Deliverable 2.4
Organization of International Scientific Conference

primesoft

Development of innovative priming technologies safeguarding yield security in soft fruit crops through a cutting-edge technological approach

Funded by the European Union

The project has received funding from the European Union's Horizon Europe programme under Grant Agreement 101079119

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Document Summary

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Contributors: CUT, KUL, CSIC, NTUA, UP

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Project coordinator: CUT

Abstract

The D2.4 entitled 'Organization of Scientific Conference' is linked with Task 2.4 of the WP2: Dissemination, Communication and Exfoliation activities.

The Conference-type workshop took place during 4-5 November, 2024 with 80 attendees both from academia/research units and private entities and local stakeholders. All preparatory steps took place during the second year of the project (M13-M24).

The program was comprised of 34 oral presentations, allocated in seven thematic sessions. In addition, two round table discussions took place at the end of each Conference day.

Thematic sessions

1. Priming technologies to combat abiotic stress conditions
2. Breeding strategies towards resilient berry production
3. Defining qualitative and phytochemical attributes of berry crops
4. Production models and cultivation practices
5. Sustainable solutions towards production of berry crops
6. Challenges in the soft fruit production sector in different climatic conditions
7. Innovations in the soft fruit production sector

Round table discussions

1. Advancing research activities and extension services in berry crops
2. What the companies seek from academia?

The Conference program (**Appendix I**)and Book of abstracts is available in a downloadable pdf format in the link: https://www.prime-soft.eu/assets/files/Primesoft_Soft_Fruits_Workshop1.pdf

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1. Priming technologies to combat abiotic stress conditions

George Manganaris
The PRIMESOFT project in a snapshot: Development of innovative priming technologies safeguarding yield security in soft fruit crops through a cutting-edge technological approach

Vassilis Fotopoulos
Plant and seed priming as green tools for sustainable agriculture on soft fruits under a changing climate

Bernd Müller-Röber
The concept of priming: How to trigger stress preparedness in plants

Salma Balazadeh
HOTmemory – How plant develops tolerance to recurring heat stress

2. Breeding strategies towards resilient berry production

Bruno Mezzetti
Pre-breeding strategies for obtaining new resilient and added value berries

Bertus Meijer
Raspberry breeding towards development of elite, resilient and season-directed (year-round) cultivars

Marco Bertolazzi
Breeder and marketer collaborative innovations in accelerating the berry variety commercialization

Graham Clarkson
Breeding, propagation, production and supply chain management protocols of Edward Vinson Ltd. for UK strawberries

Evangelos Tsormpatsidis
Strawberry production in Greece: challenges and opportunities for development through breeding

Felicidad Fernández Fernández
Breeding raspberries and blackberries for year-round supply of the northern European market

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3. Defining qualitative and phytochemical attributes of berry crops

Francisco A. Tomas-Barberan
Strawberry and raspberry are excellent sources of bioactives with impact on human health

Bart Nicolai
Advances in online quality grading of fruit

Maarten Hertog
Volatile organic compounds and aroma profile as an intricate part that defines fruit quality

Carlos Garcia
Metabolomics in agri-food: Analysis of soft fruit-relevant phytochemicals and priming to enhances their quality

Laura Jaakola
Effect of light and temperature conditions on quality of Vaccinium berries

4. Production models and cultivation practices

David Bryla
Blackberry production trends and adaption to diverse climates in the United States

Wendy Schotsmans
Janssen PMP vision for the future in soft fruits

Jorge Duarte
The blueberry fruit production within a global context: challenges and constrains

David Percival
Empowering wild blueberry plants and mitigating floral diseases with the use of biotic priming technologies

Robert Veberic
Unveiling the impact of controlled environments on highbush blueberry cultivation

Nicolas Valanides
Exploitation of different mesoclimates towards year-round raspberry production in Cyprus

Zoran Radovanovic
Raspberry cultivation for processing and fresh market in Serbia

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5. Sustainable solutions towards production of berry crops

Georgia Frakolaki
Life cycle analysis as an intricate part of assessing the environmental and socioeconomic impact of berry crops' production models

Ellen Thompson
Breeding for sustainability and global premium market

Jasminka Milivojević
Microalgae-based products as innovative technological approach to enhance performance of soilless cultivated highbush blueberries

Sujeeth Neerakkal
Sustainable technologies to enhance crop resilience to the effects of climate change

6. Challenges in the soft fruit production sector in different climatic conditions

Lisa Wakso DeVetter
Beat the heat – mitigating heat damage in raspberry

Itay Maoz
Exploring the VOC profiles within the local population of new primocane lines toward flavor-guided breeding

Antonios Petridis
Securing soft fruit production in Denmark

Amparo Monfort
Genomics to achieve disease and pest resistant strawberry cultivars as a priority in breeding programs.

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7. Innovations in the soft fruit production sector

Costanza Zavalloni
More berry with less resources: building resilient production systems

Monia Dall' Ara
Breeding's concepts for a stronger and equilibrate growth of the berry industry

Vera Theelen
Sustainable year-round strawberry cultivation with fresh everbearer plants

Dimitrios Doukas
Specialty plastic films for soft fruits

8. Round table discussions

Day 1, November 4

Title: Advancing research activities and extension services in berry crops
Moderators: Dr. Lisa Wasko DeVetter and Dr. David Bryla
Panelists: David Percival, Ellen Thompson, Jorge Duarte
Overview is available in the Appendix

Day 2, November 5
Title: What the companies seek from academia?
Moderator: Dr. Lisa Wasko DeVetter
Panelists: Wendy Schotsmans, Costanza Zavalloni, Ellen Thompson, Felicidad Fernández Fernández

Topics addressed:

- Define extension and consulting
- success stories where research and extension led to positive impact/change for the small fruit grower community and highlight tips for success
- Importance of involving economists and considering cost-benefits
- Consideration of life cycle analyses and sustainability metrics

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- To what extent the industry, as well as the extensive/consulting services are close enough with the researchers to create the solutions
- barriers to advancing extension and evidence-based practices and how can they be overcome
- Discussion and research related to climate change can be controversial among the grower community.
- What advice do you have to help navigate difficult discussions where a grower or grower community may be opposed to climate change
- How can the research community improve in sharing information with key stakeholders at local, national, and international levels
- What can industry do to aid in implementing impactful research and outreach

9. EU funding landscape and upcoming opportunities for Agricultural/Food-related R&I

Speaker: Sonja Bergner

- Horizon Europe offers a broad range of funding opportunities, from support for basic research to innovation-oriented projects and Go-To-Market activities.

- Horizon Europe can be a truly rewarding but, at the same time, also challenging when it comes to finding the best fit within the range of calls for proposals.

- A comprehensive overview of EU funding opportunities, covering both top-down and bottom-up calls, as well as practical guidance for early proposal development were provided

- The session provides a broader overview on the Horizon Europe Framework, its structure and, in particular, at the features of collaborative funding opportunities in Pillar I-III and the overarching programme on “Widening participation and strengthening the European Research Area”.

- Upcoming opportunities to PRIMESOFT partners were presented

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10. Communication activities

Website link:
https://www.prime-soft.eu/events.html

Conference program:
https://www.prime-soft.eu/assets/files/Primesoft_Soft_Fruits_Workshop1.pdf

Synopsis of Day 1 (November 4, 2024) video:
https://www.youtube.com/watch?v=ikX_kA9abME

Synopsis of Day 2 (November 5, 2024) video:
https://www.youtube.com/watch?v=AP-LFlNUjdQ

11. Appendix

I. Conference program and Book of abstracts

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Topic: International Workshop on Soft Fruit Crops

Dates: 4-5 November 2024

Hosted by: Cyprus University of Technology

Venue: Royal Apollonia Hotel, Lemesos, Cyprus

Funded by the European Union

Cyprus University of Technology

Monday,
November 4

08:00-09:00	Attendee registration
09:00: 09:10	*Welcome Remarks* George Manganaris Convener & Cooridnator of PRIMESOFT project George Botsaris Dean of the Faculty of Geotechnical Sciences and Environmental Management Nikolaos Tsapatsoulis Vice-rector of Academic Affairs, Cyprus University of Technology Representative of the Ministry of Agriculture
09:10-10:30	Session I: **Priming technologies to combat abiotic stress conditions** Moderator: **Bernd Müller-Röber**
09:10-09:30	**George Manganaris** The PRIMESOFT project in a snapshot: Development of innovative priming technologies safeguarding yield security in soft fruit crops through a cutting -edge technological approach
09:30-09:50	**Vassilis Fotopoulos** Plant and seed priming as green tools for sustainable agriculture on soft fruits under a changing climate
09:50-10:10	**Bernd Müller-Röber** The concept of priming: How to trigger stress preparedness in plants
10:10-10:30	**Salma Balazadeh** HOTmemory – How plant develops tolerance to recurring heat stress
10:30-11:00	*Morning coffee break*
11:00-12:40	Session II: **Breeding strategies towards resilient berry production** Moderator: **David Bryla**
11:00-11:20	**Bruno Mezzetti** Pre-breeding strategies for obtaining new resilient and added value berries
11:20-11:40	**Bertus Meijer** Raspberry breeding towards development of elite, resilient and season-directed (year-round) cultivars

