Faculty of Agriculture
University of Novi Sad

15th CASEE Conference
"Green transitions in agriculture, forestry, veterinary medicine and food systems under a changing climate"

BOOK OF ABSTRACTS

CASEE
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"Green transitions in agriculture, forestry, veterinary medicine and food systems under a changing climate"

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PREFACE

We are pleased to present the Book of Abstracts for the 15th CASEE Conference, titled “Green transitions in agriculture, forestry, veterinary medicine and food systems under a changing climate”, held from 25th to 27th June 2025 in Novi Sad, Serbia.

This year's conference brings together researchers, academics, and professionals to address some of the most pressing challenges facing our agriculture, forestry, veterinary medicine, food systems and the environment. The topics reflect the urgent need for sustainable solutions in light of accelerating climate change.

The conference takes place during particularly challenging times for science and higher education in Serbia. Moreover, institutions around the world navigate complex global, political, and financial pressures. Despite these difficulties, the contributions gathered here - a total of 109 abstracts - demonstrate the resilience, creativity, and commitment of the scientific community to advancing knowledge and driving innovation.

We hope that this collection of abstracts will inspire further research and collaboration, and that it serves as a valuable resource for all participants and readers interested in building a more sustainable future.

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Emerging challenges in milk safety due to mycotoxin contamination: control strategies and regulatory perspectives

Katarina Pajić[1]*, Marija Pajić[1], Radoslava Savić Radovanović[2], Zorana Kovačević[1]

[1]University of Novi Sad, Faculty of Agriculture, Department of Veterinary Medicine, Trg Dositeja Obradovića 8, Novi Sad 21000, Republic of Serbia

[2]University of Belgrade, Faculty of Veterinary Medicine, Bulevar oslobođenja 18, Belgrade 11000, Republic of Serbia

**katarina.cobanov20@gmail.com*

Milk is a fundamental component of human nutrition, particularly for vulnerable populations such as infants and the elderly. Milk safety is increasingly challenged by mycotoxin contamination, since as secondary metabolites, mycotoxins are produced by fungi, primarily *Aspergillus*, *Fusarium*, and *Penicillium* species. However, mycotoxin contamination in dairy products represents a significant food safety concern and serious health hazard, with aflatoxin M1 (AFM1) being the most strictly regulated due to its carcinogenic and mutagenic potential. The presence of AFM1 in milk is directly linked to the consumption of contaminated feed by dairy animals, highlighting the need for an integrated approach to ensure milk safety from farm to consumer due to comprehensive control measures throughout the dairy chain. Climate change, evolving agricultural practices, shifts in feed production, and global trade are further complicating mycotoxin risk management in the dairy production. The aim of this research was to discuss key factors influencing mycotoxin occurrence in milk, emphasizing the importance of risk prevention at the feed level regulatory perspectives on their control, and sustainable mitigation strategies. Emphasis should be placed on preventive measures at the farm level, including proper feed management, risk assessment tools, and the potential of biological detoxification approaches. While regulatory frameworks set maximum level for AFM1, variations between countries create challenges in harmonization and enforcement further complicating risk management in dairy production. Additionally, the emergence of new fungal metabolites and co-occurring mycotoxins raises concerns about potential risks that remain insufficiently addressed. This study highlights the importance of preventive approaches, including improved feed quality management, early risk assessment, and farm-level interventions, in reducing mycotoxin contamination in milk. Innovative strategies, including the use of biological detoxification agents and novel feed additives could be used as potential solutions for reducing mycotoxin transfer into milk. In conclusion, strengthening collaboration among dairy producers, regulatory bodies, and scientific institutions is essential for minimizing milk mycotoxin contamination risks and ensuring consumer protection. Moreover, by integrating science-based strategies, regulatory alignment, and stakeholder collaboration, the dairy industry can strengthen food safety efforts and ensure consumer protection in an increasingly complex global market.

Keywords: aflatoxin M1, dairy production, milk safety, mycotoxins, food regulation

