo, Italy.

Corresponding author: Giulia Accardi <giulia.accardi@unipa.it>

Keywords: Nutrigerontology, Nutraceuticals, Mediterranean diet, antioxidants

Over the past two centuries, average lifespan has increased significantly, with the elderly population growing rapidly, particularly in Western countries. However, the increase in healthy lifespan has not kept pace, highlighting the need for strategies to prevent age-related diseases and reduce associated medical, economic, and social burdens. Nutrigerontology, the study of the impact of the diet component on aging and age-related diseases, has emerged as a key field in this endeavor. The traditional Mediterranean diet, characterized by low glycemic index foods, low animal protein intake, and high consumption of plant-based foods and olive oil, has been widely recognized for its health benefits. It is associated with a lower incidence of age-related diseases, such as cardiovascular disease, Alzheimer's disease, and cancer. The diet's richness in nutraceuticals and functional foods contributes to these protective effects, promoting healthy aging. Functional foods, including those featured in the Mediterranean diet, are rich in bioactive compounds that modulate molecular pathways linked to aging, such as inflammation and oxidative stress. Several studies in Sicily have demonstrated the beneficial effects of local foods on various health parameters. For instance, green olives of the Nocellara del Belice variety have been shown to have antioxidant and anti-inflammatory properties, suggesting their potential as nutraceuticals. Similarly, extra-virgin olive oil (EVOO) is rich in phenolic compounds like oleuropein and hydroxytyrosol, which have been shown to modulate inflammation and oxidative stress, contributing to the health benefits associated with the Mediterranean diet. Another promising functional food is pasta enriched with *Opuntia Ficus Indica* (OFI) cladode extracts. This pasta has demonstrated antioxidant, anti-inflammatory, and hypoglycemic effects, making it a potential food for preventing age-related metabolic disorders. Additionally, dietary β -glucans, found in various enriched foods, have shown promise in regulating immune responses, inflammation, and gut hormones, further supporting their role in healthy aging.

In conclusion, the integration of nutraceuticals and functional foods into dietary patterns holds significant potential for promoting healthy aging. The Mediterranean diet, in particular, serves as a model for such an approach, offering a synergistic combination of bioactive compounds that can mitigate age-related diseases and enhance longevity. Further research and larger studies are needed to confirm the efficacy of these foods and develop comprehensive dietary strategies for healthy aging.

The nutraceutical properties of *Rhus coriaria* Linn: potential application on human health and aging biomedicine

Anna Aiello^a, Giulia Accardi^a, Anna Calabrò^a, Rosa Zarccone^a, Calogero Caruso^a & Giuseppina Candore^a

^aLaboratory of Immunopathology and Immunosenescence, Department of Biomedicine, Neurosciences and Advanced Diagnostics, University of Palermo, Italy.

Corresponding author: Anna Aiello <anna.aiello@unipa.it>

Keywords: aging; biomedicine; health; nutraceuticals; phytochemicals; Sicilian Sumac

Rhus coriaria Linn is a little plant growing in the Mediterranean basin, including Sicily, where it is known as Sicilian Sumac. Since antiquity, it has been used as a medicinal herb, considering its pharmacological properties and its recognized anti-inflammatory, antioxidant, and antimicrobial effects. Multiple studies have highlighted that the beneficial properties of Sumac extracts depend on the abundance of phytochemicals such as polyphenols, fatty acids, minerals, and fibres. Despite its wide use as a spice, the literature on Sumac effects on humans' health and aging is still scarce.

Considering its great nutraceutical potential, Sumac could be used to prevent and treat age-related diseases such as those in which the inflammatory process plays a crucial role in manifestation and progression. Moreover, the research of new phyto-therapeutic molecules and their possible applications in different biomedicine fields is growing in order to resolve or treat pathological conditions that could overcome drug resistance or sensitivity issues, improve the environmental impact, and reduce the economic drift versus more expensive pharmaceutical compounds. For these reasons, Sumac could be an interesting new insight in the biomedical field, especially in aging biomedicine.

Non-Celiac Wheat Sensitivity: a new challenge for cereal growers

Aurelio Seidita^a, Pasquale Mansueto^b & Antonio Carroccio^a

^aUnit of Internal Medicine, “V. Cervello” Hospital, Ospedali Riuniti “Villa Sofia-Cervello”, Department of Health Promotion Sciences, Maternal and Infant Care, Internal Medicine and Medical Specialties (PROMISE), University of Palermo, Italy;

^bUnit of Internal Medicine, Department of Health Promotion Sciences, Maternal and Infant Care, Internal Medicine and Medical Specialties (PROMISE), University of Palermo, Palermo, Italy

Corresponding author: Aurelio Seidita <aurelio.seidita@unipa.it>

Keywords: Non-Celiac Wheat Sensitivity, Non-Celiac Gluten Sensitivity, Gluten-Related Disorders, WheatFree Diet, Intestinal Permeability

A significant, although still undefined, percentage of the general population report problems caused by wheat and/or gluten intake. This could be behind the rapid and progressive increase in the global market of gluten/wheat-free products. Non-celiac wheat sensitivity (NCWS) is a new clinical condition which has recently been added alongside celiac disease (CD) and wheat allergy (WA) to the diseases due to wheat ingestion. Unlike these other two well-known conditions, however, NCWS still has no diagnostic biomarker and the variety of symptoms, both intestinal and extra-intestinal, self-reported by the patients often confounds diagnosis. Furthermore, the NCWS clinical presentation overlaps with irritable bowel syndrome and/or with food's hypersensitivity/intolerance, making it difficult to distinguish between these diagnoses. In this scenario, it has been hypothesized that patients suffering from NCWS are a heterogeneous group, composed of several subgroups, each characterized by different pathogenesis, clinical history, and, probably, clinical course. Thus, to date, many aspects of NCWS have yet to be clarified and, above all, diagnostic biomarkers need to be found.

Nutrition, epigenetic modulation and healthy ageing

Giuseppe Passarino^a

^aDepartment of Biology, Ecology and Earth Sciences, University of Calabria, Italy

Corresponding author: Giuseppe Passarino <giuseppe.passarino@unical.it>

Keywords: Calorie restriction, Epigenetics, Methylation, Aging

Calorie restriction has shown to be able to extend lifespan in model organisms. Recent epidemiological studies have indicated that similar results can be obtained in humans, without the side effects of calorie restriction, by means of a low animal-protein diet before 65 years of age. The analysis of numerous methylation sites has shown that it is possible to calculate the biological age of a subject and, consequently, to evaluate the rate of ageing. On the other hand, several epigenetic studies have demonstrated the plasticity of the tissue specific methylation profile. In particular, changes in the DNA methylation status have been reported to be among the mechanisms by which age and nutrition intersect each other and, in turn, influence the aging plasticity. On the ground of these results, new analyses have been planned in order to find out the correlation between nutrition and epigenetic variation in order to define the genomic regions which are affected by calorie restriction and/or analogous diet strategies. This may lead to explore the possibility to modulate these epigenetic sites to obtain a deceleration of ageing.