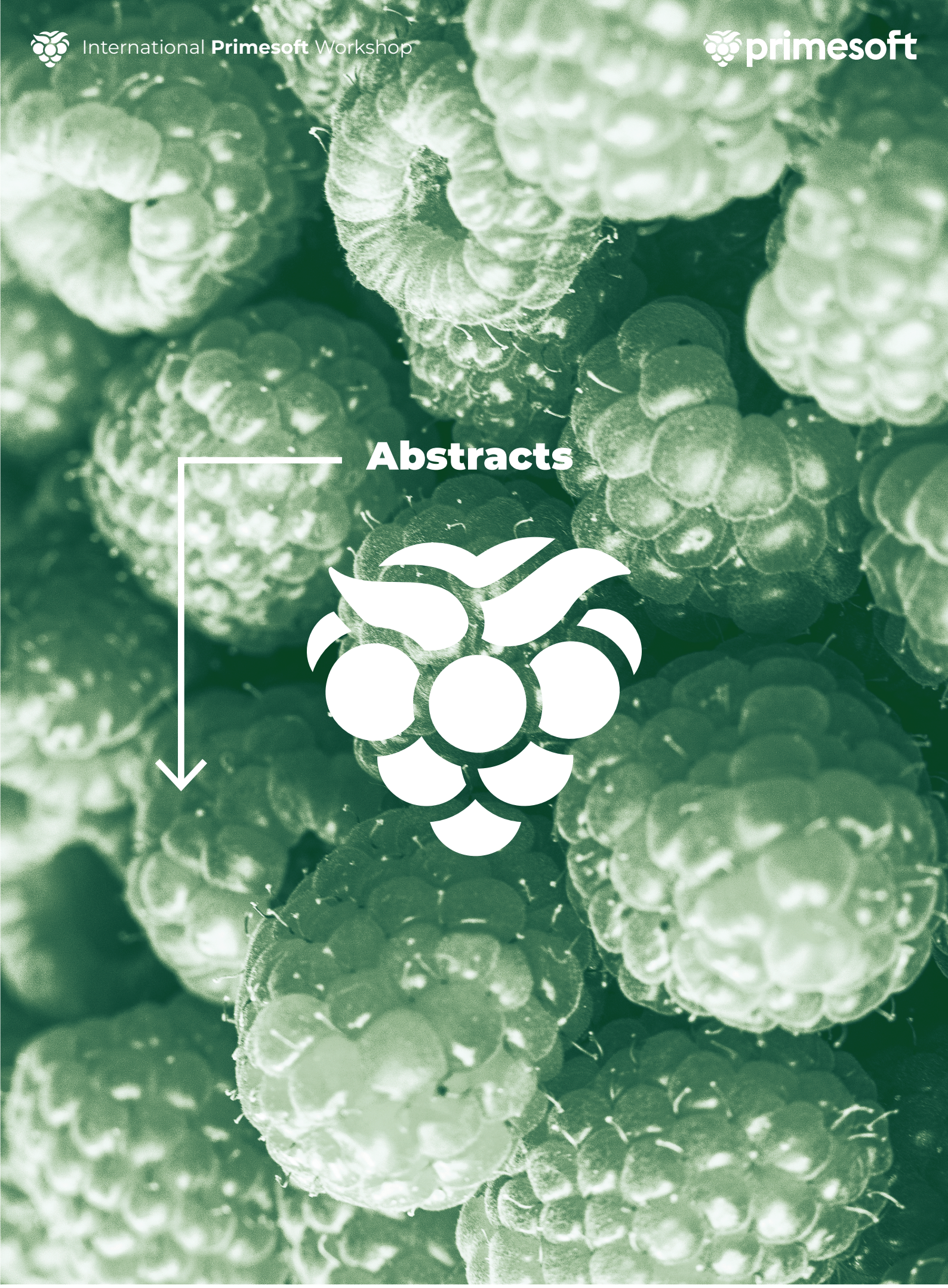
11:40-11:50	Marco Bertolazzi Breeder and marketer collaborative innovations in accelerating the berry variety commercialization
11:50-12:00	Graham Clarkson Breeding, propagation, production and supply chain management protocols of Edward Vinson Ltd. for UK strawberries
12:00-12:20	Evangelos Tsormpatsidis Strawberry production in Greece: challenges and opportunities for development through breeding
12:20-12:40	Felicidad Fernández Fernández Breeding raspberries and blackberries for year-round supply of the northern European market
12:40-14:30	*Lunch break*
14:30-16:00	Session III: **Defining qualitative and phytochemical attributes of berry crops** Moderator: **Maarten Hertog**
14:30-14:50	Francisco A. Tomas-Barberan Strawberry and raspberry are excellent sources of valuable bioactives with impact on human health
14:50-15:10	Bart Nicolai Advances in online quality grading of fruit
15:10-15:30	Maarten Hertog Volatile organic compounds and aroma profile as an intricate part that defines fruit quality
15:30-15:45	Carlos Garcia Metabolomics in agri-food: Analysis of soft fruit-relevant phytochemicals and priming to enhances their quality
15:45-16:00	Laura Jaakola Effect of light and temperature conditions on quality of Vaccinium berries
16:00-17:00	*Evening coffee break*
17:00-18:30	**Round table discussion:** Advancing research activities and extension services in berry crops Moderators: **David Bryla, Lisa DeVetter**
19:30	Departure from Royal Apollonia Hotel
20:00 – 23:00	*Gala dinner*

Tuesday,
November 5

09:00-10:50	Session IV: **Production models and cultivation practices** Moderator: **Lisa DeVetter**
09:00-09:20	David Bryla Blackberry production trends and adaption to diverse climates in the United States
09:20-09:35	Wendy Schotsmans JanssenPMP vision for the future in soft fruits
09:35-09:50	Jorge Duarte The blueberry fruit production within a global context: challenges and constrains
09:50-10:10	David Percival Empowering wild blueberry plants and mitigating floral diseases with the use of biotic priming technologies
10:10-10:25	Robert Veberic Unveiling the impact of controlled environments on highbush blueberry cultivation
10:25-10:40	Nicolas Valanides Exploitation of different mesoclimates towards year-round raspeberry production in Cyprus
10:40-10:50	Zoran Radovanovic Raspberry cultivation for processing and fresh market in Serbia
10:50-11:30	*Morning coffee break*
11:30-13:00	Session V: **Sustainable solutions towards production of berry crops** Moderator: **Fransisco Tomas-Barberan**
11:30-11:50	Georgia Frakolaki Life cycle analysis as an intricate part of assessing the enironmental and socioeconomic impact of berry crops' production models
11:50-12:10	Ellen Thompson Breeding for sustainability and global premium market
12:10-12:25	Jasminka Milivojević Microalgae-based products as innovative technological approach to enhance performance of soilless cultivated highbush blueberries
12:25-12:40	Sujeeth Neerakkal Sustainable technologies to enhance crop resilience to the effects of climate change
12:40-14:30	*Lunch*

14:30-15:40	Session VI: **Challenges in the soft fruit production sector in differenct climatic conditions** Moderator: **Vassilis Fotopoulos**
14:30-14:50	Lisa Wasko DeVetter Beat the heat – mitigating heat damage in raspberry
14:50-15:05	Itay Maoz Exploring the VOC profiles within the local population of new primocane lines toward flavor-guided breeding
15:05-15:20	Antonios Petridis Securing soft fruit production in Denmark
15:20-15:40	Amparo Monfort Genomics to achieve disease and pest resistant strawberry cultivars as a priority in breeding programs.
15:40-16:30	*Evening coffee break*
16:30-17:30	Session VII: **Innovations in the soft fruit production sector** Moderator: **Evangelos Tsormpatsidis**
16:30-16:50	Costanza Zavalloni More berry with less resources: building resilient production systems
16:50-17:00	Monia Dall' Ara Molari berries and breeding's concepts for a stronger and equilibrate growth of t he berry industry
17:00-17:20	Vera Theelen Sustainable year-round strawberry cultivation with fresh everbearer plants
17:20-17:30	Dimitrios Doukas Specialty plastic films for soft fruits
17:30-18:00	Sonja Bergner EU funding landscape and upcoming opportunities for Agricultural/Food-related R&I
18:00-19:00	**Round table discussion:** A What the companies seek from academia? Moderators: **Lisa DeVetter, Wendy Schotsmans, Costanza Zavalloni, Ellen Thompson**

Abstracts



The PRIMESOFT project in a snapshot: Development of innovative priming technologies safeguarding yield security in soft fruit crops through a cutting-edge technological approach

George Manganaris

Cyprus University of Technology, Department of Agricultural Sciences, Biotechnology & Food Science, 3603 Lemesos, Cyprus

Plants get stressed. Crop plants are vulnerable to various abiotic stresses (salinity, flooding, heat, cold, excess light) that reduce productivity and ultimately threaten efforts to nourish the planet. One solution is to use priming agents. Plants can be primed by chemical compounds, such as sodium nitroprusside and hydrogen peroxide. Today, the development of non-toxic priming agents (PAs) is an important R&D activity. The EU-funded PRIMESOFT project will explore innovations in the application of PAs in value-added soft fruit. It aims to bridge the gap between chemical and nanomaterial priming research and smart farming practice. The project will use computational analysis and mechanistic modelling to identify components that regulate the mode of action of PAs.

