LITHUANIAN RESEARCH CENTRE FOR AGRICULTURE AND FORESTRY

Nordic Association of Agricultural Science

4th International Conference
on the Scientific Actualities and
Innovations in Horticulture 2024
SAIH 2024

Horticultural Value Networks

PROGRAMME and ABSTRACTS

Kaunas, September 16–18, 2024

CONFERENCE INFORMATION

SCIENTIFIC COMMITTEE

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ORGANISING COMMITTEE

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SYMPOSIUM VENUE

Business Conference Center
K. Donelaičio St. 60/62, Kaunas, Lithuania

PROGRAMME

ORGANISERS

LITHUANIAN RESEARCH CENTRE FOR AGRICULTURE AND FORESTRY

Nordic Association of Agricultural Science

SAIH2024 outline conference programme
September 16–18, 2024

Monday, 16 September

9.30–10.00	**Registration, coffee**
10.00–10.10	**Opening.** *Gintaras Brazauskas*, Director of the Lithuanian Research Centre for Agriculture and Forestry, *Giedrė Samuolienė*, Institute of Horticulture, LAMMC

Session 1. Plant physiology and genetics for horticultural strategies

Chairs — *Vidmantas Bendokas*, *Irina I. Vaseva*

Keynote lecture

10.10–10.40	**Irina I. Vaseva.** Drought-mitigating strategies based on hormonal regulation of stress response

Oral presentations

10.40–10.55	**Ana Dovilė Juškytė.** Expression profile of blackcurrant (*Ribes nigrum* L.) transcription factors under chill-hardening *in vitro*
10.55–11.10	**Raminta Antanynienė.** *De novo* assembly of *Monilinia fructigena* genome
11.10–11.25	**Augustina Kolytaitė.** Characterisation of potential microbial antagonists against brown rot disease
11.25–11.40	**Edvinas Misiukevičius.** Unveiling the drought resilience of tetraploid daylilies: insights into ploidy's impact on plant adaptation
11.40–12.00	**Coffee, conference photo**

PROGRAMME

Session 2. Plant response-based cultivation technologies

Chairs	*Giedrė Samuolienė, Francesco Orsini*
	Keynote lecture
12.00–12.30	**Francesco Orsini.** Cultivating tomorrow: where and how indoor vertical farming will bring a horticultural revolution
	Oral presentations
12.30–12.45	**Akvilė Viršilė.** Plant-derived exosome-like nanoparticles: the relations between plant material and the consistency of particle yield and properties
12.45–13.00	**Ieva Gudžinskaitė.** Evaluation of nutritional value in mustard microgreens under different light conditions during growth and storage
13.00–14.00	**Lunch**
14.00–14.15	**Sasan Aliniaeifard.** Natural genetic variations in populations of horticultural crops in response to different stressors based on chlorophyll fluorescence analysis
14.15–14.30	**Martynas Urbutis.** Hormone based biostimulants: effect on oilseed rape photosynthesis and productivity
14.30–14.45	**Aušra Brazaitytė.** Interactive effect of different lighting and CuO and ZnO nanoparticles on kale growth and mineral composition
14.45–15.00	**Hamayun Shabir.** Innovative farming systems for job creation and social inclusion in modern prisons: ideas from the International Student Challenge UrbanFarm2024
16.00–18.30	**City tour**

Tuesday, 17 September

Session 3. Plant protection and product quality

Chairs	*Simona Chrapačienė, Beatrix Alsanius*
	Keynote lecture
10.00–10.30	**Beatrix Alsanius.** Integrated control in new light

PROGRAMME

Oral presentations

10.30–10.45	**Simona Chrapačienė.** The level of knowledge on strawberries diseases, and plant protection among Lithuanian farmers
10.45–11.00	**Simona Chrapačienė.** Evaluation of alternative sources of biopesticides from plants for *Alternaria* disease management in carrots
11.00–11.15	**Vytautas Bunevičius.** Biocontrol capabilities of *Alternaria* spp. by plant extracts
11.15–11.30	**Aistė Balčiūnaitienė.** Physico-chemical properties and antimicrobial activity of bacterial nanocellulose biocomposite with green silver nanoparticles
11.30–11.45	**Juozas Lanauskas.** Individual strawberry cultivar variation based on consumer satisfaction
11.45–12.00	**Coffee**

Session 4. Sustainable cultivation and biodiversity

Chairs — *Lina Dėnė, Nazim S. Gruda*

Keynote lecture

12.00–12.30	**Nazim S. Gruda.** Product quality, values, and criteria for vegetables in the supply chain

Oral presentations

12.30–12.45	**Raminta Skipitytė.** Investigation of soybean-microbial interactions using stable isotopes
12.45–13.00	**Vaida Čepulienė.** Biological diversity and nutritional importance of the perennial vegetable genus *Allium*
13.00–14.00	**Lunch**
14.00–14.15	**Agnė Mačiulskaitė.** The evaluation of antioxidant activity of *Amelanchier alnifolia* L. fruits
14.15–14.30	**Greta Laurinaitytė.** Strawberry antioxidant system response and secondary metabolite content after treatment with *Syzygium aromaticum* extract
14.30–14.45	**Sandra Saunoriūtė.** Variations in antioxidant activity and phenolic content in fruit extracts of the invasive *Amelanchier* × *spicata* (Lam.) Koch from different habitats in Lithuania
14.45–15.00	**Khadija Ramzan.** Enhancing PDMS with natural pigments: a sustainable approach to polymer modification
15.00–15.15	**Closing remarks**
17.00–20.00	**Conference dinner**