Owning the past: Power & sustainable heritage in the Czech borderlands

Karel Jílek[1]*

[1]Czech University of Life Sciences, Prague, Czechia

*****jilekk@pef.czu.cz*

The cultural landscapes of the Czech border regions, shaped by post-war displacement and contemporary climate pressures, offer unique contexts to explore symbolic authority over abandoned heritage sites and its role in sustainable landscape management, building on findings from the author's preprint article: Who Owns the Past? Symbolic Authority and Heritage Revitalization in Czech Borderlands.
Qualitative research (2022–2023) combined thematic narrative interviews, semi-structured follow-ups, and archival mapping (parish chronicles, cadastral records, subsidy documents). Ten respondents from Karlovy Vary and Ústí nad Labem regions were selected through purposive and snowball sampling, including long-term residents, newcomers, recreational property owners, a heritage expert, and municipal representatives. Thematic coding analysed links between actors' motivations, power relationships, and landscape decision-making.
Key Findings: Emotional-Familial Logic: Intergenerational memories strongly motivate volunteer-based restorations, emphasising careful conservation and native vegetation, Socio-Economic Logic: Newcomers and municipalities transform heritage ruins into agro-tourism hubs, educational trails, and community spaces, enhancing rural economies, Cross-Border Memory Logic: Descendants of displaced German populations primarily contribute culturally—through shared archives and commemorations—rather than through direct financial or technical support. Restored heritage sites thus emerge as dynamic "memory nodes," focal points where diverse emotional, historical, and economic interests intersect. These nodes catalyse community initiatives for sustainable regional development, including eco-tourism, environmental education, and traditional crafts. Participatory approaches—volunteer restoration, community research, and stakeholder partnerships—proved essential for aligning interests and mobilising resources.
Effective heritage management in border regions relies more on mobilising community networks and compelling historical narratives than on formal property rights alone. Integrating stakeholder memory mapping into agro-environmental initiatives and supporting community-led restorations fosters landscape-level ecological resilience, directly contributing to CASEE's vision of Green Transitions—particularly sustainable land use, adaptive landscape management, and climate-change mitigation.

Keywords: cultural landscapes, revitalization, sustainability, heritage management, land-use practices

The process of composting – principles, methods, benefits and common objections

Costin Manea-Banica[1]*, Ana Cornelia Butcaru[1], Calina Petruta Cornea[1]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania

**manea.banica.costin99@gmail.com*

Composting is a biological process that transforms organic waste into nutrient-rich humus through microbial decomposition. This sustainable practice plays a crucial role in circular economy, soil enrichment and carbon sequestration. The composting process relies on the activity of microorganisms, such as bacteria and fungi, which break down organic matter in the presence of oxygen. Key factors influencing composting efficiency include the carbon-to-nitrogen (C/N) ratio, moisture content, aeration and temperature regulation. There are various composting methods, including traditional aerobic composting, composting with special machines, and vermicomposting, each with specific advantages depending on the type of organic waste and environmental conditions. Aerobic composting, the most common technique, requires periodic turning of the compost pile to ensure oxygen availability to avoid producing methane as a byproduct. Vermicomposting, which involves the use of earthworms, accelerates decomposition and enhances nutrient availability in the final compost. The benefits of composting extend beyond waste reduction, contributing to soil fertility, water retention, and the mitigation of greenhouse gas emissions. Moreover, compost applications in agriculture and horticulture improve plant health and reduce dependency on synthetic fertilizers. Given its environmental and economic advantages, composting represents a key component of circular economy strategies and sustainable waste management practices. Further research and technological advancements are essential for optimizing composting processes and increasing its adoption on a global scale. This review presents a variety of benefits of composting, along with practical exemples found in literature.

Keywords: composting, benefits, organic waste, circular economy, waste management

Emerging technologies applied in the mead production in order to enhance its sensory and volatile profiles

Ioana Susana Macea, Elena Mudura, Carmen Rodica Pop, Corina Maria Șutea, Mariana Alexandru, Petruț-Cristian Balaș, Teodora Emilia Coldea*

[1]Department of Food Engineering, Faculty of Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 400372 Cluj-Napoca, Romania

[2]Department of Food Science, Faculty of Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 400372 Cluj-Napoca, Romania

**teodora.coldea@usamvcluj.ro*

Mead, also known as hydromel, is an alcoholic beverage created by fermenting honey with water. It is one of the oldest known fermented drinks, dating back thousands of years to ancient civilizations such as the Greeks, Romans, and Vikings. The fermentation process is carried out by yeast (S. cerevisiae, S. bayanus), which converts the honey sugars into alcohol. Malolactic fermentation is essential for a balanced sensory profile of mead. The malolactic bacteria used for mead are mainly represented by Oenococcus oeni, Lactobacillus plantarum. Mead can be made in various styles, from dry to sweet, and can have different alcohol content depending on the fermentation time. Some variations include the addition of fruits (melomel), spices (metheglin), or herbs to enhance flavor and aroma.
Many recent studies emphasized fermentation would increase the bioavailability of honey bioactive compounds, making mead a functional beverage. Mead is a rich source of antioxidant compounds such as quercetin**,** kaempferol**,** and caffeic acid**.** The antioxidant activity of mead can vary depending on factors such as the type of honey used, additional ingredients like fruit juices, and the fermentation process.
In conclusion, mead's unique chemical composition, shaped by the fermentation process and aging, offers a range of bioactive compounds that contribute to its sensory characteristics and health benefits. Ongoing research into fermentation techniques and ingredient additions continues to enhance our understanding and appreciation of this ancient beverage.