Soft fruits, also referred to as small fruits or berries, represent a wide and very diverse group of crops that have high nutritional value but are very perishable with limited shelf-life potential. These crops are also greatly affected by stress conditions. The concept of the application of priming agents (PAs) to enhance yield performance and quality attributes of soft fruit crops is entirely novel. The presentation will provide information regarding the prospects of priming agents as a novel agricultural and technological approach to improve stress tolerance, giving special reference to strawberry cultivation. To our knowledge, existing technologies representing major competition are limited to relatively few formulations/biostimulants based on silicon nutrition/supplementation and which do not always provide cross-protection against multiple abiotic stress factors, such as drought, salinity and heat.

The novelty of our scientific strategy lays on the fact that it encompasses (1) the exploration of both a naturally derived priming agent (PA) in the form of melatonin as well as a synthetic PA recently co-patented by the HO (use of NOSH/NOSH-A in plants; WO/2015/123273) and (2) the employment of both advanced nanomaterial engineering and encapsulation techniques through electro-hydrodynamic processes to enhance PA's efficiency towards increment of yield, enhancement of health-promoting properties and additionally ameliorate plant damage under climate change-related abiotic stress conditions in added-value soft fruit crops, namely strawberry and raspberry.

Plant and seed priming as green tools for sustainable agriculture on soft fruits under a changing climate

Vassilis Fotopoulos

Cyprus University of Technology, Department of Agricultural Sciences, Biotechnology & Food Science, 3603 Lemesos, Cyprus

Increased frequency of extreme environmental events resulting from global climatic changes remarkably influences plant growth and development. Close examination of plant-to-plant communication in nature has revealed the development of unique strategies from plants for responding to abiotic stress, with one of the most interesting being through priming for improved defense responses. The process of priming involves prior exposure to a biotic or abiotic stress factor making a plant more tolerant to future exposure. Priming can also be achieved by applying natural or synthetic compounds which act as signaling transducers, 'activating' the plant's defense system. The development of sustainable, 'green' technologies is therefore becoming of utmost importance, also due to the need for reduced agrochemical use. The current presentation gives an up-to-date description of main research activities carried out at the Cyprus University of Technology with the employment of chemical compounds, microorganisms and advanced nanomaterials and polymers applied as priming agents for stress protection and improved growth at plant and seed level. This technology offers an attractive alternative to established approaches such as conventional breeding and genetic modification with key advantages, representing a characteristic example of integrative plant physiology where multiple disciplines such as materials science, agriculture and analytical chemistry join forces to develop exciting new tools in modern agriculture.

The concept of priming: How to trigger stress preparedness in plants

Bernd Mueller-Roeber

University of Potsdam, Germany

Plants, as sessile organisms, lack the ability to escape adverse environmental conditions such as water scarcity, cold and freezing temperatures, or excessive heat. The ability of plants to effectively respond to environmental stress is paramount for their survival and an optimal development of fruits and seeds. In Nature, abiotic stress often escalates over time, during hours or days. To counteract these challenges, plants have evolved intricate molecular and biochemical mechanisms that encode information about gradually intensifying stress conditions into their cellular response programs. This adaptive capability enables plants to withstand severe environmental stress that would otherwise be lethal or impede their growth and development. A pivotal focus of current research involves unraveling the intricate control exerted by genetic, molecular, and biochemical factors on the preparedness of plants to cope with severe environmental stress. Researchers are also exploring how physical or (bio) chemical priming agents can be harnessed to enhance crop resilience. I will be presenting an introductory talk on the concept of plant priming.

HOTmemory – How plant develops tolerance to recurring heat stress

Salma Balazadeh

Institute of Biology Leiden (IBL), Leiden University, The Netherlands

Increasing experimental evidence indicates that exposure to a transient, non-lethal HS induces not only an immediate stress response but also a molecular 'thermomemory' that persists for some time in the absence of the HS that generated it. This 'primes' the plant, enabling it to respond more rapidly and strongly if such stress recurs before the memory fades. Thermomemory holds significant importance as a survival strategy for crops and other plants growing in many natural and agricultural environments, in which elevated temperatures are often transient, recurrent, and progressively increase in intensity. In my presentation, I will summarize the mechanisms behind thermomemory across different levels, with an emphasis on findings from our lab.

Pre-breeding strategies for obtaining new resilient and added value berries

Bruno Mezzetti[1], Sonia Osorio[2], Klaus Olbricht[3], Jahn Davik[4], Saila Karhu[5], Björn Usadel[6], Lena Prochnow[7]

*[1]*Department of Agricultural, Food and Environmental Sciences - Università Politecnica delle Marche - Via Brecce Bianche 10, 60131, Ancona, Italy*

[2]*Universidad de Málaga-Consejo Superior de Investigaciones Científicas, Instituto de Hortofruticultura Subtropical y Mediterránea "La Mayora", Departamento de Biología Molecular y Bioquímica. Campus de Teatinos, Málaga, Spain*

[3]*Hansabred GmbH & Co. KG, Dresden, Germany*

[4]*Norwegian Institute of Bioeconomy Research (NIBIO), Department of Molecular Plant Biology, Ås, Norway*

[5]*Natural Resources Institute Finland (Luke), Turku, Finland*

[6]*Forschungszentrum Jülich, Institute of Bio- and Geosciences, IBG-4 Bioinformatics, BioSC, CEPLAS, Jülich, Germany*

[7]*EURICE – European Research and Project Office GmbH*

The BreedingValue project drives sustainable and competitive strawberry, raspberry and blueberry, known by its high economic impact and potential production across Europe (being the most important in EU berry industry) addressing the need for new cultivation systems as well as high-quality produce due to current challenges posed by climate change and environmental preservation. With this main objective the BreedingValue project will provide knowledge and tools to utilize strawberry, raspberry and blueberry GenRes and pre-breeding material to increase breeding companies capacity to create new cultivars with resilience to different and changing climatic conditions, as well as adaptability to different cultivation systems. Equally important, achievements targeted at producing consumer-desirable fresh-fruit cultivars of berries with high nutritional quality. This project will apply the most recent technical advances: a) to identify conserved and maintained germplasm of the main genera appropriate for sustainable berry production throughout the EU; b) to apply new and advanced genotyping and phenotyping tools for the characterization of local races and varieties, breeding populations and pre-breeding material; c) to identify the genetic base of the most important resilience traits and fruit quality traits for selecting new cultivars with increased adaptability to different and changing climatic conditions and cultivation systems; d) to develop studies on EU consumers preference; e) to apply Life Cycle Analyses to evaluate the ecological benefits derived by the application of resilient pre-breeding material and varieties; f) to generate a novel efficient data analyses strategy; g) to develop prototype visualization tools; and h) to disseminate and communicate the results to breeders, GenRes managers, researchers, growers, market organizations, consumers, food industries, health authorities and regulatory and legislative authorities. The final outcome of the project will be the larger inclusion of Berry GenRes in different EU public and private GenRes collections and breeding programs that will bring benefit to the society for increased competitiveness of Eu berry industry and consumer accessibility to better and healthy fruit.

Raspberry breeding towards development of elite, resilient and season-directed (year-round) cultivars

Bertus Meijer

Delphy ISFC, The Netherlands

The presentation will provide an overview of a number of available varieties towards 52 weeks production per year combining production in Southern Europe in winter season and Western Europe in summer season.

Geert de Weert selected low-chill varieties to grow raspberry fruit on his farm in Tanzania. Kwanza is a well known, elite cultivar all over the world and in some countries is still expanding. Sarafina, the variety selected for growing in regions with a low number of chilling hours, showed a very good reaction on pruning at all moments of plant development and most seasons. This made it possible to grow year-round in Tanzania.

For European production however seasons are more complicated, mostly foggy or wet in autumn and cold in winter in mid and western Europe, whereas summer in southern Europe will be mostly too hot for production. Maybe even more important for us were the extremely high costs using long canes by growers. Not only the costs of producing these canes, but also the costs for transporting and cool storing the voluminous canes.