Wednesday, 18 September

10.00–16.00	**Conference tour**

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SESSION 1. Keynote lecture

ABSTRACTS OF PRESENTATIONS

Session 1. Plant physiology and genetics for horticultural strategies

S1.K1. Drought-mitigating strategies based on hormonal regulation of stress response

Irina I. Vaseva

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Extreme climatic events like prolonged lack of rainfall, floods or unusually high or low temperatures have become more frequent over the last decades due to the ongoing climate crisis. According to the United Nations Convention to Combat Desertification (UNCCD) report, regional droughts have increased by 30% since 2000, posing one of the most serious dangers to agricultural systems. Consistent science-based efforts are necessary to address the negative effects of climate change on food crops worldwide. The proposed new approaches should also take into account the requirements of organic plant breeding for a healthier and cleaner environment. Understanding the complex hormonal interactions that trigger adequate stress response is a crucial step in developing efficient and eco-friendly strategies for drought resilience of field-grown crops. It has been demonstrated that besides their role as growth promoters, natural substances could also be used as tolerance boosters or stress recovery facilitators. Such applications are linked to hormonal components that are included in most of the plant-derived biostimulants in physiologically active concentrations. Exogenously applied plant growth-regulating substances that simulate exposure to hormetic stress could activate intrinsic plant defence mechanisms. Subsequently, the triggered protective reactions would confirm the chances for survival under unfavourable conditions. The testing of this concept delivered promising results in leafy vegetable species primed with plant growth regulators in bioequivalent doses.

The experimental data suggest that hormone mixtures consisting of stress- and growth-promoting hormones mixed in specific ratios could effectively reduce drought stress.

S1.O1. Expression profile of blackcurrant (*Ribes nigrum* L.) transcription factors under chill-hardening *in vitro*

Ana Dovilė Juškytė*, Ingrida Mažeikienė, Edvinas Misiukevičius

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A dormant period in winter is crucial for the successful flowering of many garden plants. Chill-hardening of orchard plants causes metabolic changes and allows to withstand subsequent and more severe conditions. A plant's response to chill-hardening can be physical, morphological, and biochemical, all of which are determined by the peculiarities of the genome.

In temperate climate zone, where blackcurrants are grown, a large yield reduction is caused due to insufficient winter hardiness and frost resistance. The provision of a cold-stress stable germplasm collection is a vital component in *Ribes* spp. breeding. However, the genes controlling resistance to cold, their origin, interaction and inheritance is a complex mechanism that needs more research. *De novo* blackcurrant transcriptome opened opportunity to identify the mechanisms of resistance to low temperature.

The study aimed to determine the expression of blackcurrants' transcription factors (TFs) during hardening at 4°C for a period of 4 days. According to the obtained data, a protein-protein interaction (PPI) network and a heatmap were constructed. It was determined that 32 TFs, including members of the bHLH, bZIP, IAA, MYB, MYC, WRKY, etc., were involved in the PPI network, of which 19 TFs had a significantly up-regulated expression level (log2FoldChange) and 13 – down-regulated. The expression of TFs ranged from −33.014 for histone-lysine N-methyltransferase (ATXR6) to 32.475 for basic leucine zipper 4 (bZIP4). Oligonucleotide primers for these TFs were generated and specific fragments were amplified using RT-PCR method.

TFs are important elements in the triggering of plant defence mechanisms. Therefore, the obtained results will provide valuable insights into the cold-stress response mechanism and identify effective ways to increase cold tolerance in blackcurrants.

S1.O2. *De novo* assembly of *Monilinia fructigena* genome

Raminta Antanynienė*, Monika Kurgonaitė, Birutė Frercks

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In Rosacea family plants, the most economically important diseases – blossom blight, brown rot and twig canker – are caused by fungus *Monilinia* spp. pathogens worldwide. In the National Centre for Biotechnology Information (NCBI) database available referenced genome of *Monilinia fructigena* is contig-level only and sequenced using Illumina and Pacific Biosciences sequencing platforms. However, the published *M. fructigena* genome is not complete, and additional information is required to acquire the genome at the chromosomal level. A complete genome of *M. fructigena* would allow analysis of genomes and genes between species and be useful for understanding the pathogenicity of the fungi. The aim of the study was to sequence the complete *M. fructigena* genome and assemble a full *de novo* genome sequence at the chromosomal level. The pathogen of *M. fructigena* was collected and isolated from plum (*Prunus domestica* L.) fruits in the orchard of the Institute of Horticulture of the Lithuanian Research Centre for Agriculture and Forestry. The genomic DNA of the *M. fructigena* fungal culture was extracted from isolated culture, after which long-read and short-read sequencing was performed using next-generation sequencing platforms from Oxford Nanopore Technologies and Illumina, respectively. A hybrid *de novo* genome assembly was performed to construct the *M. fructigena* genome. The resulting contig-level genome is similar to the published reference genome of *M. fructigena* (43 Mbp, ref. No. ASM326056v1). Benchmarking Universal Single-Copy Orthologs (BUSCO) analysis was performed to assess genome completeness before proceeding to further bioinformatics analysis in order to achieve the genome at the chromosomal level.