Keywords: mead, fermentation, alcohol, additional ingredient, antioxidants

Effect of rapid aging procedure on the quality of Romanian pear brandy

Petruț-Cristian Balaș[1], Elena Mudura[1], Carmen Rodica Pop[2], Alina Maria Truța[3], Corina Maria Șutea[1], Ioana Macea[1], Mariana Mărginean[1], Teodora Emilia Coldea[1,*]

[1]Department of Food Engineering, Faculty of Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 400372 Cluj-Napoca, Romania, [2]Department of Food Science, Faculty of Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 400372 Cluj-Napoca, Romania, [3]Department of Forestry, University of Agricultural Sciences and Veterinary Medicine, 400372 Cluj-Napoca, Romania

**teodora.coldea@usamvcluj.ro*

The aging of natural distillates in the presence of wood fragments, combined with physical treatments, aims to speed up the development of aged characteristics and increase the product's economic value. A major benefit of this approach is that it allows production of standardized quality products (aroma and color) through a controlled process. Unconventional physical methods for rapid aging include thermal treatment, micro-oxygenation, ultrasonic waves, gamma irradiation, electric fields, photocatalysis with gold nanoparticles, and high-pressure application. The main reason for using these methods is to shorten the aging time of natural distillates, reduce production costs, and maintain sustainability.
The present study introduces an innovative approach to accelerate the aging process from 12-24 months to 20-60 minutes, utilizing electric field treatment for consistent and efficient extraction control. The experimental design involved exposing pear distillate samples and wood fragments (American oak, common oak, and mulberry) to electric fields at 20V, 35V, and 50V for 20, 45, and 60 minutes, respectively. Pear distillate samples and wood fragments (American oak, common oak, and mulberry) were simultaneously exposed to an electric treatment. After the treatment, the pear distillate`s chromatic caracteristics were measured and compared to control samples, which consisted of untreated (raw) distillate and 3 days maturation that contained wood fragments (the same mentioned above) and distillated without using the electric treatment. The best result for color intensity was obtained with traditional mulberry wood at 20 volts, showing nearly double the value compared to 3-day maturation without electric treatment. Compared to the barrel-aged grape marc distillate study (2014), similar hue values were obtained for Quercus robur in samples V20T45, V35T45, and V50T45: 4.18, 4.12 and 4.45 vs. 4.8 in the study. Volatile and phenolic compounds were also determined and compared to untreated (raw) distillate and 3 days wood fragments maturation samples. The amount of ethyl acetate for V20T20 mulberry sample increased significantly compared to 3 days wood fragments maturation: 85.5 mg/L vs 49.27 mg/L for the mulberry wood. Regarding phenolic compounds, the samples subjected to the highest treatment time (V20T60) showed the best results: 15.148 µg/ml vs 0 µg/ml for American oak.
The findings demonstrate that this method achieves sensory quality parameters comparable to traditionally aged pear brandy in wooden barrels. This electric field technique reduces aging costs, adapts well to limited storage capacities and minimizes alcohol loss, as confirmed by physicochemical analyses. Furthermore, its straightforward mechanism makes it easily applicable in industrial settings. Implementing this method decrease excise costs due to faster sales, and a lower price with wood, leading to increased sustainability alongside significant savings in time and storage space required for aging.

Keywords: rapid aging, pear brandy, wood fragments, electric field, volatile, phenolic profile.

Morphological characterization of terrestrial orchids for breeding purposes: application in sustainable horticulture

Jovana Ostojić[1]*, Tijana Narandžić[1], Milica Grubač[1], Magdalena Pušić Devai[1], Mirjana Ljubojević[1]
[1]University of Novi Sad, Faculty of Agriculture, 21000 Novi Sad, Serbia

**jovana.dulic@polj.uns.ac.rs*

The diversity of terrestrial orchids in the Fruška Gora mountain (Serbia) could be of interest for their potential introduction into breeding programs, expanding their application in horticulture. The great potential of terrestrial orchids for use in sustainable horticulture is primarily reflected in their high decorativeness, long lifespan and flowering period, as well as their ability to grow in temperate climates. The aim of the study was the morphological characterization of the species *Gymnadenia conopsea* (L.) R. Br., *Anacamptis pyrami*dalis (L.) Rich. and *Spiranthes spiralis* (L.) Chevall, which have been recognized in previous studies as promising candidates for horticultural and landscape architecture applications. The analysis included both quantitative and qualitative characteristics of the vegetative and generative organs of each species and aimed to determine the variation in size, shape, and color of the leaves and flowers. Morphological characterization included the analysis of the following characteristics: plant height, inflorescence and flower height, flower width, number of flowers, leaf length and width, leaf shape and color, flower stalk position, shape of sepals and petals, and number of flower colors. The results obtained indicate significant diversity among the studied species, with the greatest differences observed in morphometric characteristics. The highest habitat values were measured in the species *G. conopsea*, with an average height of 569.33 mm, an average inflorescence length of 151.33 cm, an average of 51.30 flowers per plant, and the greatest average flower width of 12.94 mm. The shortest inflorescence length was recorded in *A. pyramidalis*, with an average of 45.73 mm. Broad diversity was also observed in qualitative characters, with the shape of the lateral sepal varying from narrow elliptic to ovate, and the number of lip colors ranging from 1 to 2.6. The species also differed in flower color, with flowers appearing in white, light purple, or vivid pink. From the results obtained, it can be concluded that the species investigated in this study exhibit a wide variety of flower shapes, sizes, and colors, representing a good starting material for the selection of ornamental traits with high commercial value.