With true primocane varieties we developed genotypes that give rise to enough production in the primocane year very early spring. It turned out the cv. 'Baridi' also had a good production from mow down. The shorter the time between planting and producing, the better the planning of production will be. Therefore, the new true primocane varieties give a good possibility for production planning without the use of expensive long canes

Breeder and marketer collaborative innovations in accelerating the berry variety commercialization

Marco Bertolazzi

Sanlucar srl, Spain

Leading fruit marketers and berry breeders can strategically devise projects to streamline the plant breeding process by aligning objectives, collaborations, and processes. Through optimizing resource allocation and ensuring a better fit between plant varieties and market demands, these initiatives not only expedite the introduction of new varieties but also enhance the efficiency of breeding efforts. The presentation explores general strategies that have been adopted to effectively establish these cross-functional projects in real cases.

Breeding, propagation, production and supply chain management protocols of Edward Vinson Ltd. for UK strawberries

Graham Clarkson

Edward Vinson Ltd., United Kingdom

Edward Vinson Ltd. (EVL) has been growing fruit for over 150 years in the South East of England. EVL is unique within the UK for focussing on premium varieties, plants and berries. Our breeding programme commenced in 1986 to breed improved Everbearer strawberries for UK growers. The programme has now evolved into three strawberry breeding programmes to cover the major commercial strawberry types, with selection operating in the UK and Spain. Important commercial releases include Everest, Evita, Evie2, Sweet Eve, Eves Delight 2 and Eves Joy, and these varieties are grown in number of regions across the globe. The success of the breeding programme lead to the development of a propagation business, Edward Vinson Plants Ltd. (EVP), to manage the demand for the varieties and high-quality plants. The propagation business now produces 25 million tray plants across the South of England and Bulgaria. The berry growing operations in and around Faversham, Kent, grow plants from EVP, of EVL breeding, to supply strawberries to leading retailers in the UK. Only berries of EVL bred varieties are grown, under tunnels, and picked for packing in EVL's new packhouse. Fruit is dispatched from the packhouse to a range of UK retailers in collaboration with our marketing desk partners. Current methods for plant breeding, plant propagation, fruit production, fruit packing and supply in the UK will be described.

Strawberry production in Greece: challenges and opportunities for development through breeding

Evangelos Tsormpatsidis

BerryPlasma Worldwide LTD, Varda Ilias, Greece

Greece is one of the earliest sites for strawberry production in South Europe, located in North west Peloponese. Thanks to its proximity to the markets, most of the production (>85%) is being exported in West and East Europe from as early as November to late May- early June. Over the last decade there has been a tremendous increase in acreage from 1000 ha in 2012 to 2400 ha in 2023. Despite its development over the last years, the Greek production is facing new challenges which put into risk the production such as: climate change, new emerging diseases, withdrawing materials for crop protection and soil disinfectants for nursery production. Labour issues are becoming also a major problem for Greek and European agriculture. On top of these challenges Greece (in contrast to Spain and Italy, countries competing Greece in the European market), has not yet a mature breeding program to select varieties adapted to the Greek production system. The Greek production system differs from the Spanish in many aspects. For example, the growers in Spain are removing the tunnels every season and renovating the beds. In contrast, in Greece, they keep the beds for up to 6 years. The planting In Spain is done in the open field whereas in Greece under plastic tunnels (thus plant losses in Greece is much higher than in Spain). The covering of the tunnels in Spain is done after plant establishment. Thus, adaptation of a variety to the Greek strawberry production system in relation to climate change and our special market needs makes the development of Greek varieties a necessity more than ever. At Berryplasma we have been working extensively over the last decade to develop varieties that firstly adapt to our climate, secondly to our production system but at the same time meet the needs of our markets. Thus, we have registered 4 new varieties (Kallisti, Elektra, Phaedra and Aethra) with superior quality characteristics that adapt to our climate and our market requirements. Our vision is to further expand in other countries where similar quality characteristics are required.

Breeding raspberries and blackberries for year-round supply of the northern European market

Felicidad Fernández Fernández

NIAB EMR, New Road, East Malling, Kent, ME19 6BJ, United Kingdom

Raspberries and, increasingly, blackberries are very popular fruits in the UK and other northern and central European countries. Both are popular in frozen mixes and used extensively in processed products but, supply of fresh berries is now expected year-round in UK and other European markets. Retailers have a strong preference for cultivar continuity with cannot be fully met in berries providing incentives to grow the same cultivars in and off season. This posseses challenges to breeding programmes and producers alike. NIAB East Malling has long-standing fruit breeding programmes in collaboration with industry. In this talk, I will aim to provide a summary of UK production standard as well and the work carried out by the EM Rubus Breeding Consortium to help us met those industry demands.

Strawberry and raspberry are excellent sources of valuable bioactives with impact on human health

Francisco A. Tomas-Barberan

Quality, Safety and Bioactivity of Plant Foods, CEBAS-CSIC, Murcia, 30100, Spain

Strawberries and raspberries are excellent sources of bioactive polyphenols. Anthocyanins, proanthocyanidins and ellagitannins are the main ones. Here we review the contribution of agronomic and postharvest practices on the content in these bioactives and their impact on human health. The health effects of strawberries have been demonstrated in different clinical trials, and polyphenols have been considered as one of the main responsible for these effects. Anticancer, neuroprotective and cardiometabolic benefits have been reported. In some of the studies a large inter-individual variability in the effects is observed.

The polyphenol absorption In the Intestine is very low and they reach the colon at high concentrations and interact with microbiota. Therefore, local effects associated to unabsorbed polyphenols are observed as well as systemic effects associated with the interaction with gut microbes. Gut microbiota converts berry polyphenols into absorbable and active molecules. Good examples of this relevant metabolic function are the conversion of hydrolysable tannins into urolithins, and condensed tannins into valerolactones. Evidence of the health effects of these metabolites, and particularly urolithins, is growing every day.

Plant breeding programmes, agronomic, and postharvest storage practices have a high impact on the quantity and quality of the berry bioactives and therefore on their health effects. In general, the best berry sensory quality also matches the best bioactives content. The effects of priming agents and biostimulants on the quality and bioactives composition of berries still needs to be better understood.

Advances in online quality grading of fruit

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The ISO 9000 standard defines quality as the 'degree to which a set of inherent characteristics fulfills requirements of the customer'. For the horticultural industry this requires the availability of nondestructive techniques to inspect quality attributes of fruit and to use these techniques for online sorting and grading. While until a decade ago this was limited to color, size and absence of skin defects, novel technologies have appeared that allow to measure important taste attributes such as sugar content and firmness nondestructively at commercial grading speeds. However, internal disorders remain difficult to detect. In this presentation we will compare different nondestructive techniques for online quality grading of fruit a, with a special focus on berry crops. We will address the advantages but also inherent limitations of optical methods and then focus on novel imaging technologies based on X-ray radiography and tomography. We will discuss how artificial intelligence techniques and deep learning neural networks can facilitate and automate the interpretation of the images obtained with these techniques. We will show how recent developments in both hardware and software enable to reduce the acquisition and data processing times that inherently come with them to levels which are becoming compatible with industrial requirements.

Volatile organic compounds and aroma profile as an intricate part of fruit quality

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Fruit volatiles play a pivotal role in determining the quality of fresh fruits. Besides contributing to fruit flavor, they also provide valuable information about the fruit's overall condition, such as its ripeness, senescence, or microbial load. These volatile organic compounds (VOCs) result from a complex set of biochemical pathways that are impacted by genetic and environmental factors. Therefore, post-harvest handling and storage practices, can be highly influential on fruit aroma as well. This can be used to our advantage by using these VOCs to better monitor and control postharvest fruit quality. This includes developing aroma-based markers for assessing fruit quality and optimizing post-harvest practices to maintain aroma integrity. This contribution will give an overview of the various VOC based applications we are currently exploring to give new directions to fruit breeding and post-harvest management.

Metabolomics in agri-food: Analysis of soft fruit-relevant phytochemicals and priming to enhances their quality

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Numerous studies highlight the health benefits associated with the consumption of soft fruits, linked to their phytochemical content. Therefore, phytochemicals are an important parameter for assessing the quality of soft fruits. The ability to accurately characterize these compounds and determine the concentration of each within soft fruits is essential for quality evaluation. The phytochemicals present in soft fruits, known as polyphenols, belong to a wide family of metabolites with distinct chemical properties, especially regarding their absorption spectrum, which facilitates their identification. Metabolomic tools provide an analytical solution for characterizing these metabolites, equipped with suitable instruments that combine UV-VIS detectors for polyphenol type characterization and mass detectors for precise metabolite confirmation. Furthermore, the growing need for agri-food solutions to support an increasing population, while optimizing resources without compromising the quality and health benefits of the products, is increasingly apparent. Thus, developing new and promising priming strategies to address these issues is a promising endeavor. In this context, advanced techniques of untargeted metabolomics allow for the exploration of a sample's complete metabolome to detect unknown metabolites. These techniques have been applied in agronomy to identify the metabolites truly responsible for the effects of bacterial biostimulants, thereby enhancing their production and yield through tailor-made approaches. Integrating both techniques could significantly advance the design of new priming products, further allowing for the evaluation of their effects on phytochemicals.