S1.O3. Characterisation of potential microbial antagonists against brown rot disease

Augustina Kolytaitė*[1], Saulė Raklevičiūtė[2], Birutė Frercks[1]

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It is already known that plant microbiota can not only be neutral or negatively affect the host, but also promote its growth and even protect it from various stresses, including pathogens. After noticing the benefits of microorganisms, the development of biological products that could replace mineral fertilisers and chemical plant protection products began. Nowadays, there are various studies about local beneficial microorganisms for crops and orchards, but the availability of biological products against specific pathogens is still scarce. One of the examples is brown rot disease, whose causative agent is the extremely aggressive pathogen *Monilinia fructigena*, which affects both pome and stone fruit orchards. To fill this gap, the microorganisms of the local plum orchard were investigated. The aim of the study was to identify the isolated plum orchard microorganisms and to describe their properties at the genetic potential level and antagonistic abilities to inhibit *M. fructigena* pathogen. Microorganisms were isolated from the local plum orchard rhizosphere, plum buds and fruits. Pure cultures were tested against *M. fructigena*. In total, 12 isolates showed antagonistic activity ranging from 56% to 90%. Whole genome-sequencing data revealed three distinct genera of bacterial organisms (*Bacillus pumilus*, *B. velezensis*, *Lysinibacillus agricola*, *Pseudomonas chlororaphis*, *P. fluorescens*, and *P. graminis*) and one genus of yeast-like fungi (*Aureobasidium pullulans*). KEGG (Kyoto Encyclopedia of Genes and Genomes) pathways, antibiotic resistance, pathogenicity, and secondary metabolites were predicted as related to antagonism and growth promotion.

In conclusion, all 12 isolates are potential biological control strains with important application value for future development of biocontrol products in the Baltic region. The results of the study and additional experiments with fruits and field trials will help to further investigate the mechanism of all these microbial isolates in the biological control of plant diseases and promote their application.

S1.O4. Unveiling the drought resilience of tetraploid daylilies: insights into ploidy's impact on plant adaptation

Edvinas Misiukevičius*, Ingrida Mažeikienė, Viktorija Žukauskaitė, Vidmantas Stanys

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Climate change significantly impacts plant physiology, emphasising the need for water conservation and sustainable management practices in horticulture. The research aims to investigate how ploidy affects the ability of daylilies to withstand drought stress by comparing the morphological and physiological changes in diploid and tetraploid cultivars under controlled water deficit conditions. 19 diploid and 21 tetraploid daylily cultivars were selected for the study to evaluate their performance in arid environment. The research methods involved subjecting the daylily plants to controlled water deficit conditions and analysing morphological (plant height, leaf length, and leaf yellowing) and physiological (chlorophyll, flavonoid and nitrogen balance indices, and ROS accumulation) parameters to assess their response to drought stress. Additionally, the study used the drought stress response index to quantify plant response to water deficit challenges. The study revealed different responses between diploid and tetraploid daylilies under drought-stress conditions. Tetraploid plants demonstrated enhanced adaptability and resilience to water deficit challenges compared to diploid ones. Specifically, tetraploid daylilies exhibited superior stress tolerance, reduced chlorophyll index decline, and better performance under severe drought conditions.

These results suggest that ploidy plays a significant role in shaping plant responses to drought stress and highlight the potential for developing drought-tolerant cultivars through targeted breeding programmes. In conclusion, this research emphasises the significant role of ploidy in shaping plant resilience to water deficit. These insights have direct implications for sustainable floriculture practices, landscape horticulture, and breeding programmes aimed at developing drought-tolerant genotypes.

SESSION 2. Keynote lecture

Session 2. Plant response-based cultivation technologies

S2.K2. Cultivating tomorrow: where and how indoor vertical farming will bring a horticultural revolution

Francesco Orsini

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Food systems are responsible for a third of global greenhouse gas emissions and have a significant impact on water, soil and mineral nutrient consumption. Indoor vertical farming is gaining relevance globally as an innovative crop production system that is resilient to climate change, resource efficient and adaptable to densely populated environments. Although the technology finds main applications in the Global North, its widespread adoption in other regions of the world is limited by both the elevate capex (mainly related to lighting technology) and opex (mostly associated with energy consumption). At the same time, consumer acceptance of the technology is still limited due to persistent skepticism about its potential on producing quality food or reducing the environmental impact of the food system. However, recent studies have demonstrated that vertical farming may prove sustainable in a range of different climates where traditional greenhouse production techniques have to deal with either limited availability of resources (water, nutrients) or higher energy costs for cooling or lighting the growing environment. This is especially true for fresh vegetable crops, whose specificities in terms of quality requirements and market price may counterbalance the increased production costs in vertical farms. Within the national research project Sustainable Vertical Farming (VFarm), research on crop diversification and sustainability assessment of the technology is currently being performed.

The study demonstrated that through constant and accurate monitoring of the use of resources associated with the individual elements of the system, the main sources of impact are identified, and sustainable management technologies and protocols in both economic and environmental terms are developed.

S2.O1. Plant-derived exosome-like nanoparticles: the relations between plant material and the consistency of particle yield and properties

Akvilė Viršilė*, Giedrė Samuolienė, Kristina Laužikė, Audrius Pukalskas

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Medicinal and agricultural plants accumulate a number of phytochemicals that have biological effects on human health. It is known that these substances are often encapsulated in nanovesicles involved in intercellular communication, which serve as capsules protecting their stability and biological activity and facilitating tissue penetration. Therefore, the application of plant-derived exosomes (PE) and other nanovesicle preparations in cosmetics and pharmaceutics has great potential, but the quality and integrity of the plant raw material are critical for the reproducibility of the results. Followingly, this study aimed to evaluate and compare the properties (yield, morphology, particle concentration, biochemical properties, and biological activity) a number of medicinal and agricultural plants: tomatoes, strawberries, cucumbers, pepper leaves and fruits, *Hypericum perforatum*, *Chelidonium majus*, *Artemisia absinthium*, *Scutellaria baicalensis*, *Silybum marianum*, *Kalanchoe daigremontiana*, *Calendula officinalis*, etc. Plants were grown in controlled environment agricultural systems under different conditions of temperature, lighting, and nitrogen nutrition. Important knowledge was gathered on the effect of the environment on the constancy of the yield and antioxidant properties of PE preparations and the possibilities to achieving higher PE yield and antioxidant properties by purposefully adjusting the parameters of the growing environment.