Molybdenum biofortification as eustress factor through arbuscular mycorrhizal fungi application in a cherry tomato soilless system

Lorena Vultaggio^a, Beppe Benedetto Consentino^a, Pietro Bellitto^a, Salvatore La Bella^a & Leo Sabatino^a

^aDepartment of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Corresponding author: Lorena Vultaggio <lorena.vultaggio@unipa.it>

Keywords: cherry tomato, *G. intraradices*, Mo-supply, abiotic distresses, nutritional value

Molybdenum (Mo) is an essential trace element for humans and plants. The use of agronomic biofortification to increase the accumulation of micronutrient in plant tissue can be a valuable approach to overcome nutritional deficiencies affecting over the half of the world population. Concomitantly, the application of microbial biostimulants, such as arbuscular mycorrhizal fungi (AMF), is an effective strategy to stimulate plant yield and quality features, overcoming abiotic distresses, such as trace element overdose which could determine phytotoxic effects. The aim of the current research was to evaluate the synergistic influence of Mo dose (0.0, 0.5, 2.0 or 4.0 $\mu\text{mol L}^{-1}$) and the *Glomus intraradices* arbuscular mycorrhizal fungi inoculation on yield and qualitative traits of cherry tomato (*Solanum lycopersicum L.*) 'Tyty' F1 hybrid grown in an open cycle soilless system. Total yield, marketable yield, fruit dry matter, soluble solids content (SSC), ascorbic acid (AA), lycopene, polyphenol and molybdenum concentration were observed. Furthermore, to appraise the physiological plant response to AMF and Mo treatments, malondialdehyde and proline concentrations were determined. Data revealed that AMF application increased yield traits, SSC, ascorbic acid, polyphenols, and fruit lycopene concentration. Moreover, Mo supply significantly enhanced SSC, polyphenols, tomato Mo concentration and proline. Furthermore, results showed that AMF inoculation alleviated the harmful effect of high Mo dosages. The combination of AMF and Mo application highlighted an improvement of lycopene and Mo fruit concentrations. This study suggests that Mo supplementation at 2.0 or 4.0 $\mu\text{mol L}^{-1}$ in combination with AMF inoculation could be a viable cultivation strategy to enhance plant yield and fruit quality in cherry tomato, improving the Mo dose in human diet.

Effects of pasture supplemented with Aloe Vera on lamb meat production: preliminary results

Simona Prestigiacomo^a, Marianna Pipi^a, Marialetizia Ponte^a, Nicoletta Lala^a, Lucia Dinolfo^a, Giuseppe Di Miceli^a, Adriana Bonanno^a & Antonino Di Grigoli^a

^aDepartment of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Corresponding author: Simona Prestigiacomo <simona.prestigiacomo01@unipa.it>

Keywords: *Aloe vera*, meat quality, grazin, carcass yield, sensory analysis, muscle composition

The sheep meat supply chain in Italy is still predominantly oriented towards the seasonal production of milk-fed lambs slaughtered at about 30 days of age, with live weight lower than 13 kg, tender meat, low fat content, and a delicate flavour. Improving production and quality is possible by adopting models that extend the slaughter age and allow for obtaining heavier, more muscular carcasses. The adequacy of forage systems and the addition of natural supplements to the diet can enhance the quality and sustainability of sheep meat production, in line with current consumption trends. *Aloe vera* (*Aloe vera barbadensis* Miller), with over 200 natural compounds, is known for its anti-inflammatory, antibacterial, and antioxidant properties. Although its anthelmintic properties and the effects on ruminal fermentation, blood parameters, and milk production in ruminants have already been highlighted, its nutritional role in sheep meat production is still underexplored. The aim of this study was to introduce *Aloe vera* in the diet of lambs to evaluate the quantitative and qualitative responses of meat production. The study involved 32 lambs about 90 days old, divided into four homogeneous groups, fed with two different dietary regimes. Two groups grazed freely, while the other two groups were confined indoors and fed with hay for the entire experimental period. Only one grazing group and one confined group received a daily supplement of fresh aloe provided ad libitum, whereas all animals received a concentrate integration (900 g/day as feed per lamb). Lambs feed intake were monitored until slaughter, which took place at 120 days of age. During grazing, forage availability (using exclusion cages) and floristic composition were monitored. At slaughtering, the weights of carcasses, perirenal and pelvic fat, hind leg, and longissimus dorsi (LD) muscle were recorded, as well as pH and tenderness of the LD muscle; also the color of perirenal fat and LD muscle section was measured according to the CIELAB system. The thawing and cooking losses of LD meat were also measured. The cooked LD meat was evaluated through a sensory analysis session with 12 panellists. Preliminary results indicate that there was no effect on weight gain or carcass yield, but significant differences emerged in terms of percentages of muscle and fat in the hind leg, redness (a*) and yellowness (b*) values of LD muscle and fat, and the cooking weight losses. As for the sensory analysis, significant differences due to grazing emerged for tenderness, chewiness, and chew residues. These preliminary results will be integrated with data of chemical analysis of aloe, chemical characterization of meat, and the results in terms of plasma biomarkers to assess the lambs' oxidative and metabolic status, that are in progress.

Can the combination of two apulian traditional agri-food products generate a superfood? The case of functional taralli with *Pleurotus eryngii*

Fortunato Cirlincione^a, Gaetano Balenzano^a, Giusy Rita Caponio^b, Rocco Silletti^a, Antonella Pasqualone^a, Maria Letizia Gargano^a, Agata Gadaleta^a, Ilaria Marcotuli^a, Graziana Difonzo^a

^a Department of Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro, Bari, Italy;

^b Department of Bioscience, Biotechnology and Environment (DBBA), University of Bari Aldo Moro, Bari, Italy.