Effect of light and temperature conditions on quality of Vaccinium berries

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Light and temperature affect the fruit development and ripening having the major impact on the fruit quality. In northern Europe, wild Vaccinium berries grow abundantly and are generally picked and utilized. Due to the special growth conditions at high latitudes combining long day length and cool temperature, we have had focus on understanding the effect of light conditions (day length, light intensity and spectral quality) and temperature on the quality of bilberry (V. myrtillus) and lingonberry (V. vitis-idaea). The controlled and field studies have shown that day length and light quality both affect the production of the phenolic compounds, especially anthocyanins, which are they key health beneficial compounds in these berries. Our results have also revealed new knowledge on the mechanisms regulating accumulation of phenolic compounds in ripening berries. Besides phenolic compounds, light conditions also affect the carotenoid and sugar metabolism of the ripening berries. These compounds are also affected by temperature, and our results indicate origin specific adaption on the specific temperature conditions for the Vaccinium ecotypes.

Blackberry production trends and adaption to diverse climates in the United States

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Blackberries are the fourth most economically important soft fruit in the United States, accounting for over US $600 million in retail sales annually. Production is concentrated in the western and southern portions of the country, where it is essential to rural livelihoods in these growing regions. The industry continues to expand in the United States, but like in many countries, it is facing serious climate-related issues that threaten the economic viability. For example, high temperatures during flowering and fruit ripening are reducing fruit quality of the crop and causing poor berry set, incomplete drupelet development, sunscald, white drupelet disorder, red drupelet reversion, and a general loss of plant vigor. Winter injury to the canes or insufficient chilling hours are also limiting production in northern and southern portions of the country, respectively. Therefore, understanding the effects of extreme temperatures on plant growth and fruit development will be key to the continued success and further expansion of the industry. We and others are conducting research throughout the United States to learn more about the impact of various environmental conditions on berry production, fruit quality, and water and nutrient use and to find ways to help blackberry growers mitigate climate limitations and expand production. By documenting climate patterns during the growing season, we are beginning to identify new breeding populations and developing new cultivars that are tolerant to high summer temperatures, water stress, and variable chilling hours. We are also locating genetic markers for tolerance to abiotic stresses and understanding the impact of these stresses on fruit quality, physiochemical properties, and flavor. Finally, we are developing new and modified horticultural systems, including the use of priming agents, to promote adaptation and profitability in diverse climates. Improved knowledge and development of these tools will help growers adapt to changing climates and ensure that profitability remains sustainable in key berry production regions of the United States and elsewhere where blackberries are grown for fresh and processed markets.

Janssen PMP vision for the future in soft fruits

Wendy Schotsmans

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The crop management story of JanssenPMP started with Imazalil, the reference standard in terms of fungicide applied on citrus fruits. Since then, we have expanded and added new technologies for disease control as well as products to maintain the overall quality of produce during their shelf life to our portfolio. Our vision for soft fruits is reflected in one of our newest quality focused products that will hit the market soon. This new 1-MCP based technology can be used for smaller packages, hence, opening the possibilities for soft fruits to benefit from the amazing advantages of 1-MCP. For disease control, we follow the overall tendency and need to focus on natural products and as an additional requirement we look specifically for new technologies that can be used with no or limited use of water which again opens the possibilities for soft fruits. Recently we have also started a new product line, the biostimulants, with specific focus on products that have a clear effect on post-harvest quality by making the plants more resilient to various types of stress. This is especially important for berries that have a relatively high-water demand.

The blueberry fruit production within a global context: challenges and constrains

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Blueberry (Vaccinium spp.) commercial cultivation is considered long term in comparison to other soft fruit investments. Therefore, when a grower or agronomist designs a new blueberry orchard, they need to justify establishment costs and generate adequate income at acceptable quantitative and qualitative levels for at least 10 to 15 years. To that extend, an orchard designed in 2024, planted in 2025 will still be in production in 2035 or 2040. Consequently, the agronomical investment must consider both depreciations, return of investment but also potential challenges of the world's market in 15 years.

Climate change was primarily a topic discussed by scientists and academics since the mid-1980's, however it is now becoming harsh and real for everyone, especially people working in agriculture. The climate anomalies that in the past were only local events now are happening increasingly at global scale., According to climate change projections, high-chill zones will transition to mid-chill in 10 years, and many mid-chill areas will become low-chill. Eventually, low-chill regions will turn into no-chill areas. These changes will significantly affect production cycles and the global blueberry market in the coming years.

The global spread in many blueberry areas also bring new pests: Drosophila suzukii and Scirtothrips dorsalis have already altered the mindset of several blueberry producers. Looking ahead, due to the global movement of plant material and the more suitable climate condition for some diseases due to the climate change, we may witness a global pressure of important diseases, such as Xylella fastidiosa, Monilinia vaccinii -corymbosi (Mummy berry), or Popillia japonica.

Economically, the massive expansion of new berry plantations by small and major blueberry players over the last 5 years will inevitably transform blueberries into an increasingly common commodity; this market evolution, coupled with climate change and the spread of new pests, will increase the complexity to achieve economic success for producers and investors.

The challenges before us are immense and global, whereas the decision to make a blueberry orchard will need careful and professional design. This decision will need to be accommodated with serious contemplate on how the world will be like in 10 or 20 years. Only then the blueberry entrepreneur can make conscious and profitable decisions.

Empowering wild blueberry plants and mitigating floral diseases with the use of biotic priming technologies

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The wild blueberry sector focuses on the production of berries from naturally occurring populations of several Vaccinium species. A two year production cycle is used to facilitate yield potential and harvest efficiency. However, with the berries being produced in a maritime climate with an abundance of infection events and foliar diseases including Septoria, blueberry rust, and Sphaerulina leaf spot diseases and also floral diseases including Monilinia and Botrytis blossom blight diseases persisting, significant damage and yield losses often occurs. Although the status of the causal fungal pathogens (is sporulation occurring), the growth and development stage of the blueberry plants (vegetative and floral bud stages), and the environmental conditions (temperature, wetness duration, and relative humidity) are closely monitored, intervention and mitigation practices are used to minimize berry yield losses and improve harvestable berry quality. With an increasing proportion of end-users requesting minimal to no detectable residues of conventional disease control fungicides, the transition to alternative disease management practices including the use of biofungicides has occurred. Combined with this, it has been observed that regardless of the presence of the fungal pathogens, blueberry plants can acquire improved resistance against pathogen attacks upon being exposed to foliar applications of priming biotic inducers including Bacillus amyloliquefaciens with changes in PR gene expression, phenolic compounds, carbon assimilation and metabolism, and harvestable berry yields being observed. In many cases, these more environmentally friendly technologies have provided equivalent or better disease control than conventional management practices and are also serving as part of a resistance management strategy.

Unveiling the impact of controlled environments on highbush blueberry cultivation

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Cultivating blueberries in pots within protected environments, such as high tunnels or greenhouses, offers benefits like climate control, reduced pest and disease risks, and improved water and nutrient management. Our studies aimed to investigate how highbush blueberry plants respond to modified microclimatic conditions in plastic greenhouses versus anti-hail nets and compared various cultivation methods, including ridge planting and pot cultivation. We also explored additional techniques like using differently colored anti-hail nets, optimizing the fruit-leaf ratio, and applying biostimulants to manage plant stress. The protected environments, particularly the greenhouse, had significant effects on environmental factors like air temperature, humidity, light intensity, substrate temperature, and water content. Elevated air temperature and leaf vapor pressure deficit led to reductions in net photosynthesis, stomatal conductance, and actual PS II efficiency, with more pronounced effects observed in high tunnels. Pot planting offered superior control over substrate pH, a critical factor in blueberry cultivation, with different outcomes observed among cultivars ('Duke', 'Aurora' and 'Brigitta'). While ridge planting had some minor advantages, especially in the initial years, pot production proved advantageous due to the easier implementation of agrotechnical measures. The application of biostimulants like salicylic acid had limited effects on fruit quality and ripening. Our studies underscore the importance of considering modified microclimatic conditions, particularly increased air temperature and reduced light intensity in plastic greenhouses when assessing the physiological and chemical aspects of highbush blueberry plants. These insights are pivotal for improving blueberry crop quality and yield while addressing challenges posed by microclimatic variations in production.