The obtained results show that the species and even the cultivar has a significant influence on the properties of the PE preparations. It is also important to consider their dependence on the plant developmental stage and distribution in plant organs. Biomass from agricultural plants, such as tomatoes, cucumbers, strawberries, etc., can be purposefully used for PE extraction, as they are characterised by high productivity, yield of proteins and nanoparticles in PE preparations.

S2.O2. Evaluation of nutritional value in mustard microgreens under different light conditions during growth and storage

Ieva Gudžinskaitė*[1], Giedrė Samuolienė[1,2]

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Light is one of the most important growing environmental factors that can influence nutritional value, visual appearance, and overall taste of plants. The research aimed to show that lighting intensity and spectral composition may have an impact on antioxidant activity of microgreens. Mustard (*Brassica juncea* L.) microgreens were grown in peat substrate, photoperiod 16 h, temperature 21 ± 3°C. The experiments were conducted in a greenhouse (lat. 55°, January, natural photosynthetic photon flux density (PPFD) ~10–15 µmol m^{-2} s^{-1}) (I) with supplemental white (4000K) light-emitting diodes (LEDs) lighting, a total PPFD of 100, 150, 200, and 250 µmol m^{-2} s^{-1} was maintained; (II) for supplemental light, lamps with different spectral composition ratio consisting of red (R), blue (B), and white (W) light, maintaining PPFD of 250 µmol m^{-2} s^{-1}, were used; (III) cation-exchange capacity (CEC) spectral composition consisted of deep red 61%, blue 20%, white 15%, and far red 4%, a total PPFD of 150, 200, and 250 µmol m^{-2} s^{-1} was maintained. After harvesting, the microgreens were stored in light (8 h) and dark conditions at a temperature of +4°C. Samples were taken on harvest day (D_0) and after one (D_1), three (D_3) and five (D_5) days of storage. The research data show the impact of PPFDs and light spectral composition during growth on the response of mustard microgreen antioxidant system and the dynamics of nutritionally valuable metabolites after harvest.

In conclusion, lighting conditions during growth and storage may impact secondary metabolism and shelf-life of microgreens. Moreover, the selection of proper growing and storage lighting conditions is important to both economic and nutritional benefits.

S2.O3. Natural genetic variations in populations of horticultural crops in response to different stressors based on chlorophyll fluorescence analysis

Sasan Aliniaeifard[1, 2]

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Chlorophyll fluorescence is widely recognised as a reliable indicator of photosynthesis functionality. In the present study, an imaging system and fluorometers capable of measuring and analysing chlorophyll fluorescence in a non-destructive manner were used to assess the response of different horticultural crop species to various stressors. During the experiment, controlled stress conditions were applied such as cold, salt, light, and drought stresses to the plant populations (including tomato, rose, chrysanthemum, basil, and cucumber) and measured their healthiness of electron transport systems using chlorophyll fluorescence analysis. Maximum photosystem II quantum yield, photosystem II efficiency, rapid induction of chlorophyll fluorescence, light curve, and non-photochemical quenching were used to study the response of plant populations to stressors. It was found that parameters related to the chlorophyll fluorescence are more reliable indicators to assess stresses such as cold and light stresses compared to the biochemical indicators. For assessing the light levels, analysis based on the light curve data resulted in the best responses. The drought factor index calculated based on performance index on the absorption basis discriminated the tomato genotypes nicely in response to drought stress.

In conclusion, using chlorophyll fluorescence as an indicator, it is possible to identify variations in stress responses between different horticultural crop populations. This information can be of great value for breeders and researchers in selecting stress-tolerant cultivars and developing targeted interventions to increase crop productivity.

S2.O4. Hormone based biostimulants: effect on oilseed rape photosynthesis and productivity

Martynas Urbutis*[1], Giedrė Samuolienė[1,2]

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To increase plant yield and optimise nutrient utilisation, phytohormone-based biostimulants play a crucial role in the adaptation processes, having a significant influence on the physiological responses of plants. The study investigated the effect of external plant hormones on the productivity, photosynthesis, and nutrient composition of oilseed rape cultivar 'Mercedes'. The experiment was carried out in a greenhouse, maintaining a 16-hour photoperiod, 70% humidity and an average temperature of 21–22°C during the day and 15–17°C at night. A combination of two phytohormones: kinetin (KIN), indole-3-acetic acid (IAA), gibberellic acid (GA_3), abscisic acid (ABA) and salicylic acid (SA), in ratio 1:1 per treatment was applied at 30 mg L^{-1} concentration of each. A combination of exogenous phytohormones was applied at BBCH 14–16, BBCH 31–35, and BBCH 51–55 development stages. Analysis was performed 5 days after each application, and plant productivity was assessed at the end of maturity. Stimulation of plants with phytohormone-based biostimulants showed a significant increase in photosynthetic productivity, particularly in combinations of growth- and stress-related phytohormones: IAA+SA and GA+ABA. Moreover, IAA+SA was found to significantly increase the photosynthesis rate, while KIN+SA increased the pod number per plant.