Keywords: biodiversity, breeding, endangered orchids, landscaping, natural populations

Determination of lead and mercury concentrations in wild boar tissues in the Kichevo-Brod hunting area (North Macedonia)

Kristijan Cokoski[1], Miroslava Polovinski-Horvatović[2]*, Dejan Beuković[2], Vladimir Maletić[1], Marko Vukadinović[2] Elizabeta Dimitrieska-Stojkovic[3], Vangelica Enimiteva[3]

[1]Hans Em Faculty of Forest Sciences, Landscape Architecture and Environmental Engineering, Ss. Cyril and Methodius University in Skopje, 16 Makedonska brigada St. No. 1, Skopje,1000, Republic of North Macedonia

[2]Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, 21 000 Novi Sad, Serbia

[3] Faculty of Veterinary Medicine, Ss. Cyril and Methodius University in Skopje, St. "Lazar Pop-Trajkov" 5-7, Skopje, Republic of North Macedonia

**miroslava.polovinski@stocarstvo.edu.rs*

Despite the emergence of the African swine fever virus and the decline in wild boar populations, hunting of this species of game is still highly popular in North Macedonia. In the 2023/24 hunting season, 60 samples (30 kidneys and 30 livers) were collected from a total of 30 wild boars, classified by sex and age, from the Kičevo - Brod hunting area. In these tissues, measurements of Pb and Hg were conducted using inductively coupled plasma with mass spectroscopy (ICP-MS) on an PlasmaQuant MS-Q instrument. The mean concentrations of Pb were higher in the liver (0,076 mg/kg) than in the kidney (0,030 mg/kg), while conversely for Hg higher concentrations were observed in the kidney (0,061 mg/kg) compared to the liver (0,029 mg/kg). However, the mean values for both heavy metals in the examined tissues were below the permissible limits according to the legal regulations. Only one individual liver sample for Pb (3,3%) and 5 kidney samples for Hg (16,5%) exceeded the permissible limits which are regulated by EU and National legislatives. Regarding the sex and age of wild boars, no statistically significant difference was found for both heavy metals in the two tissues examined ($p > 0,05$). A statistically significant correlation for Pb concentration was confirmed between liver and kidney ($r = 0,384$), however the correlation for Hg concentration in the same tissues was statistically insignificant ($r = 0,176$). The results of the study show that the Kichevo-Brod hunting area had minimal pollution, despite potential contamination from the Oslomej thermal power plant and the abandoned "Tajmište" mine.

Keywords: liver, kidney, wild boar, hunting area

Genomic insights and functional characterization of novel antimicrobial compounds from food-origin strains of lactic acid bacteria

Marcelina Karbowiak[1]*, Michał Wójcicki[2], Jae-Eun Hyun[3], Piotr Szymański[4], Yan -Dong Niu[3], Dorota Zielińska[1]

[1]Institute of Human Nutrition Sciences, Warsaw University of Life Sciences, Warsaw, Poland

[2]Bacteriophage Laboratory, Department of Phage Therapy, Hirszfeld Institute of Immunology and Experimental Therapy, Polish Academy of Sciences, Wrocław, Poland

[3]Faculty of Veterinary Medicine, University of Calgary, Calgary, AB, Canada

[4]Department of Meat and Fat Technology, Prof. Waclaw Dabrowski Institute of Agricultural and Food Biotechnology – State Research Institute, Warsaw, Poland