Exploitation of different mesoclimates towards year-round raspeberry production in Cyprus

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Cyprus is a water depleted Mediterranean country, especially when it comes to irrigation water. Fortunately, dams and wells are available to provide irrigation water during production months. However, extreme heat waves during spring, summer and fall, render most cultivation water inefficient. Two more factors maximize the water scarcity problem, year-round droughts for consequent years and water wells overuse near coast areas that makes irrigation water to reach high salinity levels during droughts. Therefore, farmers shift their production during the summer to the mountains, where quality irrigation water is more abundant and heatwaves are milder. Thus, red raspberry (Rubus idaeus L.) cultivation is limited in the mountaineous region of Troodos from June to September. However, its value and demand is rising and people are asking for fresh berries year round. The fresh fruit availability is limited due to mainly unawareness of the new practices dynamic worldwide. Specifically, mountain growers cultivate in open fields in alkaline sandy soils, without advanced fertigation regimes and unaware of each cultivar dynamic and potential. Our research looks to overthrow the old practices and utilize priming agents to create advanced protocols for year-round production of red raspberries in Cyprus. New fast growing, heat resistant and low-chill substrate grown cultivars, will be planted as fresh tray plants starting mid spring in the Mountain. The goal is to stretch the biennial growing system to achieve 3 harvests within 14 months. The cultivars will reach first harvest in the mountains from August-October and will be transplanted in November in a greenhouse to attain floricane harvest during the winter from December until March. Last harvest from primocanes will be initiated from May to June, one year after planting. This work will additionally report lessons learned during the lifetime (2014 onwards) of the established soft fruit program at Cyrpus University of Technology.

Raspberry cultivation for processing and fresh market in Serbia

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Raspberries have been grown in Serbia for more than 70 years for freezing and industrial processing, while raspberry cultivation for the fresh market began after 2000. According to FAOSTAT data, Serbia had a yield of 116,093t in 2023, while the projected yield for 2024 is around 108,000t. The areas under raspberry plantations in Serbia vary between 15,000 and 24,000 ha from year to year. The main reason for large fluctuations in the area under raspberry is the price of the fruit. The largest region for raspberry production in Serbia, with around 85% of total production, is the southwestern part of Serbia, especially in the hilly and mountainous areas. Traditional raspberry production is still dominant with production of raspberries are the municipalities of Ivanjica and Arilje, which are also the largest regions in the world for growing raspberries with about 5,000 ha of plantations and only 50,000 inhabitants. During the raspberry harvest season, producers hire 5,000-8,000 workers who come from other parts of Serbia, but also from Bosnia, Albania, Nepal and India. It is estimated that about 90% of the population in those two municipalities is directly involved in raspberry production. Of these, about 30% of producers are professional producers engaged in raspberry cultivation and other agricultural activities, and the other 70% are part time producers, i.e. people who have their permanent jobs in state institutions or private companies, while during the raspberry harvest season they use their annual vacations to harvest fruit from their raspberry plantations. It is also specific that on the territory of the municipalities of Ivanjica and Arilje there are and are working more than 500 small and medium-sized refrigerators company that buy raspberry fruit directly from the producer and quickly freeze them so that good quality is preserved by quick freezing immediately after harvesting. In 95% of cases, they sell their frozen fruit to large cold stores company that classify, pack and export raspberry fruit. More than 95% of millet fruit produced in Serbia is exported to the EU, USA, Russia, Japan and the rest of the world. The price of raspberry fruit in Serbia varies from year to year and in the last 20 years it ranges from a minimum of 0.7€ (2018 rainy season) to 4.7€ (2022). The dominant raspberry variety for freezing in Serbia is 'Willamette' with about 70% of the area, which came to Serbia from the USA as far back as 1965. The Hungarian variety 'Fertodi Zamatos' is also grown with about 10%, and the other 20% are 'Meeker', 'Tulammen', 'Glen Ample' from floricane varieties that are harvested by hand and 'Polka', 'Polana', 'Enrosadira', 'Himbo Top', 'Tula Magic' from primocane varieties that are also grown in 90% of cases are picked by hand and 10% are picked by machine. In the last 10 years, the production of raspberries for the fresh supermarket market in Serbia has been increasing because the domestic market is developing, but also for export mainly to EU countries. The dominant variety for growing fresh raspberries is 'Enrosadira', and in smaller quantities are the 'Himbo Top', 'Tula Magic', 'Glen Ample' and 'Tulameen' varieties. Climatic conditions make raspberry production difficult,

so that a number of producers cannot adapt to the new growing conditions and abandon production. Another part of the producers is looking for a solution in growing raspberries in substrates in a covered and closed space with maximum production control. One of the problems of transitioning to new technologies is the traditional mentality of producers who are already the third generation in the family engaged in the same business and find it difficult to adapt to market demands and changed climatic conditions. The ban on the use of many protective agents leads producers to switch to organic or integral or zero residue production, which is increasingly in demand in the world. The state helps producers with subsidies for seedlings and accompanying growing equipment, which is a great support, but not enough for many. The constant cooperation of state institutions with buyers and producers of raspberries in Serbia represents joint efforts to solve many emerging problems, because only joint efforts can overcome problems that are increasingly present mainly due to changed climatic conditions and the demands of end customers. Conclusion: Only the best is good enough.

Life cycle analysis as an intricate part of assessing the enironmental and socioeconomic impact of berry crops' production models

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Life Cycle Analysis (LCA) serves as a critical tool in the evaluation of the environmental and socioeconomic implications of different berry crop production models. Berry crops, encompassing a diverse array of fruits such as strawberries, blueberries, raspberries, and blackberries, have gained global popularity due to their rich nutritional profile and health benefits. However, the cultivation and production of these berries involve intricate agricultural practices that can yield significant environmental and socioeconomic consequences. LCA offers a systematic framework to analyze the life cycle of berry crops, from the initial stages of cultivation and planting to harvesting, transportation, processing, packaging, and consumption. The analysis encompasses a broad spectrum of factors, including resource utilization, energy consumption, waste generation, greenhouse gas emissions, and water usage. By scrutinizing each phase of the life cycle, LCA helps to identify potential environmental hotspots and allows for the development of targeted mitigation strategies to reduce the overall environmental footprint of berry crop production. Moreover, LCA does not solely focus on the environmental aspects but also delves into the socioeconomic dimensions of berry crop production. It evaluates the impact on local communities, considering factors such as labor practices, employment opportunities, economic benefits, and social well-being. This holistic approach ensures that the assessment considers the broader implications of berry crop production beyond ecological concerns. By integrating LCA into the evaluation process, stakeholders, including farmers, policymakers, and consumers, can make informed decisions aimed at promoting sustainable berry crop production models. These models seek to minimize negative environmental impacts, optimize resource utilization, improve economic outcomes for farmers and communities, and enhance overall social well-being. LCA plays an integral role in assessing the environmental and socioeconomic impact of berry crop production models. By providing a comprehensive understanding of the life cycle stages and their implications, LCA guides the development of sustainable practices that balance environmental, economic, and social considerations in the cultivation and production of berry crops.

Breeding for sustainability and the premium berry market

Ellen Thompson

Hortifrut Genetics Limited, USA

As the largest producer of fresh-market blueberries - second largest in raspberries - and operating its own farms in 10 countries, Hortifrut is no stranger to the increasing climate events negatively affecting soft fruit production across the globe. Vertically integrated, from (pre-) breeding through marketing, the company is uniquely positioned to address climate change from start to finish across the supply chain.

At its core, sustainability consists of fulfilling the needs of current generations without compromising the needs of future ones, while ensuring a balance between Environmental care, Social well-being, and economic growth through Governance (ESG). Collectively, ESG forms the "pillars of sustainability" that public and private institutions use as a foundation. The United Nation's Sustainability Development Goals (SDG's) further provide targets to achieve. Multi-national companies like Hortifrut are regularly assessed on how their global goals are set, how metrics are being achieved and the subsequent impact on local, regional and international stakeholders. Retailers increasingly evaluate their suppliers SDG's and, in some cases, collaborate.

Breeding subsidiary Hortifrut Genetics Ltd. is investigating several methods to define and incorporate sustainability into its global breeding programs. Defining sustainability metrics for genetics programs is an endeavor that requires innovation, technology, collaboration – as well as a diverse germplasm base. Breeding for resilience starts with knowledge of producer needs (high yield, disease tolerance), while balancing the needs of the market (high quality, shelf-life). Core economics is the dominant driver for all parties, and molecular tools help leverage the slow-yet-steady gains made by breeders.

Premium berry products are emerging via new marketing segments in the retail space. Consumer data indicates that freshness and shelf life are of critical importance. Purchase data shows that consumers are willing to pay more for jumbo and super-sweet berries. Some retailers are not willing to add new (premium) SKU's to the shelf, while others are helping create new products.