S2.O5. Interactive effect of different lighting and CuO and ZnO nanoparticles on kale growth and mineral composition

Aušra Brazaitytė*, Rūta Sutulienė, Martynas Urbutis, Kamilė Stašytė, Pavelas Duchovskis

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The study aimed to determine how different LED lighting spectra combined with CuO and ZnO nanoparticles (NPs) affect the growth of the elemental composition of kale (*Brassica oleracea*, 'Lacinato'). Plants were grown in hydroponic systems with red-blue (R90%:B10%, RB) and white-red-blue (W65%:R30%:B5%, WRB) LED lighting at an intensity of 250 ± 5 µmol m^{-2} s^{-1}, sprayed with aqueous suspensions of CuO (40 nm, 30 ppm) and ZnO (35–45 nm, 800 ppm) NPs. Their elemental composition was measured using an ICP-OES spectrometer, hazard quotients were calculated, and growth parameters such as fresh and dry weight and leaf area were determined. Cu accumulation was higher when plants were treated with CuO NPs and RB lighting combined. The combination of CuO NPs and lighting had no significant effect on the content of many other mineral elements (ME). Zn was released, which increased approximately three times in the combination of CuO NPs and WRB, while Mn decreased almost twice under these conditions. LED lighting, especially WRB, combined with the ZnO NPs application, significantly affected Zn accumulation in kale. Such a combination increased Mo, decreased Cu content and had no effect on other ME. The calculated hazard quotients showed that the limits were not exceeded when the selected concentrations of CuO and ZnO NPs and growth conditions were applied to kale. CuO NPs positively affected kale growth under WRB but had no effect under RB lighting. Meanwhile, ZnO NPs slightly increased the growth of kale under WRB, but decreased their weight and leaf area under RB lighting.

In conclusion, CuO and ZnO NPs had the most substantial effect in increasing the respective microelements. However, the increase depended on lighting: RB lighting was more appropriate for Cu accumulation, and WRB – for Zn accumulation.

S2.O6. Innovative farming systems for job creation and social inclusion in modern prisons: ideas from the International Student Challenge UrbanFarm2024

Hamayun Shabir*, Giuseppe Rizzello, Francesco Orsini, Giuseppina Pennisi

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Under the framework of the International Student challenge UrbanFarm2024, students from the University of Bologna Alma Mater Studiorum and the Swedish Agricultural University collaborated and shared ideas for the development of an innovative agricultural system to be integrated into a prison facility located in Trelleborg, Skåne, Sweden. Students were asked to combine interdisciplinary solutions involving urban horticulture, landscape design, and smart farming systems alongside the concept of biophilia, in order to amplify advantages of green design on human wellbeing. The three pillars of sustainability were essential elements in the development process, along with the choice for adapting solutions to specific environments involving users and stakeholders. This innovative and interdisciplinary educational approach allowed students to apply their theoretical knowledge into practice, while also providing an opportunity to participate in an international experience, strengthening soft skills and interpersonal relations. The presentation will illustrate a selection of technological solutions, management models, dissemination and communication activities as well as business model proposed by two student teams (namely Hyphae and Green Mates) with the aim to implement innovative strategies for engaging inmates in farming for revenue generation as well as recreational, social and therapeutical functionalities.

Session 3. Plant protection and product quality

S3.K3. Integrated control in new light

Beatrix Alsanius*, Maria Hellström, Samar Khalil, Maria Karlsson, Anna Karin Rosberg

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Artificial assimilation lighting is a common practice in circumpolar greenhouse horticulture to compensate for low levels of natural light. The introduction of light-emitting diodes (LEDs) in commercial horticulture allows applications to be tailored to crop needs and specific crop management practices. The use of LEDs is an emerging area to improve the effectiveness of biocontrol agents in the management of common foliar diseases such as grey mould and powdery mildew in controlled environment horticulture, e.g., greenhouses, polytunnels, and plant factories. The study considers the potential of light-assisted improvement of biocontrol agents based on the phyllobiome, i.e. the canopy and its associated microbiota. It focuses on the fate of non-phototrophic microorganisms. The effects of light on some important fungal plant pathogens causing foliar diseases in controlled environment horticulture have been studied in detail. Wavelength, exposure dose, and light delivery (e.g., incident, photoperiod) were identified as important factors. The presence of photoreceptors has been demonstrated in several non-phototrophic heterotrophic bacteria. These photoreceptors globally regulate metabolic functional activities and can induce metabolic and lifestyle changes that are important for biocontrol efficacy.

There is no general blueprint for using non-phototrophic microbes for biocontrol purposes. The wavelength, exposure dose and efficacy enhancers as well as the placement of the light source within the canopy must be chosen based on the requirements of the individual biocontrol organism.

S3.O1. The level of knowledge on strawberries diseases and plant protection among Lithuanian farmers

Armina Morkeliūnė, Simona Chrapačienė*, Alma Valiuškaitė, Juozas Lanauskas, Neringa Rasiukevičiūtė

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Strawberries belong to the Rosaceae family and are one of the most popular berries in the world, consumed for their nutritional content and pleasant taste. *Colletotrichum* spp. causes significant losses in strawberry yield. The most popular means of reducing the damage caused by pathogenic fungi is chemical disease control. *Colletotrichum* spp. control is difficult due to the pathogen's ability to cause damage at any stage of plant growth. The European Union aims to reduce the use of chemical pesticides; therefore, plant protection focuses on environment-friendly alternatives. Essential oils (EO) can be used as an environment-friendly alternative. The study focuses on determining the level of knowledge of Lithuanian farmers about plant diseases, the most grown strawberry cultivars, biological products and their effectiveness. Approximately 61.90% of the farmers were aware of plant diseases and knew where to find more information. The most widely grown strawberry cultivars were determined: 'Malvina' 21%, 'Rumba' 19%, 'Asia' 17%, 'Flair' 12%, others – 31%. Strawberry anthracnose causes the most damage to strawberries – this was stated by 11 respondents. Biological insecticides and fungicides are used by the 17.64% of respondents. The evaluation of the effectiveness of biological products shows that 18% are effective, 59% are effective but not as chemicals, 18% are insufficiently effective, and 5% are effective only under certain conditions.