**marcelina_karbowiak@sggw.edu.pl*

The search for sustainable biopreservation strategies, driven by increasing food safety concerns and the impact of climate change, has intensified interest in antimicrobial compounds produced by lactic acid bacteria (LAB), particularly members of the Lactobacillus genus. These microorganisms are well known for their long history of safe use in fermented foods, broad antimicrobial spectra, and ability to produce diverse bioactive compounds under various environmental conditions. This study investigated the genomic and functional properties of antimicrobial substances produced by *Lacticaseibacillus paracasei* strain B1 and *Lactiplantibacillus plantarum* strain O24, isolated from traditional Polish fermented foods. Whole-genome sequencing (Illumina technology) and bioinformatics analyses (BAGEL4) identified several bacteriocin-encoding regions, including genes for lactococcins, plantaricins, and enterolysin A, located on chromosomal and plasmid DNA. Antimicrobial activity was experimentally validated through protease sensitivity assays (trypsin, pepsin, and proteinase K), heat (40–100°C) and pH stability tests, and antimicrobial spectrum evaluation against Gram-positive and Gram-negative bacteria, notably *Listeria monocytogenes* and *Escherichia coli*. Structural characterization was performed using Fourier-transform infrared (FT-IR) spectroscopy, SDS-PAGE electrophoresis (revealing protein bands of ~15 kDa and ~10 kDa), and liquid chromatography–tandem mass spectrometry (LC-MS/MS). LC-MS/MS results suggested low homology with known bacteriocins, indicating the potential discovery of novel antimicrobial peptides. These findings underline the potential of food-origin lactic acid bacteria strains as sustainable sources of innovative bioactive compounds. Future research should focus on the purification and structural elucidation of these peptides, detailed mechanisms of action, and the development of their applications in food biopreservation.

Keywords: lactic acid bacteria, antimicrobial activity, food biopreservatives

Nutritional value of grass biomass produced in olive orchards under different soil management in Mediterranean

Kristina Kljak[1]*, Manuel Matišić[1], Igor Bogunović[1]
University of Zagreb Faculty of Agriculture, Zagreb, Croatia
**kkljak@agr.hr*

The biomass produced in the olive orchards can be used for animal nutrition as pasture or for the production of forage feeds. However, in the highly specialised production systems that are common today, this practise is outdated, even though this biomass is a valuable resource. Growing concern about soil degradation has led to more sustainable practises, but it is not known how these might affect the nutritional value of biomass. The aim of this study was to investigate the effects of different soil management practises in Mediterranean olive orchard on biomass proximate composition and organic matter digestibility (OMD). The trial was carried out on Cromic Cambisols in a 12-year-old olive grove with an organic farming system. The main treatments were natural grass species (GRASS) – permanent soil cover by different natural grass species mowed 2-4 times per year and sown legume common sainfoin (LEGUME). Four sub-treatments were applied within each main treatment: farmyard manure (mixture of chicken and horse manure; 40 t/ha), wood biochar (40 t/ha), olive pomace (40 t/ha) and no addition (control). Each sub-plot was randomised to cover an area of 36 m^2 around the olive tree in three replicates, giving a total of 3 olive trees per sub-treatment, 12 olives per main treatment and 36 in total with an experimental area of 1296 m^2 covered. Three harvests were carried out (April, May and June 2024) and the contents of moisture, ash, crude protein (CP), crude fat (CF), and neutral and acid detergent fibre (NDF and ADF, respectively) were determined. The OMD was calculated using equations based on contents of CP and ADF. A factorial ANOVA was conducted to test the main effects and their interactions. If the ANOVA indicated a significant effect ($P<0.05$), Fisher's test was applied for post hoc comparisons between means. As expected, the content of CP, ash and CF decreased with later harvests, while the content of NDF, hemicellulose, ADF and cellulose increased. Accordingly, the estimated OMD decreased from 74.53% at the first harvest to 64.57% at the third harvest. Management affected only ash content, which was higher in the LEGUME treatment (113.60 vs. 106.58 g/kg DM). This result indicates that common sainfoin was less abundant than natural species in LEGUME plots to contribute to more prominent differences in chemical composition and OMD of the biomass. On the other hand, management had a significant effect on other determined properties ($P<0.05$). Wood biochar and olive pomace achieved similar contents of CP and CF and OMD as the control (177.07 vs. 171.07 and 34.89 vs. 35.31 g/kg DM, and 68.26 vs. 66.67%, respectively), but not as farmyard manure (222.96 and 41.77 g/kg DM and 71.71%, respectively). Accordingly, farmyard manure yielded the lowest cellulose and ADF contents (318.62 and 273.82 g/kg DM, respectively) compared to similar contents of the other three treatments (344.10 and 290.99 g/kg DM, respectively). In conclusion, wood biochar and olive pomace can be used as soil amendments without negative effects on the nutritional value of the biomass. In Mediterranean olive orchards, organic amendments have proven to be a good practise to preserve soil health and promote resource efficiency, contributing to resilient and sustainable agroecosystems.