Microalgae-based products as innovative technological approach to enhance performance of soilless cultivated highbush blueberries

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This study illustrates the effect of the microalgae-based fertilizers 'Algafert' and 'Biofat 600' (Bioreason, Almeria, Spain) on the leaf concentration of pigments (chlorophyll a and b and total carotenoids), proteins and enzymes (polyphenol oxidase and peroxidase) as well as on the productivity, fruit weight, soluble solids content (SSC), total acids (TA), total phenolics (TPC), total anthocyanins (TACY) and total antioxidant capacity (TAC) of soilless grown highbush blueberry cv. 'Duke'. The field study was conducted in 2023 in a blueberry plantation established in spring 2019 as a soilless culture in the municipality of Ruma (Serbia). The pots were filled with Legro substrate (Netherlands) and placed at 0.8 m apart in a row and 2.8 m between rows (4,400 plants/ha). Irrigation and fertigation were provided by 4 spear drip emitters in each pot. The foliar treatments of the tested microalgae-based fertilizers 'Algafert' (0.75% N; 7.40% P2O5, 3.20% K2O, 5.60% free amino acids) and 'Biofat 600' (2.70% N, 6.70% Ca, 0.10% P2O5, 0.10% K2O, 6% free amino acids) were applied three times in spring as follows: i) 1st application on April 21 (50% of open flowers); ii) 2nd application on May 3 (full flowering), and iii) 3rd application on May 15 (20 days before harvest). Both fertilizers were used in the amount of 1,2 L each and mixed with 400 L of water per application. No fertilizer was applied in the control treatment. The experiment was set up in a completely randomized design with 3 replicates and 10 plants each (30 plants per treatment). Leaf and fruit samples were collected for analysis at the second harvest (mid-June). The leaf concentration of chlorophyll b and total carotenoids was positively affected by the microalgae-based products (13.62 and 1.56 µg g-1 FW, respectively), thus influencing the photosynthetic potential and the physiological status of the plant. The leaf protein content of the tested cultivar increased in the treatment with microalgae-based fertilizers (0.017 mg prot/ml), as well as the activity of the polyphenol oxidase enzyme (91.98 U/mg protein). As a result of the positive effect of microalgae -based fertilizers, an increase in yield and fruit weight (3.93 kg/bush and 2.53 g, respectively) was also recorded compared to the control treatment (2.97 kg/bush and 2.11 g, respectively). SSC and TA in the fruits did not differ significantly between the applied treatments, whereas TACY and TPC in the fruits from the treated plants was lower (70.83 mg c-3-g eq 100 g–1 FW and 1.18 mg GA eq g-1 FW, respectively) than in the control treatment. The significant decrease in TPC can be explained by the fact that the polyphenol oxidase enzymes, which were more abundant in the leaves of treated plants, use these compounds as a substrate. In contrast to phenolic compounds, fruit TAC was higher in the microalgae-based fertilizer treatment (2.53 mg ascorbic acid eq g–1 FW) compared to the control treatment (1.97 mg ascorbic acid eq g–1 FW).

Sustainable technologies to enhance crop resilience to the effects of climate change

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Global climate change negatively impacts soil and crop health. A broad range of crops are sensitive to sub-optimal temperatures, poor water availability and shifts in soil microbial communities, which leads to reduced crop yield and quality. These problems are compounded by the lack of sustainable technologies in the area of soil health and abiotic stress management. MicroGrow™ is an effective technology tailor-made to foster the proliferation of beneficial microorganisms in soil and to support vigorous crop establishment. Microbial biodiversity assessment demonstrates that MicroGrow applications can alter bacterial community structure. The shifts induced by MicroGrow are attributed to decreases in the relative abundance of Fermicutes, a marker of poor soil health due to abiotic/biotic factors, and increases in the relative abundance of beneficial species such as actinobacteria, proteobacteria and saccharibacteria. MicroGrow application is also proven to increase 'root nodules' (+27%), improving the legume-rhizobia symbiosis. Super Fifty® Prime is a new technology that functions as an 'Molecular Priming' agent in crops. The process involves prior application of SuperFifty Prime as a foliar spray onto crops, at the flower bud emergence and at bloom stages. SuperFifty Prime functions by priming and triggering a series of oxidative stress adaptations, rendering crops tolerant to oxidative stress, thus improving fruit-set and yield in crops. Using high-throughput OMICS and advanced bioinformatics, an in-depth analysis of this priming process was undertaken at the molecular level. MicroGrow and SuperFifty Prime technologies are available to improve soil health and can be employed in climate-smart strategies to alleviate oxidative stress-induced damage in crops.

Beat the heat – mitigating heat damage in raspberry

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Recent extremes in heat have caused yield and fruit quality losses within the fresh and processed red raspberry (Rubus idaeus) industry in leading regions of production in the United States (US). The fresh market industry, concentrated in California, largely uses primocane-fruiting cultivars with the majority of growers using plastic hoop tunnels and several growing in substrate. Sunscald of the fruit is one problem associated with heat and is more common outside of hoop tunnels during times of warmer temperatures and low humidity. Heat stress can also be exacerbated in tunnels leading to suppressed plant growth, larger, rapidly growing two-spotted spider mite (Tetranychus urticae) populations, and even outright plant death. Within the historically cooler maritime climate of the Pacific Northwest (Oregon and Washington states), floricane-fruiting raspberry cultivars are grown in soil and machine-harvested for the processing market. However, climate change projections have forecasted increasing frequencies in high temperature extremes within the Pacific Northwest and the raspberry industry is unprepared to deal with these challenges. Heat damage within the Pacific Northwest has caused partial to total crop loss, scorched leaves, and sunscald of fruit. Growers need tools that allow them to mitigate the negative consequences of heat effectively and economically. Research has shown that floricane-fruiting raspberry genotypes vary in their susceptibility to heat stress. A better understanding of the physiological and genetic mechanisms that confer heat tolerance is an important long-range goal to incorporate into breeding programs, as well as evaluating the performance of breeding material under elevated stress conditions. Research is also underway to evaluate evaporative cooling systems and shade cloths across several genotypes of floricane -fruiting raspberry. Both evaporative cooling and shade clothes have demonstrated efficacy in mitigating heat stress across other horticultural crops but require substantial infrastructure and financial investments. Another promising technique is employment of priming agents, which do not require new infrastructure and have been shown to improve photosynthetic efficiencies and biomass when raspberry plants are exposed to heat stress. Future work should continue to evaluate multiple approaches that provide both short- and long-term solutions for growers to effectively “beat the heat” while allowing farming operations to remain economically viable.

Exploring the VOC profiles within the local population of new primocane lines toward flavor-guided breeding

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Raspberries (Rubus idaeus) are woody perennials of the Rosaceae family with a unique and distinctive flavor. Raspberry is a relatively new crop, mostly grown in temperate and cold climate regions. The annual-fruiting cultivars (Primocane) have the entire plant growth and reproduction cycle in a single growing season almost independent of day length and, therefore, are more suitable for warmer regions. High temperature, a short shelf-life, and increased demand necessitate adaptation for local production in the Mediterranean basin. Flavor is expected to play a larger role in decision-making, especially in high-end perishables, as it determines the second purchase and long-term value. However, flavor is a complex trait to breed with a delicate balance between non-volatiles (taste) and volatile compounds (aroma). The basic tart taste in raspberry fruit consists of >2% titratable acidity, while the sugar/acid ratio determines the overall taste. The aroma of raspberry fruit consists of dozens of VOCs that can potentially contribute to its flavor. Several VOCs have been characterized as crucial for the typical flavor, including the infamous raspberry ketone or β-ionone. Within our population, we have identified only a handful of VOCs that potentially contribute to the flavor. Still, there is much to learn regarding the quality of raspberry fruit grown under local conditions and the effect of the local temperature on flavor development. During my talk, I will present the local practices for raspberry cultivation and our recent efforts in pre- and postharvest research.

Securing soft fruit production in Denmark

Antonios Petridis

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How can we meet the rising demand for locally produced berries among Danish consumers when the area dedicated to soft fruit production in Denmark is decreasing? This challenge becomes even greater considering the increasing occurrence of environmental stresses, such as drought and temperature extremes, and the fewer molecular and genetic tools for investigating soft fruit crops compared to those available for staple crops. In my talk, I will provide an overview of our newly established research program within the soft fruit area and expand on research priorities that we have set, aiming to improve yield, berry quality and environmental resilience of soft fruits in a sustainable manner. In the long-term, our ambition is to increase the access of Danish consumers to safe and healthy berries, and to promote the profitability and sustainability of soft fruit industry in Denmark and beyond.

Genomics to achieve disease and pest resistant strawberry cultivars as a priority in breeding programs

Amparo Monfort

IRTA, Centre for Research in Agricultural Genomics (CRAG), CSIC-IRTA-UAB-UB, Barcelona, Spain

Production of the cultivated strawberry *(Fragaria x ananassa)*, which has become the most popular species of small fruits and berries, has been increasing over the last twenty years. Like all crops, strawberries are susceptible to several pathogenic fungi such as Podosphaera aphanis, which causes powdery mildew disease, a major threat to strawberry productivity. To reduce productivity losses caused by these fungi, farmers are forced to adopt expensive and environmentally harmful chemical treatments. The best action would be to grow cultivars that are resistant to these fungi and promote more sustainable agriculture. To identify genomic regions that contribute to plant resistance, we conducted a genome-wide association study (GWAS) using a large collection of strawberry cultivars, and a validation in segregating biparental populations. The discovery of crucial genomic areas and candidate genes related to increased resistance represents a substantial achievement. The integration of resistance genes through marker-assisted selection (MAS) provides tools to guide breeding programs (MAB) towards the development of new cultivars with greater resistance to powdery mildew infection.