The findings highlight the importance of understanding aspects of effective disease control and sustainable farming practices.

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S3.O2. Evaluation of alternative sources of biopesticides from plants for *Alternaria* disease management in carrots

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The increasing prevalence of *Alternaria* diseases, caused by fungal pathogens *A. dauci* and *A. radicina*, poses a significant threat to carrot crops worldwide, leading to substantial yield loss and quality degradation. Conventional chemical fungicides, though effective, pose environmental and health concerns, driving the need for sustainable and eco-friendly alternatives. The study investigated the potential of plant extracts as a method of biological control of *Alternaria* diseases in carrots. Laboratory and field experiments were conducted to evaluate the efficacy of thyme, clove, and clove-laurel extraction products *in vitro* and controlling *Alternaria* spp. infection in a carrot field. For the *in vitro* experiment, different *Alternaria* isolates were grown on PDA with extracts at a concentration of 0.01–4%. Field spraying was started when the carrot roots were larger than 0.5 cm in diameter until they were fully developed and reached the characteristic shape and size. In comparison, chemical fungicide was applied twice, while plant extracts (0.01–1.1%) five times.

The results demonstrated a significant reduction in disease incidence and severity compared to untreated controls. Thyme essential oil and clove-laurel extract most effectively inhibited the growth of *Alternaria* spp. *in vitro* and significantly inhibited carrot diseases under field conditions compared to untreated carrots.

S3.O3. Biocontrol capabilities of *Alternaria* spp. by plant extracts

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Pathogenic fungi can cause various plant diseases that affect their growth and development and lead to yield loss. Nowadays, crop protection depends on chemical pesticides, but their use can have a negative impact on the environment and human health. Residues of chemical pesticides can remain in the soil for years; therefore, it is necessary to look for effective and harmless biological control measures. An alternative is the use of plant extracts (PE) and essential oils (EO). PE and EO contain many valuable biologically active substances, many of which can be used safely and effectively to control pathogens. The research aimed to investigate the inhibitory effect of rosemary (*Rosmarinus officinalis* L.) plant extract and peppermint (*Mentha piperita* L.) essential oil against *Alternaria* spp. The PE was obtained by CO_2 extraction and the EO – by hydrodistillation. Monocultures of *Alternaria* spp. were treated with PE and EO at concentrations of 1200, 1600, and 2000 µl L^{-1}. The mycelium diameter was measured after 2, 4, and 7 days. The results of the study showed that both PE and EO had inhibitory effects against *Alternaria* spp. Mycelial growth was more effectively inhibited by peppermint EO than rosemary PE. It was also found that the substances at these evaluated concentrations had only a temporary effect.

The results of the study suggest that properly adapted plant-based materials can be used as biocontrol products allowing to inhibit the pathogenic fungi of *Alternaria* spp.

S3.O4. Physico-chemical properties and antimicrobial activity of bacterial nanocellulose biocomposite with green silver nanoparticles

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Green silver nanoparticles (AgNPs) synthesised using medicinal plant extracts as capping and reducing agents show significant potential in addressing infection-related threats. In the study, a sustainable, low-toxic and cost-effective composite of bacterial nanocellulose with AgNPs using oregano (*Origanum vulgare* L.) as a reducing agent due to its rich biological components was developed. The formation of AgNPs in the composite and their morphological properties were analysed using scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), and transmission electron microscopy (TEM). The antimicrobial activity was evaluated using the agar diffusion Kirby-Bauer method against Gram-positive and Gram-negative bacterial strains. The composite of bacterial nanocellulose with AgNPs demonstrated strong antimicrobial activity against all bacterial cultures tested. Structural analysis via TEM confirmed the presence of spherical AgNPs in the cellulose composite.

This approach to creating antimicrobial composites is promising in the fight against antibiotics, antibiotic-resistant bacteria and other strains of Gram-positive and Gram-negative bacteria.

S3.O5. Individual strawberry cultivar variation based on consumer satisfaction

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Strawberries are quite popular in Lithuania and throughout the European Union. The quality of strawberries depends on consumer requirements and satisfaction with the sensory properties of the fruits. Fruit firmness, colour coordinates, anthocyanin content, soluble solids, phenolic compounds and other properties can be evaluated by performing various analyses. However, the analyses do not always represent the consumers preference for fruits. Nowadays, are important not only the nutritional properties of fruits, but also the responsibility of consumers. The sensory panel was used at the Institute of Horticulture, LAMMC in 2023. During the consumer test, five strawberry cultivars were evaluated for taste (1–5 scale), sensory properties (15), appearance (1–5 scale) and descriptive properties (11). The consumer panel consisted of 32 customers, of which 75% were female and 25% male. The age range was from 20 to 80 years, 34.4% were 30–40 years old and 28.1% 61–70 ones. The overall reliability of the appearance results revealed that mostly likeable were strawberry cultivars 'Faith' and 'Sonsation'. Consumers prefer strawberries with regular shape (21.2%) and large (21.2%) fruits, with fruit truss (18.13%), brilliant (14.1%) and dark red (13.1%) colour. The taste overall likeable was also a variety 'Sonsation' strawberries. Consumers prefer strawberry flavour (13.0%), pleasant flavour (12.0%), juicy (12.0%), low sweet (10.0%), and crunchy (9.0%) fruits.

The results of the study showed that consumer tests provide a broader view of the sensory properties of strawberry fruits.