Keywords: biomass, proximate composition, digestibility, amendment, olive orchard

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The current research status on pawpaw (*Asimina triloba* L. Dunal) under the climatic conditions of Bucharest, Romania

Ioana Mihaela Mihălcioiu[1]*, Alen Luis Gabriel Olteanu[1], Andrei Florin Tabacu[1,3], Ana Cornelia Butcaru[2], Cosmin Alexandru Mihai[1], Florin Stănică[1,2]

[1] Faculty of Horticulture, University of Agronomic Sciences and Veterinary Medicine of Bucharest, Bdul. Mărăști, nr. 59, București, Romania, [2] Research Center for the Study of Quality Food Products, University of Agronomic Sciences and Veterinary Medicine of Bucharest, Bdul Mărăști nr. 59, București, Romania, [3] Didactic, Research&Development Station of Viticulture and Fruit Growing, Istrița de Jos, Buzău, Romania

**ioana.mihaela611@gmail.com*

Asimina triloba (L.) Dunal, commonly known as pawpaw, is the only temperate-continental species within the *Annonaceae* family. Native to North America, it ranges from Florida to southern Canada. In Romania, pawpaw was first introduced in 1926 in Transylvania by the Suciu family from Alba County. This study presents an overview of the current research conducted on pawpaw, cultivated in Bucharest, Romania, focusing on propagation methods, biochemical composition of the fruit, post-harvest storage capacity, and consumer preferences based on sensory analysis.

The research summarized in this abstract is based on studies carried out on genotypes cultivated at the Faculty of Horticulture, University of Agronomic Sciences and Veterinary Medicine of Bucharest, where the first experimental pawpaw plantation was established in 2000 with 22 genotypes. This collection was expanded in 2012 with Neal Peterson's cultivars and further in 2019 with 11 new cultivars and 66 hybrids. The results presented here are based on a selection of these genotypes, with focus on representative cultivars for which consistent data are available.

Regarding propagation, the most effective methods identified are seed propagation, with a germination rate exceeding 80%, and grafting, with a scion success rate of over 90%. Biochemical analyses of the fruit, conducted under the pedoclimatic conditions of Bucharest, indicate a sugar accumulation between 16–26°Brix, depending on the cultivar. The Artemis cultivar (exhibited the highest values in 2023, reaching 29.2°Brix, with fructose and glucose contents of 30.67 g/100 g and 30.59 g/100 g fresh weight, respectively. An increasing trend in sugar content was observed across seasons, particularly from 2023 onward. Fruit acidity, expressed as % citric acid, decreased during the same period.

Post-harvest analyses revealed that fruits stored in cold conditions (1–2 °C) for four weeks maintained quality, with sugar content increasing and acidity continuing to decrease. Sensory evaluation, based on structured tasting score sheets, showed that Romanian consumers prefer fully ripe to overripe fruits, which offer superior sweetness and aroma profiles.

In conclusion, *Asimina triloba* demonstrates strong adaptability to the climatic and soil conditions of Bucharest, producing fruits with notable biochemical qualities and appreciated organoleptic characteristics. The effectiveness of its propagation methods and the fruit's capacity to maintain quality during storage further support its relevance as a promising species for cultivation under temperate conditions.

Keywords: biochemical analyses, propagation methods, post-harvest storage, pawpaw propagation

The effect of extraction solvent on phenolic content and antioxidant capacity of thyme (*Thymus vulgaris* L.)

Marijana Peić Tukuljac[1]*, Dejan Prvulović[1], Sonja Gvozdenac[2]

[1]University of Novi Sad, Faculty of Agriculture, Trg D.Obradovića 8, 21000 Novi Sad, Serbia

[2]Institute of Field and Vegetable Crops Novi Sad, M. Gorkog 30, 21000 Novi Sad, Serbia

**marijana.peic@polj.uns.ac.rs*

Thyme (*Thymus vulgaris* L.) is a plant from the Lamiaceae family, growing in mountainous areas. Thyme has strong antioxidant, antibacterial, antifungal, and antiviral properties due to the high amount of phenolic compounds. It has been widely used as an herbal remedy and spice since ancient times.

The aim of this study was to estimate the content of total phenolics, tannins, and flavonoids, as well as the antioxidant capacity of thyme extracts prepared with different extraction solvents (70% methanol, 70% ethanol, 70% acetone, and distilled water). The results were reported as mean ± standard deviation of at least three independent samples.

The highest content of total phenolics and total flavonoids was found in acetone extracts (45.67 ± 1.94 mg quercetin equivalent (QE)/g dry weight (DW) and 8.31 ± 0.52 mg QE/g DW, respectively). In aqueous extracts, the lowest concentration of total phenolic was measured (39.27 ± 3.89 mg QE/g DW). Ethanol extracts showed the lowest content of total flavonoids (4.56 ± 0.06 mg QE/g DW). The highest amount of total tannins was estimated in aqueous extracts (22.13 ± 2.61 mg QE/g DW), while the lowest was found in acetone extracts (10.90 ± 1.21 mg QE/g DW). In order to determine antioxidant capacity, ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)), total reduction capacity (TRC), and total antioxidant activity (TAA) assays were used. The acetone extracts showed the highest values of all used antioxidant tests (322.52 ± 5.06 mg trolox/g DW, 294.65 ± 5.04 mg trolox/g DW and 822.79 ± 31.44 mg trolox/g DW, respectively). The lowest values of ABTS and TRC tests were found in aqueous extracts (197.03 ± 8.69 mg trolox/g DW and 161.15 ± 8.29 mg trolox/g DW, respectively). The lowest TAA was in ethanolic extracts (245.84 ± 48.11 mg trolox/g DW)