Corresponding author: Fortunato Cirlincione <fortunato.cirlincione@uniba.it>

Keywords: medicinal mushrooms, polyphenols, beta-glucans, PAT, DPPH, ABTS, FRAP

Taralli is a popular bakery snack food from the south of Italy that has gained worldwide popularity. It is considered a savoury snack or bread substitute and is part of a niche market of Italian food certified as Apulian Traditional Agri-food Products (PAT). Taralli are ring-shaped baked goods with a texture similar to breadsticks, made using specific ingredients such as flour, wine, vegetable oil, salt, and sometimes fennel seeds or other herbs/spices. In the last decade, the growing demand for foods with high nutritional value, that promote health encourages the food industry to develop research toward innovative products containing higher concentrations of nutrients with bioactive components. At the same time, there has been growing interest in adding mushroom powders or extracts to commonly used foods because of high nutritional value and unique flavour and aroma. Their functional properties have been demonstrated in several studies, specifically the enrichment of grain-based foods with mushrooms increased the total availability of vitamins, minerals, fibres, beta-glucans, and antioxidants. *Pleurotus eryngii* (DC.) Quél. is a widely cultivated edible mushroom known as food and a natural source of bioactive compounds, especially dietary fiber, and is also included among Apulian PATs as “Cardoncello”. In this investigation, we developed functional taralli with improved nutritional properties including **P. eryngii** powdered (PeP). Control samples of taralli were prepared using a mixture of semolina and stone-ground whole meal semolina (1:1), sunflower seed oil, white wine, salt, and baking powder, while fortified taralli were prepared by replacing semolina mixture with PeP respectively 5% and 10% (w/w). Sensory analysis showed, no significant differences between the control and experimental trials for most of the descriptors considered. Preliminary analysis showed that the addition of PeP affected texture and colour parameters. Analyses of nutritional value and bioactive molecules such as beta-glucans and polyphenols are ongoing. Antioxidant activities are being evaluated by in vitro assays for the DPPH (2,2-Diphenyl-1-picrylhydrazyl), ABTS (2,2'-Azinobis-(3-Ethylbenzthiazolin-6-Sulfonic Acid)) radicals scavenging and FRAP (Ferric Reducing Antioxidant Power Assay).

Differential physiological activity and metabolomic signatures of lettuce plants grown under nitrogen deficiency conditions and treated with different vegetal derived biostimulants

Christophe El Nakhel^a, Stefania De Pascale^a, Youssef Rouphael^a

^aDepartment of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Corresponding author: Christophe El Nakhel <nakhel_christophe@hotmail.com>

Keywords: biostimulants, protein hydrolysates, *Lactuca sativa*, nitrogen deficiency

Biostimulants are sustainable inputs that can be used to reduce chemical fertilizers application, improving nutrient absorption, production and quality of crops. Protein Hydrolysates (PH) are a category of biostimulants used to counteract reductions in production in non-optimal nitrogen (N) conditions. On this basis, a comparison was made between a new PH derived from the Malvaceae botanical family and a commercial PH derived from the Fabaceae botanical family on *Lactuca sativa* L. var. *capitata* cv. “Maravilla De Verano Canasta” grown in a cold greenhouse (from 2 October for 42 days) at the Department of Agriculture (Portici, NA), in a container on an inert substrate (quartz sand) with optimal concentrations (8 mM NO₃⁻) and N deficiency (1 mM NO₃⁻) in the nutrient solution. Both PHs improved biometric parameters including production, although to a lesser extent under nitrogen deficiency conditions. PH derived from legumes recorded higher values of Fv/Fm, lutein and β-carotene as well as higher levels of catalase and phenolic acids totals. In contrast, Ph derived from Malvaceae did not influence the content of total phenolic acids but increased the leaf concentration of Ca, Mg and catalase, reducing H₂O₂. Among the different organic compounds synthesized by plants, phenylpropanoids were mainly accumulated in plants subjected to nutritional stress. In conclusion, the application of IP, although inducing a general improvement in nutrient absorption in optimal conditions, cannot compensate for the negative effects of a severe N deficiency.

Evaluation of Olive Oil Polyphenols' Properties on Ex Vivo Models: Results from Preliminary Studies

Anna Calabrò^a, Anna Aiello^a, Giulia Accardi^a, Rosa Zarccone^a, Calogero Caruso^a, Alejandra Pera^{abc} & Giuseppina Candore^a

^aDepartment of Biomedicine, Neurosciences and Advanced Diagnostics, Laboratory of Immunopathology and Immunosenescence, University of Palermo, Italy;

^bGC01 Immunology and Allergy Group, Maimonides Biomedical Research Institute of Cordoba (IMIBIC);

^cDepartment of Cell Biology, Physiology and Immunology, University of Cordoba, 14004 Cordoba, Spain)

Corresponding author: Anna Calabrò <anna.calabro@unipa.it>

Keywords: oleuropein; oleocanthal; immunomodulation; vaccine; aging.

Oleuropein (OLE) and its derivative, hydroxytyrosol, along with other polyphenols, like oleocanthal (OLEo), are found in leaves and fruits of *Olea europaea* Linn and exhibit potent anti-inflammatory and antioxidant effects both in vivo and in vitro. OLEo, in particular, mimics the action of ibuprofen on cyclooxygenase I and II, conferring significant anti-inflammatory benefits. Our studies aim to evaluate these compounds as capable of counteracting the low-grade inflammation, called inflamm-aging, oxidative stress and cellular senescence associated with aging. For this reason, the immunomodulatory effects of OLE have been evaluated on peripheral blood mononuclear cells (PBMCs) from young (<65 years) and older (>65 years) adults as part of the Improved Vaccination Strategies for Older Adults (ISOLDA) project. PBMCs were obtained from healthy individuals before (T0) and after (T1) influenza vaccination with Flucelvax® Tetra and treated in vitro with different concentrations of OLE, with or without the addition of BIRB796, an inhibitor of p38MAPKs. The results about T-cells producing cytokines (TNF- α , IFN- γ , IL-10) suggested significant OLE immunomodulatory properties, which may enhance the immune response and reduce inflammation in older adults, post-vaccination. Furthermore, it has been shown a possible antioxidant activity of these compounds in the reduction of Reactive Oxygen Species in the supernatant of the cell cultures treated with OLE alone or in combination with BIRB796 in terms of Relative Fluorescence Units. The immunomodulatory role of OLEo on monocyte-derived dendritic cells (mo-DCs) is under study, to understand the capacity of this compound to modulate the immune response directly. OLEo in pure form and dissolved in emi-NADES is tested on mo-DCs derived from PBMCs of healthy donors and analysed in cell cultures, at different concentrations. Mo-DCs are analysed for immunophenotype through flow cytometry and for gene expression related to the NF- κ B pathway through qPCR. The first findings about OLE and OLEo support the potential of these olive oil bioactive compounds as boosters for immune function, in contrast to age-related decline.

SESSION 4

Entomology and Pathology: pesticide which scenario for the next future in a contest of the new European Green Deal?

Plant protection products in EU: too many or too few? A look to fungicides and related alternatives

Gianfranco Romanazzi^a

^a Department of Agricultural, Food and Environmental Sciences, Marche Polytechnic University, Ancona, Italy

Corresponding author: Gianfranco Romanazzi <g.romanazzi@univpm.it>

Keywords: food loss, fungicides, biocontrol, pesticides, sustainability, supply chain