More berry with less resources: building resilient production systems

Costanza Zavalloni

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Climatic changes are increasing temperatures and the frequency and severity of extreme weather events like heat waves. Berries are very sensitive to weather extremes and as a result, every year significant yield losses are experienced by our independent growers. Driscoll's declared among its goals the prioritization of the concept of growing "More Berries with Less Resources". We established water conservation and the improvement of water quality as the first targets. Water is a critical resource for residents and industry and is already constrained in some growing regions like Oxnard (California, USA) and Portugal. In addition, some growers face critical water quality issues (e.g., Baja California, Mexico). Driscoll's set an ambitious goal of increasing by 30% the water use efficiency of berry production systems using as metric liters of water per kilogram of fruit. Also, Driscoll's is focusing on reducing greenhouse gas emissions and the use of plastic, as well as improving plant health. Innovative agtech solutions that lower production costs and improve the conservation of natural resources are currently evaluated and trialed in partnership with growers. An overview of the sustainability priorities including current efforts on incorporating resource use efficiency into Driscoll's breeding programs pipeline will be presented.

Molari Berries and breeding's concepts for a stronger and equilibrate growth of the berry industry

Monia Dall' Ara

Molari Berries & Breeding, Italy

Our daily activity is studying the market, the trends and to develop solutions that the berry industry can implement in its mechanisms to continue its growth. There are different players involved in the chain: (a) growers (from nursery to the grower that end having the fruit to sell), (b) fruit Sellers (marketing companies, fruit traders, super markets, traditional markets), (c) customers (the final consumer, the one that taste the fruit). The trend in the last years is been to extremize the varieties, improving tremendously the fruit qualities as requested by the Fruit Sellers in order to satisfy the Customer expectations. The varieties are better in fruit quality, but not better in terms of rusticity, adaptability and management, as the grower require. Moreover, an increase in the offer of new varieties is somehow giving more possibilities, but at the same time less time to evaluate them and find the right variety for each company. There is not anymore, the space for a single variety, good for everyone. It's also important to guarantee a continuous availability of good fruits, all year round, to each category, if we want to have a full development of the market, giving the possibility to each internal market to be able to supply the chain internally as much as it can. A more sustainable and less impacting growing techniques is more and more requested, as well as a shorter distance from production place to consumption location. For these reasons we as Molari Berries and Breeding are working on different concepts that we believe will give better instruments to the whole players involved in the berry industry: Easy Concept, Gil Program, Naike blueberry club, Blackberry year-round.

Sustainable year-round strawberry cultivation with fresh everbearer plants

Vera Theelen

Delphy ISFC, The Netherlands

At the Delphy ISFC the past couple of years, several trials have been done with new ways to grow Everbearers year-round. This includes a year-round unlighted fresh cropping, a LED lighted winter cropping and a double cropping with Everbearers. In the Netherlands but also in other parts of the world a lot of Junebearera are grown. This however, comes with some disadvantages that are linked to cultivating Junebearers. Junebearers have a long pre-cropping period are known for their short peak production. This means not only a peak in plant performance where a lot of production has to be produced in a short period of time, but also a peak in labour. Everbearers however offer more potential for continuous, even production over a longer period. In the past five years, growers have increasingly opted for the cultivation of Everbearers which produce flowers under both day neutral and long day conditions. Everbearers can have a good yield, quality, taste and fruit size potential. When grown right an Everbearer has the potential to give an balanced throughout production and the cultivation can be more efficient cost wise compared to the cultivation of a Junebearer. However, some plant specific aspects of an Everbearer are less know due to its complexity. An important aspect for growing Everbearers is that it offers more options for low-energy cultivation. An Everbearer can be cultivated with an optimum use of the available light, which means that these varieties generally require less energy. Also, Everbearers have less leaf mass compared to Junebearers and therefore have less transpiration. This means a lower use of energy to dehumidify the greenhouse air. The difference between the day and night temperatures is smaller than with a Junebearer which is also energetically more beneficial. At Delphy ISFC different trials with different genetics of Everbearers are being done: a year-round unlighted fresh cropping, a LED lighted winter cropping and a double cropping. There is a variation per cultivation concept in propagation method, used genetics and cultivation strategy in these trials. In all trials, a RTR-strategy is used. This means relating the greenhouse temperatures to the amount of light. With higher levels of light, higher temperatures are reached. This is done so, plant physiologic processes like photosynthesis are optimized. For the year-round unlighted fresh cropping fresh plants are planted in the greenhouse in January. After a vegetative phase the production starts around march. By keeping the plant in balanced a production until the end of October is reached, with the summer period being the most stressful. In the trial of 2022 a production of 18 kg/m2 was reached. The LED lighted cropping tackles the problem of being in production during the winter, when light levels are at the lowest. Achieving good productions with everbearing varieties in a winter cultivation is quite a challenge regarding managing the energy balance of the plant and preventing the plant from going into dormancy. When strawberry plants go dormant, problems occur with leaf stem and truss elongation, fewer leaves are developed and fruit quality drops partially due to the decrease of flower quality. The effect of dormancy can

put a pause to an ongoing production and cause a lot of misshapen fruit. It also takes a while for the plant to get out of dormancy again, and energy wise the plant is not in balance. An unbalanced plant leads to an unwanted peak later in production. The main goal is to keep energy requirements within limits and keep the crop vital throughout the entire cultivation period. This requires a positive energy balance, where the plant achieves sufficient production and still has some energy left to produce new trusses. In the Everbearer double cropping, the method of a standard Junebearer production is used. Plants are planted in July and have a first production period from August until December. After the first production period in the autumn the heating is turned of and the plants receive some cold. After this cold period the leaves are cut and in January the heating starts again to go for a second production period. This second production period will go on from March until July. The goal in all cultivation concepts is to minimize the energy input. The results of the development and further optimizing of the cultivation strategies with Everbearers will presented and explained, as well as the climate strategies.

Specialty plastic films for soft fruits

Dimitrios Doukas

Plastika Kritis S.A., Heraklion - Crete, Greece

Multi-functional polyethylene (PE) films have transformed the global greenhouse industry due to their superior properties. The film is no more just a covering material but an important tool for improving the crop, by ensuring earlier harvest, higher production per acre, better crop quality and less phytosanitary treatments. However, traditional PE films have fallen short in protecting the plants and fruits from the harmful effect of droplets that condense on the film's surface, cutting the light and causing damage by falling on the plants. Anti-dripping films that cause the condensed water on their surface to form a thin layer that flows to the sides haven't been successful on typical soft fruit multi-tunnels, because the ropes that hold the film cause the water layer to fall towards the ground and at the same time they cause mist inside the greenhouse whenever the temperature rises or falls rapidly, as is the case early in the morning and at dawn. In addition, the typical anti-dripping effect lasts for just 1,5-2 years. Thus, condensation, dripping and fog have a known negative impact on the cultivation. In response to those challenges, Plastika Kritis, has developed a novel solution by use of nanotechnology. The innovative 8-layer EVO AC films provide anti-drip and anti-mist effects for many years, offering significant value to soft fruits growers - despite the use of ropes to secure the plastic that do not allow a totally droplet free environment. Growers using EVO AC films report a much better light in the tunnel, earliness, healthier crop and reduced usage of pesticides. EVO AC films can be equipped with various useful properties, such as thermicity, different levels of UV transmittance, light transmittance and diffusion, including a new solution, the "polydispersive" effect that reduces heat stress of hash light on plants and fruits in warm areas. Another novel feature is the self-adaptable light diffusion, which changes from low to ultra high levels depending on the amount of humidity on the film. Finally, for warm areas or to extend the growing period, Plastika Kritis has developed Cooling films that substantially reduce the day-time temperature inside the tunnel. Regarding soil grown soft fruits, the principal challenge of most growers is how to disinfect the soil effectively and in a sustainable way. Plastika Kritis has worked extensively with strawberry growers in Greece and have advanced the technique of solarization using TIF (totally impermeable film) that lead to a perfect disinfection of the soil without any chemicals.

EU funding landscape and upcoming opportunities for Agricultural/Food-related R&Is

Sonja Bergner

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Horizon Europe offers a broad range of funding opportunities, from support for basic research to innovation-oriented projects and Go-To-Market activities. Horizon Europe can be a truly rewarding but, at the same time, also challenging when it comes to finding the best fit within the range of calls for proposals. This talk will provide a comprehensive overview of EU funding opportunities, covering both top-down and bottom-up calls, as well as practical guidance for early proposal development. The session provides a broader overview on the Horizon Europe Framework, its structure and, in particular, at the features of collaborative funding opportunities in Pillar I-III (including top-down and bottom-up calls) and the overarching programme on "Widening participation and strengthening the European Research Area". Leaked Horizon Europe papers will give a sneak peek of upcoming opportunities to PRIMESOFT partners. During the workshop participants are invited to stay connected, engage further and exchange contacts and ideas.