The obtained results showed that *T. vulgaris* is a valuable source of phenolic compounds, but the extraction solvent has a significant impact on phenolic content and the antioxidant capacity of thyme. The extraction with 70% acetone provides a significantly higher content of total phenolic compounds and stronger antioxidant capacity than other tested extraction systems. In addition, the results suggested that phenolic are one of the main compounds responsible for antioxidant capacity in thyme extracts.

Keywords: phenolics, natural antioxidants, thyme

Optimizing led lighting spectrum for enhanced phytochemical composition of broccoli microgreens

Tin Frida[1]*, Božidar Benko[2], Sanja Fabek Uher[2], Jana Šic Žlabur[3], Kristijan Debelec[4], Sergej Lugović[1], Roberta Vrkić[1]

[1]Vesela Motika LLC, Martićeva 67, 10000 Zagreb, Croatia, [2]Department of Vegetable Crops, Faculty of Agriculture, University of Zagreb, Svetošimunska cesta 25, 10000 Zagreb, Croatia, [3]Department of Sustainable Technologies and Renewable Energy Sources, Faculty of Agriculture, University of Zagreb, Svetošimunska cesta 25, 10000 Zagreb, Croatia, [4]MSc Horticulture-Ornamental Plants, University of Zagreb, Faculty of Agriculture, Croatia

**tin@veselamotika.com*

The increased global demand for a variety of nutrient-rich, i.e. functional food and the emergence of sustainable indoor (vertical) farming systems require the selection of plant species and growing conditions that will result in plant material rich in bioactive compounds. As light is crucial for plant growth and development, the provision of appropriate light quality (spectrum) is one of the most critical elements that directly determines the rate of photosynthesis, the production of secondary metabolites, and the crops' qualitative characteristics. Understanding of spectral effects within defined parameters can greatly improve yield as well as the functional characteristics of the crops grown in controlled environment agriculture (CEA). This research aimed to determine the effects of LED lighting with blue (450 nm), red (620 nm), and a 50:50 combination of both spectra under a 14-hour photoperiod, onto phytochemicals content in broccoli microgreens. The study was conducted in a plant growth chamber with a controlled temperature (25 ± 2 °C) and relative humidity (60 ± 5%). Broccoli microgreens were harvested manually at the base of the hypocotyl in the cotyledon stage, reaching a height of approximately 7.5 cm after eight days of growth. Microgreens grown under a combination of blue and red LED lighting accumulated a significantly higher amount of dry matter (6.72%) in comparison to red and blue lighting, 6.49% and 6.14%, respectively. The highest content of total phenols and flavonoids was also determined under the combined lighting spectrum, measuring 95.36 mg GAE/100 g FW (fresh weight) and 55.27 mg GAE/100 g FW respectively. Conversely, significantly higher non flavonoids content was observed in broccoli microgreens grown under the red (44.69 mg GAE/100 g FW) and blue spectrum (42.83 mg GAE/100 g FW). Total chlorophylls and carotenoid content varied significantly under different LED lighting spectra, with highest values determined under blue lighting, 0.92 and 0.41 mg/g FW. The highest antioxidant capacity (1228.21 µmol TE/L) was measured in microgreens grown under the combined red-blue lighting spectrum, while significantly lower values were determined under monochromatic lighting. This study highlights the significant effect of LED lighting spectrum on the bioactive composition of broccoli microgreens. The combined red-blue spectrum enhances dry matter, total phenols, and flavonoids content, and antioxidant capacity, making it the optimal choice for maximizing functional quality in this scenario. These findings emphasize into focus the importance of spectral selection for the quality optimization in CEA systems.