Food loss and waste (FLW), often caused by plant pathogens in the field and after harvest, is a global challenge recognized by international governments and organizations. Reducing FLW is key to sustainably ensure nutritional food security for an increasing world population. It is a target of the Sustainable Development Goals of the United Nations, and the Farm to Fork Strategy of the European Green Deal. Losses are considered the ones that occurs from the growers to the retailers, while waste occurs when the consumer is involved, from retailers to home or other food services. An integrated list of preharvest and postharvest treatments are important to preserve the fresh fruit and vegetables from the cultivation to the consumer home, that integrate use of decision supporting systems in the field for proper application of synthetic fungicides or alternatives (biocontrol agents, natural compounds, etc.), with a monitoring of isolates resistant to fungicides in the field and in the packinghouses and alternation of fungicides with a different mechanism of action, both in the field and even for the few fungicides allowed for postharvest application. The number of synthetic fungicides for growers is decreasing since a list of key products were banned, and they were not replaced. Register a new active ingredient in EU requires nowadays around 300 million Euro and 13 years, and these costs are still the same for biocontrol agents or natural compounds. To half the amount of synthetic pesticides used in plant protection within 2030, as planned by the Farm to Fork strategy, requires the application of all possible alternatives, including the basic substances, compounds used in human diet that can have an application in plant protection. Nowadays we have 26 registered basic substances, and some of them provide good results in the manage of plant diseases in the field and postharvest, and such number is expected to further increase. Another important issue is the cooperation of actors along the supply chain. Request of retailers of fruit and vegetables with a residue of pesticides even lower than legal threshold (maximum residue level) and of a number of residues very low (even 3 to 5) requires complex strategies in the field and in the packinghouse to reach such limits with risk to have a less protected produce and increase of FLW. Last, but not least, an appropriate behavior of the consumer is important to contribute with own actions to FLW reduction.

Sustainable strategies to improve resilience to fungal diseases in berry crops

Tânia R. Fernandes^a, Nuno Mariz-Ponte^a, Chiara Murena^a, Mayerly Maldonado^a, Gonçalo Correia^a,
Inês Moura^a, Andreia Garrido^a, Susana M. P. Carvalho^a

^aGreenUPorto—Sustainable Agrifood Production Research Centre/Inov4Agro, University of Porto, Portugal

Corresponding author: Tânia R. Fernandes <tan.fernandes@fc.up.pt>

Keywords: fungicides, elicitors, botrytis, sustainability, yeasts

Diseases caused by fungi result in 20-30% losses throughout the fruit and vegetables supply chain. Current methods of diseases control mainly rely on synthetic fungicides, but their overuse leads to serious concerns on the environment and human health. This highlights the importance of establishing sustainable and natural-based alternatives to these synthetic products. However, more studies are still required to deeply understand the impact of these alternatives on plant performance, crop productivity and product quality. Two ongoing projects at GreenUPorto Research Centre (“Botrytis-XTalk” and “BFree”), focusing on the sustainable control of grey mould disease, will be presented and their main results will be discussed. The tested natural-based solutions mostly rely on improving plant defence mechanisms’ against the necrotrophic fungus *Botrytis cinerea* through the application of elicitors, namely: (i) plant hormones – salicylic acid, jasmonic acid, methyl salicylate, and methyl jasmonate (Botrytis-XTalk) or (iii) microbiological control agents. Several experiments have been performed in strawberry plants, as a highly susceptible crop to grey mould disease, grown in a semi-hydroponic system in a greenhouse. Promising results have shown that application of plant hormones during the cultivation cycle can significantly reduce disease occurrence in strawberry fruits by stimulating plant oxidative response. Moreover, we have identified endophytic yeasts with an antagonistic effect against *B. cinerea* and their foliar application prevented the incidence of grey mould disease, with no impact on plant photosynthetic rate nor on fruit quality (e.g. firmness, soluble solids content, etc.). Our ongoing experiments aim to understand the mechanisms underlying the observed responses for commercial exploitation of these natural fungicides, which will be a step towards increased sustainability on agricultural systems.

How to manage plant disease risk when implanting a new crop as sugarcane in a Mediterranean European environment

Jean Heinrich Daugrois ^a

^a Cirad-Bios-UMR PHIM-Montpellier-France

Corresponding author: Jean Heinrich Daugrois <jh.daugrois@gmail.com>

Keywords: sugarcane, pests, quarantine, viruses, resistance, adaptation

Implanting a new crop in a given region needs to take care on potentially imported diseases with the plant material and controlling local known pests able to damage the new crop. This will be the case for sugarcane that was implanted in different Mediterranean region to be tested for producing rum. Sugarcane is a vegetatively propagated semi perennial crop prohibited for importation in Europe due to 11 EU quarantine pests that can be introduced with the propagated material. Best way is to use quarantining for controlling sugarcane pests. Only one accredited sugarcane quarantine is available in Europe in Montpellier France. In addition, imported sugarcane could be under pressure of sugarcane pests already present in EU as 20 of the 95 sugarcane pests listed in the EPPO database are present in the EU. Also, viruses originating from other poaceae may be transferred to sugarcane that shares viruses at the family and genus level with Mediterranean wild poaceae but today different species are involved. Currently, it is necessary to evaluate sugarcane adaptation to local environment including pests damages as pesticides are rarely used in sugarcane crops and disease management is mainly done by using tolerant/resistant varieties.

Coming of age: metabolomics in biostimulant research and development to combat the climate crisis and secure food supply

E.-A.Papadopoulou^{a*}, C.N. Kerezoudis^{a*}, S. Giannakaris^{a*}, N. Katsenos^b, T. Ntanasi^c, I. Karavidas^c, G. Ntatsi^c, A. Efthymiadou^b, K. A. Aliferis^{ad}

^aAgricultural University of Athens, Laboratory of Pesticide Science, Athens, Greece;

^bDepartment of Soil Science of Athens, Institute of Soil and Water Resources, Hellenic Agricultural Organization-Dimitra, Athens, Greece;

^cLaboratory of Vegetable Production, Department of Crop Science, Agricultural University of Athens, Greece;

^dMcGill University, Department of Plant Science, Montreal, Canada.

*Equal contribution

Corresponding author: Konstantinos Aliferis <konstantinos.aliferis@aua.gr>

Keywords: biomarkers, plant metabolomics, plant nutrition

The European “Green Deal” comes at a pivotal moment for the agri-food sector. Climate crisis, energy costs, and regulations, threaten food security. Currently, the development of alternatives to conventional pesticides and fertilizers seems one way. The developments in the field of biostimulants could greatly assist in combating issues that the agri-food sector is facing. Biostimulants will play a significant role in agriculture, by providing improved and environmentally friendly solutions to plant protection and nutrition. Nevertheless, the mechanism(s) of action (MoA) of the majority of biostimulants are largely unknown, therefore, cutting-edge bioanalytical tools should be employed. Metabolomics can play an essential role by providing a global overview of the effects of biostimulants on target organisms’ metabolism, and subsequently insights into the underlying operating mechanisms. In this context, our research groups have been investigating the effects of microbial and non-microbial biostimulants and biocontrols on the metabolism of target organisms (plants and microorganisms) by GC/EI/MS metabolomics. The effect of such bioactives has been investigated on plant species such as tomato (*Solanum lycopersicum* L.), corn (*Zea mays* L.), olive tree (*Olea europaea* L.), cannabis (*Cannabis sativa* L.), and the aquatic plant Duckweed (*Lemna minor* L.). Metabolomics has revealed substantial impact of the applied biostimulants on plants’ metabolism, including fluctuations in metabolites that play key roles, being intermediates and signaling molecules (e.g. α -linolenate, salicylate), Krebs Cycle Intermediates (KCI), key precursors of secondary metabolites (e.g. tryptophane, tyrosine, phenylalanine), and bioactive compounds [e.g. Δ 9-tetrahydrocannabinol (Δ 9-THC), cannabidiol (CBD)]. Based on our research it is evident that metabolomics can greatly assist the research on biostimulants, thus, assisting the effort to secure food supply, while safeguarding the environment.