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Session 4. Sustainable cultivation and biodiversity

S4.K4. Product quality, values, and criteria for vegetables in the supply chain

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Ensuring product quality in the vegetable supply chain is a multifaceted that is determined by various factors, including visual appearance, texture, nutritional content, and sensory characteristics such as taste and flavour. Meeting high product quality standards while aligning with consumer expectations is particularly challenging for premium vegetable crops. Current standards focus primarily on appearance and texture, often neglecting critical aspects like nutritional content and sensory properties. Addressing this gap requires several innovations to manage the complex interplay of factors influencing vegetable quality. Strategic trade-offs are necessary to maintain environmentally friendly production practices and to ensure a balance between quality, yield, and sustainability. The integration of advanced technologies and data analytics can also play a significant role in monitoring and improving quality parameters at various stages of the supply chain. By identifying and leveraging intricate trends, stakeholders can consistently improve vegetable quality throughout the supply chain, meeting both product- and consumer-oriented demands. These insights are not only interesting, but also valuable for professionals and researchers of the horticulture and food industry. This holistic approach contributes to long-term viability and emphasises the importance of comprehensive quality criteria in improving product quality in the vegetable supply chain.

S4.O1. Investigation of soybean-microbial interactions using stable isotopes

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One of the declared objectives of the Green Deal strategy (European Commission, 2019) is to make the cultivation of protein crops in Europe more profitable and competitive. Soybeans and other legumes become key components in the diversification strategy for more sustainable farming. Increasing studies of the atmospheric nitrogen accumulation of legumes have increased the interest in their cultivation in countries with a cool climate such as Lithuania. This study aims to improve the understanding of the relationships between soybean plants and nodule-forming symbiotic bacteria to find new instruments for a better symbiosis that lead to better atmospheric N_2 fixation. Better symbiotic relationships have advantage of higher nitrogen accumulation in the seeds and therefore better yield quality. This reduces the need for nitrogen fertilisers and can reduce environmental deterioration. Efficient use of nitrogen can also be beneficial to producers and consumers as well as environmental point of view that implement Green Deal goals such as climate change mitigation and adaptation. To achieve such goals, a precise methodology allowing separation of different sources of nitrogen is needed. The stable isotope ratio method, in turn, can improve knowledge of the sources and fate of materials such as nitrogen that is the limiting element for crop growth and development. In the study, several strains of microorganisms were tested on two soybeans cultivars 'Laulema' and 'Merlin'. The plant samples were taken twice during their growth and seed production. The nitrogen stable isotope ratio was defined as δ15N, which allowed the separation of the plant-microorganism associates according to their nitrogen source. Isotopic values close to 0‰ showed greater importance in the fixation of atmospheric nitrogen. These values were also associated with higher nitrogen content.

To draw more valid conclusions based on different seasons and environmental conditions, the study needs to be continued for a longer period.

S4.O2. Biological diversity and nutritional importance of the perennial vegetable genus *Allium*

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Since ancient times, *Allium* species have played a significant role in the human nutrition, in traditional medicine for the treatment of many ailments, and in official medicine as a supplemental ingredient. Species of the genus *Allium* belong to the Amaryllidaceae family and are native to the Northern Hemisphere, and the species grow widely in various regions. Among the perennial *Allium* species growing in Lithuania, the most well-known and cultivated are *A. schoenoprasum* L., *A. angulosum* L., *A. nutans* L., *A. fistulosum* L., and *A. ursinum* L. A changing climate affects the agrobiological and nutritional properties of perennial plants. Cold resistance and winter hardiness are the main factors determining the geographical distribution of garlic. Perennial *Allium* species adapt well to local growing areas, but yields remain constant or may increase when the bulbs are transplanted under conditions similar to those in which they were grown in their original locations.

The susceptibility of garlic to pests and pathogens also poses a serious threat to genetic resources stored in uncontrolled field collections.

S4.O3. The evaluation of antioxidant activity of *Amelanchier alnifolia* L. fruits

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Saskatoon berry (*Amelanchier alnifolia* L.) is a shrub, that is found in forests or thickets. Their fruits are small black-blue berries, accumulating flavanoids, phenolic compounds and anthocyanins. Due to its composition, it has the potential to act as a highly beneficial antioxidant, anti-inflammatory, anti-tumor, hypoglycemic, anti-diabetic, and anti-radical agent. The aim of the study was to optimise the extraction and preservation method and to evaluate the antioxidant activity of their ethanol extraction. The berries were sampled from Rietavas district (55.67282, 22.11187) in July 2023. Three methods of preservation were applied: freeze-drying, drying at 40°C and freezing at −18°C. The berries were crushed. Extraction was performed in an ultrasonic bath at different temperatures (20–25°C and 50–55°C), ethanol concentrations of 30%, 50%, and 70% for 10, 30, and 40 minutes. The ratio of the materials to ethanol was 1:20. Antioxidant activity was determined by DPPH (1,1-diphenyl-2-picrylhydrazyl) and ABTS spectrophotometric analysis. The results showed significant differences in antioxidant activity depending on the extraction method. Preservation method also affected the antioxidant activity of the ethanolic extracts of saskatoon berries. The study shows the dependence of DPPH and ABTS radical scavenging activity on extraction and preservation methods.

By the optimisation of extraction conditions, the increasement in biologically active compounds may be achieved, which leads to the further use of Saskatoon berry extracts in pharmaceutical field.