Honeydew management to promote biological control

Maite Fernández de Bobadilla^a, Natalia Moreno-Ramírez^b, Miguel Calvo-Agudo^c, Marcel Dicke,
Alejandro Tena^b

^aCentro de Protección Vegetal y Biotecnología, Instituto Valenciano de Investigaciones Agrarias (IVIA). Carretera de Moncada-Náquera Km. 4,5, 46113 Moncada, Valencia, Spain

^bLaboratory of Entomology, Wageningen University & Research, PO Box 16, 6700 AA Wageningen, The Netherlands

^cAgrobío S.L., Ctra. Nacional 340, Km 419, El Viso, 04745 La Mojonera, Almería, Spain

Corresponding author: Maite Fernández de Bobadilla <fernandezdebobadilla_mar@gva.es>

Keywords: pest control, hemipterans, parasitoids, predators, ants

Honeydew is the excretion product of many plant-feeding hemipterans and some lepidopterans. This sweet excretion product is the most abundant and accessible source of carbohydrates for parasitoids and predators in many agroecosystems. Being so abundant, honeydew mediates many direct and indirect interactions that affect biological control. Here, we describe these interactions and identify honeydew-management strategies to reduce pest pressure. First, as with flowering plants, the presence of non-damaging honeydew producers in cover crops and hedges increases the abundance and fitness of parasitoids and predators. Second, breaking the mutualism between ants and honeydew-producing pests with alternative sugar sources promotes biological control of these pests. Third, we propose to explore honeydew volatiles to attract biological control agents and repel pests, as well as to induce plant defences. Finally, we urge reducing the use of systemic pesticides that contaminate honeydew and negatively affect biological control agents that feed on it. Overall, we propose that honeydew management is incorporated in integrated pest management programs to contribute to the development of sustainable agriculture.

Chemical and visual cues in the host-plant selection of the melon ladybird: new perspectives in biological control

Gianandrea Salerno^a, Giorgia Carboni Marri^a, Giulia Petroni^a, Manuela Rebora^a, Silvana Piersanti^a,
Valerio Saitta^b

^aUniversity of Perugia;

^bUniversity of Palermo

Corresponding author: Valerio Saitta <valerio.saitta@unipa.it>

Keywords: insects, olfactory, host, cues, cucurbits, pest

Phytophagous insects rely on many different sensory cues to locate their host plants, including visual, olfactory, gustatory, and tactile stimuli. These cues are processed by sensory systems and integrated in the brain to elicit a proper behavioural response. *Chnootriba elaterii* is an injurious pest of cucurbits in the Mediterranean Region which causes serious damage mainly in organic crops. This study investigates the host location process of this important pest under controlled conditions using both a Y-Tube olfactometer and an open Y-Track olfactometer. Our investigations reveal that a combination of olfactory and visual cues from the host plant synergistically guides the ladybirds toward their host plant while females demonstrate an inability to differentiate between host and non-host plants using either olfactory or visual cues alone. *Cucumis melo* and *Vicia faba* var. minor plants are used as visual and olfactory stimuli while dummy plants as visual stimuli. Among the main colours generally perceived by insects, such as yellow, green, red, blue and black, green colour is a more significant contributor to the host location process than olfactory cues. We find that green dummy plants crafted from cardboard serve as potent supernormal stimuli for the melon ladybird. These findings offer insights into the host location mechanisms of Coccinellidae and may pave the way for the development of visual or chemical traps for effective monitoring and control this significant crop pest in the Mediterranean Basin.

Effects of biostimulants and corroborants on plant pathogenic fungi

Marika Lamendola^a, Francesco Verde^a, Giacomo Fiore^a, Marzenna Maria Smolenska^b, Piotr Gulczynski^b & Livio Torta^a

^aDepartment of Agricultural, Food and Forest Sciences (SAAF), University of Palermo, Italy);

^b POMONA SRL, Via E. Notarbartolo 38, 90141 Palermo, Italy; Savory Sun, 242 Hillcrest Dr Fredericksburg, VA, 22401-4010 United States

Corresponding author: Marika Lamendola <marika.lamendola@unipa.it>

Keywords: biostimulants, corroborants, bioactivity, plant pathogenic fungi.

In recent years, biostimulants and corroborants (plant strengtheners) products have been developed to improve both the vegetative performance and the tolerance to abiotic stresses. In Italy biostimulants are regulated by the law on fertilizers (75/2010), while corroborants are regulated by D.M. 6793/2018 and, according to these guidelines, they are not considered as pesticides. Latest studies have, however, ascertained the bioactivity of some of these products against phytopathogens and insect pests. Recently, to evaluate the in vitro activity of the biostimulants Olivesaver and Agrusaver (Savory Sun VA LLC) and the corroborant Propoli Serbios (Serbios srl) against some fungal pathogens, assays were carried out at the Laboratory of Plant Pathology of the SAAF Department of the University of Palermo. Artificial agar media (Potato Dextrose Agar, PDA), simple or addicted with different concentrations of the above-mentioned formulates, were used to evaluate the differences of diametral growth of the fungi: *Corioloopsis gallica*, *Botrytis cinerea*, *Fomitiporia mediterranea*, *Fusarium sp*, *Pleurostoma richardsiae*, *Pleurotus ostreatus* and *Rhizoctonia** sp.

Biostimulants showed to contain the growth of most of the tested fungi. In particular, OliveSaver had the greatest effectiveness in inhibiting the growth of *Rhizoctonia sp.* (total inhibition), moderate in *Fusarium sp.* and *P. ostreatus* and weak on *B. cinerea*, while AgruSaver induced the growth inhibition on all the fungal pathogens, except *B. cinerea*. The efficacy of the corroborant Propoli Serbios was significant only on *P. ostreatus*. Assays aimed to evaluate the efficacy of these products on the evolution of different diseases in vivo are ongoing and preliminary results highlighted that the application of these products can have direct effects on phytopathogens. Based on these results, it is considered appropriate to re-evaluate the current legislation by attributing to these products also control activities against some phytopathogens.

SESSION 5

Innovative approaches for agricultural water management in a climate change

Experimental investigation of the performance of a seawater reverse osmosis desalination system operating under variable feed flowrate pressure and temperature

Evangelos Dimitriou^a, Jorge Camacho-Espino^b, Achileas Anastasiou^a, George Papadakis^{ab}

^a Agricultural University of Athens, Department of Natural Resources & Agricultural Engineering, Greece

^b University of La Laguna, Higher Polytechnic School of Engineering, Spain

Corresponding author: George Papadakis <gpa@aua.gr>

Keywords: Reverse Osmosis Desalination, Renewable Energy Integration, Seawater Reverse Osmosis, Membrane Performance Evaluation, Water Permeability and Flux

The integration of Reverse Osmosis (RO) desalination systems with Renewable Energy (RE) technologies offers a sustainable approach to water production. However, the inherent variability of RE sources, along with seasonal shifts in seawater temperature, present significant challenges to the effectiveness of RO membranes. Consequently, there is a critical need for research to examine the impacts of such variations on membrane performance. This study investigates the performance of a small-scale seawater RO (SWRO) unit under variable operational conditions, including non-stable feed flow rate and pressure, across three different feed water temperatures (10, 25, and 35 °C). Utilizing a simulated power produced by photovoltaics on a hypothetical cloudy day for the operation of the SWRO unit, this research aims to address the challenges posed by the variable nature of RE sources and the environmental and economic drawbacks of battery usage. The focus of this research is to assess how these operational variations affect key performance indicators such as water flux, water permeability, salt rejection, and membrane fouling. The results reveal a decrease in water flux by 0.5×10^{-6} m/s and a 12% reduction of the water permeability by the end of the unit's operation. Furthermore, extremely high values of membrane recovery (up to 40%) were noted, attributed to sudden pressure fluctuations. In addition, sharp pressure variations, especially at low temperatures, results in significantly high specific energy consumption values. These findings underscore the need for careful consideration of operation control strategies in RO units powered by RE to ensure high efficiency and membrane longevity.

Constructed wetlands as nature-based solution for sustainable wastewater treatment and reuse for agriculture: a critical assessment by experimental studies and literature

Mario Licata^a, Giovanni Urso^a, Davide Farruggia^a

^a Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy.

Corresponding author: Mario Licata <mario.licata@unipa.it>

Keywords: Constructed Wetland Systems, Agricultural Wastewater Management, Treated Wastewater Reuse
Pollutant Removal Efficiency

Constructed wetland systems (CWs) have been recognized as one of the most acceptable technologies for sustainable agricultural wastewater management. They represent green infrastructures and provide solutions to treatment of wastewaters that agricultural activities produce in different ways depending on the type of agro-industrial production. Particularly, CWs offer the advantages of treated wastewater (TWW) reuse for irrigation purpose and allow to save freshwater (FW) and nutrients with respect to conventional fertilization and irrigation. In those areas subject to prolonged period of water shortage, these systems have the potential to provide various benefits in agronomic and environmental terms.

The aim of this paper was to highlight the potential functionality of CWs in agricultural areas by a critical assessment of a set of experiments carried out on two pilot-scale systems and literature. In particular, the experimental studies were carried out in Sicily (Italy) in order to assess: i) the pollutant removal efficiency of the CW plants; ii) the reuse of TWW for irrigation of some open field crops. The two pilot-scale CWs were planted with different macrophytes and had different size. They were fed with pre-treated wastewater and showed different values in hydraulic parameters. Experimental fields of turfgrasses and tomato were set up close to the two systems and irrigated with both FW and TWW. The results showed excellent organic pollutant removal (BOD₅ 65–75%, COD 70–75%), whilst macronutrient removal was found to be lower (Total Nitrogen 45–55%, Total Phosphorus 40–45%). Pathogens load removal was found to be approximately 90%. In the short-term period, irrigation with TWW resulted in a significant variation in plant biomass rate in accordance with literature. Savings in FW and mineral fertilizers were deemed significant. These results highlight that CWs are efficient in the treatment and reuse of wastewater for irrigation purposes, especially in arid and semi-arid areas. Furthermore, they greatly contribute to sustainability of agricultural systems.

Improving irrigation efficiency by using sensors to monitor the soil-plant-atmosphere system

Massimo Iovino ^a, Vincenzo Alagna ^a

^a Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Corresponding author: Vincenzo Alagna <vincenzo.alagna01@unipa.it>

Keywords: Water Productivity Precision Irrigation, Soil-Plant-Atmosphere System, Decision Support System

Increasing water productivity is a challenge to be met in all environments characterized by water scarcity. This objective can be achieved through the precision management of irrigation practices which involves identifying the appropriate irrigation doses to be applied timely for crop needs.

The latest generation of sensors, combined with the use of ICT, makes it possible to monitor the water status of the soil-plant-atmosphere (SPA) system in real-time and to manage irrigation according to known water-saving strategies. In the citrus grove of the Villabate experimental site, the irrigation Research Group of SAAF Department is testing the most modern and advanced technologies currently available for monitoring the SPA system to obtain the most reliable estimate of crop needs.

In addition, the use of indicators that directly quantify the soil and plant water status represents a significant step towards the precision irrigation, avoiding either undesirable water stress conditions that can penalize the quantity and quality of citrus production, or excessive irrigation volumes that can cause soil waterlogging or deep drainage. These indicators will allow the development of an effective decision support system that can help the farmer to choose the most appropriate irrigation management strategy with the aim of increasing the water use efficiency.

Use of remote sensing and modeling for crop and water monitoring in Mediterranean area

Dominique Courault^a

^aUMR 1114 EMMAH, INRAE, Avignon, France

Corresponding author: Dominique Courault <dominique.courault@inrae.fr>

Keywords: Vegetation Phenology, Remote Sensing, Soil Moisture Products, Crop Modeling

Vegetation phenology is strongly impacted by ongoing climate change. With the increase of drought periods, it also becomes crucial to improve methods aiming a better management of irrigation. Remote sensing provides increasing available data at high spatial and temporal resolution which can help the monitoring of vegetation growth and the water resources. A brief overview of the main surface characteristics which can be assessed from remote sensing is presented. Some operational tools (BVNET model, can-eye software developed at INRAE) allow to compute spatial indicators (or biophysical variables) describing the crop development. Soil moisture products (SMP) developed from Sentinel1 (S1) and 2 (S2) images using neural network techniques are delivered at plot scale every 6 days via the Theia French public platform. Up to now, these products were computed and validated mainly on cereals and grasslands. Mediterranean plots are often small and present a wide variability of agricultural practices. Among them, orchards, which require high quantify of water for irrigation are not represented in SMP because of their structure heterogeneity. Our team has evaluated different models based on spectral indices computed from S1 and S2 to assess soil moisture of ocharldsof a small mediterranean watershed. The main results will be presented compared to ground measurements. These different variables derived from remote sensing can be used in crop models to predict yields and computed water balance from field scale to large regions. Some study cases will be illustrated which show that it is possible to monitor the vegetation development of various crops from Sentinel images. A crop model (STICS) can assimilate remote sensing data to assess the spatial and temporal variability of yieds at the territory scale. An example of integrated modeling is presented where remote sensing is combined with different models to assess grassland production and ground table recharge due to irrigation. With such approaches, various scenarios can be evaluated to quantify the impact of landuse modifications or changes in agricultural practices on water resources.