S4.O4. Strawberry antioxidant system response and secondary metabolite content after treatment with *Syzygium aromaticum* extract

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Syzygium aromaticum (SA) extracts have various biological activities due to the high concentration of secondary metabolites. Although the application of SA extracts appears more often in horticultural sector, little is known about how plants respond to such plant-based compounds. The study was aimed to investigate the effect of SA extract on the antioxidant system and secondary metabolites content of strawberry plants. The study was carried out at the Institute of Horticulture, LAMMC. The experiment took place in a greenhouse with controlled conditions: 21°C temperature, 70% humidity, and 16-hour photoperiod. A randomised block design with three replicates of five plants per variant was applied. The plants were sprayed three times with SA extract mixture (0.2% concentration), and untreated plants were used as control. Samples of ten equal-sized trifoliate leaves were collected at three different stages of the experiment from each variant, lyophilised and used for extracts preparation. Biochemical analysis of the extracted samples for ABTS, DPPH, and FRAP antioxidant activity, total phenolic compounds, chlorophylls, and carotenoids was performed. The results revealed that ABTS antioxidant activity decreased by 18% from the initial value of 1492 to 1224 mM TE g^{-1} and finally increased by 241% to 4178 mM TE g^{-1}. Reducing DPPH antioxidant activity (by 41% from 454 mM to 266 mM TE g^{-1}) and a stable FRAP antioxidant activity (1091–1207 µmol TE g^{-1}) were found at different experimental periods in strawberries after treatment with SA extract. This indicates that the antioxidants in plants respond differently to clove extract exposure. When evaluating the concentration of carotenoids, chlorophylls, and total phenolics, a general trend of variation was also observed. SA slightly increased (from 56.83 to 69.65 mg GAE g^{-1}) the concentration of total phenolic compounds 3 days after the last spraying, but a decrease in concentration was observed after 7 days. The SA extract initially increased the concentration of chlorophyll *a*, *b*, and carotenoids in strawberries in the first stages of the experiment.

In conclusion, clove bud extract at a concentration of 0.2% had no negative effect on the concentration of secondary metabolites and the activity of the strawberry antioxidant system and has a great potential for further research and application in plants.

S4.05. Variations in antioxidant activity and phenolic content in fruit extracts of the invasive *Amelanchier* × *spicata* (Lam.) Koch from different habitats in Lithuania

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Plants of the genus *Amelanchier* (Medik.) are known to accumulate a variety of biologically active compounds that are beneficial to health, including phenolics, anthocyanins, triterpenes, minerals, and vitamins. Different species and cultivars of *Amelanchier* exhibit strong antioxidant properties, making them highly valuable for application in the food, pharmaceutical, veterinary, and cosmetics industries. The aim of the study was to determine the amount of total phenolic compounds in the extracts of the invasive *Amelanchier* × *spicata* (Lam. K. Koch) fruits and to assess their antioxidant activity. Fruits of *A. spicata* were collected in July from urbanised areas and natural and semi-natural habitats in Lithuania. In the study, the total phenolic content was determined by Folin-Ciocalteu assay, and antioxidant activity was determined using FRAP and CUPRAC assays. The amount of total phenolic compounds varied significantly from 19.38 to 26.03 mg GAE g^{-1} DW. The highest amount of total phenolic compounds (26.03 ± 0.33 mg GAE g^{-1} DW) was determined in fruit extracts collected from Bartlaukis (a semi-natural habitat in the western part of Lithuania). The strongest reducing activity by FRAP (4149.24 ± 68.90 µmol TE g^{-1} DW) and CUPRAC (2172.14 ± 20.50 µmol TE g^{-1} DW) was determined in fruits extracts collected from Nevardėnai (a semi-natural habitat in the western part of Lithuania) and Vievis (a natural habitat in the eastern part of Lithuania). The lowest content of phenolic compounds (19.38 ± 0.33 mg GAE g^{-1} DW) was found in fruits extracts collected from Kęsai (a semi-natural habitat in the western part of Lithuania). The weakest reducing activity by CUPRAC (1760.32 ± 9.49 µmol TE g^{-1} DW) and FRAP (2080.82 ± 89.96 µmol TE g^{-1} DW) was found in fruit extracts collected from semi-natural habitats in the western part of Lithuania, especially in Klaišiškiai and Bartlaukis.

In conclusion, the fruits of *A. spicata* are sources of phenolic compounds and natural antioxidants. Research data indicate that different habitats significantly influence the variation of total phenolic content and antioxidant activity in serviceberry fruit extracts.

S4.06. Enhancing PDMS with natural pigments: a sustainable approach to polymer modification

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Vegetables and fruits are essential sources of organic substances. Fruits and vegetables are the most wasted foods in the food supply chain with more than 70% being thrown out. The study presents a new research initiative that aims to transform commercial polymer coloring by using naturally occurring biodegradable pigments derived from fruit and vegetable by-products. According to the European Green Deal (EGD) policy for sustainable innovation, the initiative addresses the long-term problem of plastic waste and the serious environmental risks caused by existing synthetic pigments. The research methodology involves the extraction and identification of pigments (betalains, anthocyanins, and carotenoids) from frequently-ignored by-products produced during routine processing of fruits and vegetables. These pigments are then mixed into a PDMS (polydimethylsiloxane) matrix. These pigments are sourced from fruits and have antibacterial and antioxidant properties. Since the 1990s, PDMS, a synthetic organosilicon polymer, has been appreciated for its chemical and physical stability, transparency, and flexibility, and ease of production. The objective of the study was to transform PDMS using organic colors to gain insight to investigate how the filler affected the polymer matrix. The structure, surface energy, morphology, and water absorption test of the PDMS/beetroot composites were investigated. The morphology of the composites was studied using scanning electron microscopy (SEM). Solitary drop technique was used to measure contact angles at room temperature (23°C). A droplet of deionised water (~5 µL) was dropped on the surface of the sample. The mass of the sample was also determined for the absorption test. According to the SEM examination, the PDMS/beetroot composites had a rough surface. The filler affects hydrophobicity as measured by the contact angle measurements, which show that the contact angle decreases with increasing filler concentration. The quantity and particle size of PDMS fillers determine how much water they absorb. The hydrophobic properties of the polymer are reduced due to the natural hydrophilicity of the filler.

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