Biostimulants, N level and drought stress intensity synergistically orchestrate yield, quality and physiology of greenhouse-grown basil

Beppe Benedetto Consentino^a, Lorena Vultaggio^a, Pietro Bellitto^a, Salvatore La Bella^a, Leo Sabatino^a

^a Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy.

Corresponding author: Beppe Benedetto Consentino <beppebenedetto.consentino@unipa.it>

Keywords: Drought stress, nitrogen shortage, sweet basil, resources use efficiency

Accurate nitrogen (N) fertilization management is imperative with the view of achieving high crop performance without jeopardizing product quality. Nonetheless, excessive application of synthetic N fertilizers might have detrimental impacts on both environment and human healthiness. Moreover, climate changes modified water availability with repercussions on farmers' habits. Accordingly, there have been efforts aimed to reduce/optimize the application of agricultural inputs, such as fertilizers and water. Investigate and develop new approach able to reduce the crop damages caused by water restrictions and N shortage are pivotal to make agroecosystems more resilient and sustainable. At this regard, we evaluated the impact of three drought stress levels (100%, 80% and 60% of the field capacity) and four N supply doses (0, 50, 100 and 150 kg ha⁻¹) on the performance of 'Gervaso' F1 hybrid sweet basil plants cultivated in a protected environment. Concomitantly, we also investigated the effects of two biostimulants application, a seaweed extract (Kelpstar®) and a protein hydrolysate (Tyson®), on plants - subjected or not - to drought stress and nitrogen shortage. The study focused on the influence of these treatments on plant yield, physiological parameters, resources use efficiency, nitrate, phenols and ascorbic acid concentrations. Drought stress significantly reduced yield, stomatal conductance and nitrogen use efficiency. Conversely, an increase of N dose had positive effect on yield, chlorophyll and nitrate content. The application of both biostimulants guarantee increase in yield, stomatal conductance, water productivity, chlorophyll, phenols and ascorbic acid. Remarkably, the improvement of yield and quality and the enhancement of physiological traits were also observed in water and nitrogen stressed plants when biostimulants were administered. Our study demonstrated that the use of seaweed extract and protein hydrolysate could be a valuable strategy for increasing the resilience of sweet basil plants exposed to drought stress or N shortage, increasing plant water and N use efficiency.

Risk perception and the water crisis: a geographical approach

Gaetano Sabato^a

^aDepartment of Psychology, Educational Science and Human Movement, University of Palermo, Italy

Corresponding author: Gaetano Sabato <gaetano.sabato@unipa.it>

Keywords: Risk Perception, Water Crisis, Human Geography, Cultural Geography

The water crisis due to droughts or floods increasingly affects many places in Southern Europe. Linked with climate change, it is a serious emergency causing great concern. More specifically, within the Italian situation, the conditions in Sicily today appear very serious, since the island in 2023 experienced one of the worst droughts in the last thirty years and in the first half of 2024. The low rainfall, well below seasonal averages, is not enough to fill the reservoirs (dams, artificial lakes) with water for crops and livestock. The lack of rainfall is aggravated by an outdated and in many cases undersized water infrastructure. In addition, measures such as water rationing in inland areas and in many towns have become necessary, with many inconveniences for residents, breeders and farmers, as well as a further risk for the tourist economy, one of the most significant in Sicily. This paper, starting from a Human Geography approach that studies the perception of risk, intends to offer an essay of a research currently underway on the perception of the water crisis that some inhabitants and farmers in some areas of Sicily have. Studying the perception of this risk can help i) to understand certain behaviours implemented by individuals or small communities in a situation of emergency or potential crisis; ii) to highlight which approaches, which solutions and which interventions could be more suitable and effective in mitigating the drought problem because they are shared with the people living in the communities affected by the crisis. The research is conducted using a qualitative method, through ethnographic interviews. This makes it possible to highlight some significant cultural and symbolic elements such as the narratives (re)produced by those living in rural contexts and which include value systems and attributions of meaning to the interaction of human beings with the environment.

Continuous monitoring of tree water potential in olive for efficiently irrigation management

Paula Guzman Delgado^a, Amrit Pokhrel^a, Emily Santos^a & Giulia Marino^a

^a Plant Science, University of California Davis, Davis, USA

Corresponding author: Paula Guzman Delgado <pguzmandelgado@ucdavis.edu>

Keywords: plant-based irrigation, pressure chamber, water potential, stomatal conductance

Water scarcity challenges agricultural production, demanding more precise and efficient irrigation management. Plant-based continuous monitoring has emerged as a promising approach for optimizing irrigation as it can detect water stress progression, although it is often difficult to interpret sensor outputs. Plant water potential is a robust water status indicator widely used for managing irrigation. However, its measurement is time-consuming and requires skilled personnel, making it difficult to obtain high-frequency data. In this study, we explored the potential of using continuous water potential sensing to determine water status in olive trees and its response to irrigation. Specifically, we compared continuous and single timepoint water status measurements at the tree-level using microtensiometers and the pressure chamber, respectively. The microtensiometers captured tree water status dynamics, enabling a prompt assessment of the effect of irrigation practices. Preliminary analyses show a good linear correlation between midday trunk and stem water potential values obtained with microtensiometers and the pressure chamber, with trunk water potential being less than 0.5 MPa lower. This difference could be associated with each method's measurement and within-tree location. Overall, this study suggests microtensiometers can be a useful to optimize water application in olive. Importantly, having continuous data allows the extrapolation of various water status parameters in addition to midday values.

Regulated Deficit Irrigation to Boost Processing Tomato Sustainability in Mediterranean Environment

Nicolò Iacuzzi^a, Davide Farruggia^a, Federica Alaimo^a, Noemi Tortorici^a, Salvatore La Bella^a, Teresa Tuttolomondo^a

^aDepartment of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Corresponding author: Nicolò Iacuzzi <nicolo.iacuzzi@unipa.it>

Keywords: tomato, irrigation, regulated deficit irrigation, water productivity, commercial yield

One strategy to improve the efficiency of irrigation water is regulated deficit irrigation (RDI), which consists of reducing water supplies, in some phenological phases, in relation to the water needs of crops. An experiment was conducted on processed tomatoes (cv: Tayson F1) to evaluate the effect of deficit irrigation practice on the quantity and quality of tomato production in order to reduce the irrigation water volumes of this crop. The test was carried out in 2022 in the Sicily region (Italy) under open field conditions. Four plots (40 m x 40 m) were created to compare two irrigation systems: complete restoration of crop water requirements (100% CWR) and regulated deficit irrigation (70% RDI during the phenological phases: transplantation - first flower release; swelling fruits - harvesting). In the comparison theses, the same cultivation practices were carried out and the same micro-irrigation system was used, managed through continuous monitoring of the water balance of the soil using capacitive probes and tensiometers. The cumulative water volume (irrigation + rain) administered to the tomato was 4552.87 m³ (RDI) and 4807.47 m³ (100% CWR). The two different irrigation regimes significantly influenced both the yield (98.83 t ha⁻¹ for the RDI and 126.65 t ha⁻¹ for the 100% CWR) and the quality parameters. Fruit brightness (L*), firmness (N), °Brix and dry matter content (%) were significantly higher in the RDI treatment compared to the 100% CWR treatment. Despite the deeper research that is necessary, the results suggest that for the processed tomato the practice of irrigation in deficit is able to save water without adversely affecting the yield and quality, while preserving farmers' incomes and increasing the sustainability of production.

RIUBSAL: opportunities for expanding the use of reclaimed water for olive tree irrigation

Francesco Abbatantuono, Anas Tallou, Giuseppe Lopriore, Salvatore Camposeo, Gaetano Alessandro Vivaldi^b

^aDepartment of Soil, Plant and Food Science, University of Bari Aldo Moro, Italy

Corresponding author: Francesco Abbatantuono <francesco.abbatantuono@uniba.it>

Keywords: decision support systems, remote sensing, water management, olive

Water scarcity, combined with the increased food demand, requires a more efficient use of resources as well as recourse to unconventional sources. The main goal of the RIUBSAL project is to develop innovative technologies for monitoring and reusing urban wastewater, evaluating their sustainability, efficiency, and nutrient recovery capacity. The study was conducted in an olive orchard in Gallipoli (*Olea europaea* L. cv. 'Leccino') involving two field treatments: 1) irrigation with treated municipal wastewater, and the use of 'RIUBSAL' Decision Support System for smart fertigation and nutrients recovery; 2) irrigation with treated municipal wastewater and conventional fertigation. This system monitors various water quality parameters continuously (NH_4^+ , NO_3^- , K, P_2O_5 concentration, water EC, pH and temperature). RIUBSAL integrates data from soil moisture, temperature, and EC field probes, facilitating irrigation and fertigation management. From May 2021, monthly surveys of physiological parameters (stem water potential, gas exchange, leaf chlorophyll content, Normalized Difference Vegetation Index, and Photochemical Reflectance Index) were conducted. The absence of statistically significant differences in both yield and measured parameters shows that the smart nutrient reduction in the RIUBSAL model (-17% for N and -33% for K) did not cause alterations in the physiological state. Furthermore, a predictive model using Random Forest has been developed to estimate the Chlorophyll Content Index (CCI). Using 8-band multispectral images from PlanetScope, with a spatial resolution of 3 meters, the model achieved an R^2 of 0.85 during training and 0.65 during testing. According to bibliography, these results demonstrate that applying multispectral bands and indices may provide a faster, cheaper, and simpler alternative to traditional field measurement methods. In conclusion, RIUBSAL project aims to reduce pressure on conventional water use and ensure sustainable nutrient management. Reusing reclaimed water in agriculture decreases marine discharges and groundwater extractions, reducing seawater infiltration and energy costs. Efficient nutrient management prevents eutrophication and lowers the environmental impact of fertilizer production. 'RIUBSAL' offers a data-driven approach for efficient, sustainable orchard management.

Trend of research on durum wheat irrigation by bibliographic mapping

Noemi Tortorici^a, Nicolò Iacuzzi^a, Federica Alaimo^a, Teresa Tuttolomondo^a

^aDepartment of Agricultural, Food and Forest Sciences, University of Palermo, Italy

Corresponding author: Noemi Tortorici <noemi.tortorici@unipa.it>

Keywords: bibliographic coupling, co-authorship and citation networks, durum wheat, durum wheat irrigation, PRISMA protocol, Scopus

Nowadays irrigation of durum wheat represents a key point to provide food security in a context of climate change. Although this topic has caught on particular attention from the global scientific community, many issues and aspects remains understudied. To fill the knowledge gap and collate present evidences, this analysis used a combined bibliometric and thematic approach to synthesize the peer-review literature from SCOPUS main collection, covering the period 1977-2023, as a result 332 documents were included. The main findings of this work are as follows:

- (1) Spain and Tunisia hosts the most productive institution in this field;
- (2) the journal Agricultural Water Management emerged as the most prolific, with the largest number of articles and citations;
- (3) a wide range of topics and approaches on durum wheat irrigation has been identified, with particular emphasis on controlled water deficit and remote sensing driven management;
- (4) the mapping of bibliographic data coupling with co-occurrence map remains a poorly examined area of study.

The results suggest the need of strengthened institutional partnerships and synergize the research on durum wheat irrigation, particularly in the most vulnerable areas where climate change are acting heavily. Future studies should aim to contribute to the understanding of the impacts of climate change through innovative techniques in order to improve our understanding of the durum wheat water needs and their application in crop management, while ensuring ongoing updates to the existing collection of knowledge to face future challenges.

Climate change, water scarcity and adaptation strategies in Sicily

Antonino Drago^a

^aDepartment Agriculture Sicily Region, Italy

Corresponding author: Antonino Drago <adrigo@regione.sicilia.it>

Keywords: Water Scarcity, Irrigation Scheduling, Decision Support System (DSS), Water Balance

Sicily is a Mediterranean region with evident structural problems of water scarcity and especially in this last period of the last 12 months we are having a severe drought crisis. The climate change emphasises the typical characteristic of the Mediterranean semiarid climate of our region. Different strategies can be adopted to contrast water scarcity and to mitigate the impact of the climate change, e.g.: chose of crops with lower needs, agronomical technics of soil management to optimize soil water content, fine definition of the optimal crop cycle duration, improvement of farm and territorial infrastructures for saving and distribution of water resources. One of this concerns the possibility to introduce and apply DSS to optimize the use of irrigation water resources. IRRISIAS is the web-based SIAS model for water balance and irrigation scheduling at farm scale. Operationally implemented on the SIAS information system platform, IRRISIAS provides the user, as a final result, an estimate of the irrigation needs, related to the evolution of the water reserve in the soil. This estimate is determined through successive iterations over time, on a daily basis. Estimation of the irrigation variables is based on an iterative calculation procedure that processes specific datasets and coefficients. The determination of irrigation day, watering volume value (also expressed in terms of system operating time irrigation) is calculated to restore the optimal water content in the soil, taking into account the soil water reserve (totally available water or Total Available Water, TAW), which depends on the hydrological characteristics and the depth of soil irrigation. From TAW and some specific characteristics of the crop, depends the water immediately available for the crop (Readily Available Water, RAW). The main characteristics of IRRISIAS are: initialization by last irrigation date or conventional date (January, 1st of current year), farm precipitation data (if available), reconstruction of phenological cycle and calculation of Kcb for the different phases. The model runs for 50 cm soil depth irrigation, is possibility to apply a controlled water deficit and it also takes into account the SILAM forecasts for ET0 estimate in the 7 days following the execution date. The results of the model are graphically represented as a farm irrigation scheme processed for each individual plot (parcel) entered by the user, indicated in the output with the related main irrigation variables.



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