Keywords: *Brassica oleracea* var. *italica* (Plenck), microgreens, specialized metabolites, antioxidant capacity

Influence of low temperatures on physiological indices in rabbits

Ion Balan[1]*, Mihail Moroz[1], Dmitrii Matencu[1], Elena Ceban[1], Valeriu Cociu[1], Nicolae Starciuc[1], Eugen Voinitchi[1], Viorica Gurdis[1]
[1]Technical University of Moldova, Chisinau, Republic of Moldova

**balanion@rambler.ru*

Heat stress is a factor that affects the welfare of all animals, especially rabbits. The current study investigated the effect of low temperature on physiological indicators in rabbits under certain maintenance conditions.
The research carried out on New Zealand rabbits included 15 males, divided into three batches, 5 rabbits for each experimental series, each animal kept in individual cages. Prior to the experiments, the pre-experimental period of training and adapting the animals to new maintenance conditions took place within 30 days. Subsequently, experimental periods I and II followed, within 30 days each. Low maintenance temperatures of 0-3 ^{o}C and +6-8 ^{o}C were applied to the animals from experimental batches I and II (LE-I, LE-II). The animals from the control batch (LM) were maintained in thermal conditions of 16-18 ^{o}C. Throughout the experimental period, the animals were monitored by daily clinical examination, morning and evening, with evidence of heart and respiratory rate.
The temperature action of 0-3 ^{o}C increased heart rate in both experimental groups up to 258.8±3.95 and 252.6±2.87 contr/min, corresponding for LE-I and LE-II compared to 217.3±4.07 contr/min in LM ($p<0.05$). Exposure to low temperatures was perceived as a stressor, and the response to stress was an increase in heart rate, i.e. it triggered a reaction of adaptation of the body to hypothermic conditions of the environment. At the same time at low temperatures, there is also the mechanism of vasoconstriction of peripheral blood vessels that can influence the heart rate to maintain blood pressure. The influence of the temperature of +6-8 ^{o}C, conversely, decreased the heart rate of the animals in the corresponding LE-I and II, up to 144.5±3.02 and 183.4±2.88 contr/min, compared to the LM which recorded a frequency of 208.2±3.47 contr/min ($p<0.05$). This possible process was caused by a lower metabolic rate that caused a decrease in the oxygen requirement of the tissues and, respectively, a reduction in heart rate.
The frequency of breathing at the action of low temperatures evolves, practically, according to the same principles as the heart rate, but with some exceptions. At 0-3 ^{o}C only in LE-I the frequency of respiration increased (54.8±2.54 resp/min) compared to LM (48.2±1.91 resp/min) ($p<0.05$). At temperature +6-8 ^{o}C the frequency of respiration also decreased only in LE-I up to 38.9±2.35 resp/min compared to LM – 46.4±1.83 resp/min ($p<0.05$). Variations in increasing and decreasing the frequency of respiration, in general, represent the body's response reaction by increasing energy metabolism and, correspondingly, by decreasing oxygen levels under the influence of low temperatures.
Therefore, the application of low temperatures (0-3 ^{o}C and +6-8 ^{o}C) on the experimental herd of rabbits leads to an increase and decrease in the values of the studied indices. Low temperatures as stressors influence the heart rate and breathing rate in rabbits through physiological reactions of adaptation to new maintenance conditions while maintaining homeostasis and animal health.

Keywords: rabbit, thermoregulation, heart rate, respiration.

Assessing growing season dynamics in Serbia: Integrating ground observations and satellite data

Ana Firanj Sremac[1]*, Branislava Lalic[1], Milena Marcic[1,2]

[1]Group for Meteorology and Biophysics, Department of Field and Vegetable Crops, Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia, [2]Forecasting and Warning Service in Plant Protection of Serbia, Novi Sad, Serbia

**ana.sremac@polj.edu.rs*

Accurately determining the start (SOS) and end (EOS) of the growing season length (GSL) is essential for understanding vegetation responses to climate variability and supporting agrometeorological applications. In this study, we investigate the applicability of the Normalized Daily Temperature Range (DTRT) for defining vegetation seasonality in Serbia by comparing it with satellite-derived phenological metrics. We use data from 27 synoptic weather stations across Serbia, covering the period 2000–2020. Surface air temperature data are sourced from the Global Historical Climatology Network – Daily (GHCN-D), a dataset provided by the National Oceanic and Atmospheric Administration (NOAA). Additionally, ERA5-Land, a high-resolution reanalysis dataset from the European Centre for Medium-Range Weather Forecasts (ECMWF), is used as an alternative temperature source. Satellite-based SOS and EOS are derived from the Moderate Resolution Imaging Spectroradiometer (MODIS) Normalized Difference Vegetation Index (NDVI) product (MOD13Q1), obtained through Google Earth Engine (GEE). To capture the station footprint, NDVI values are averaged over a 3×3 grid surrounding each station, covering an area of approximately 1 km². This approach ensures that the vegetation dynamics captured by the satellite reflect the conditions around the synoptic station rather than a single pixel observation.

The length of the growing season and the four distinct seasons, are determined following the methodology outlined in previous research. We assess the agreement between DTRT-based and NDVI-derived seasonality across different climate zones in Serbia and analyze potential trends over the 20-year period. Additionally, we evaluate whether changes in the growing season length exhibit spatial consistency and whether DTRT can serve as a reliable proxy for phenological monitoring in the region. The statistical comparisons (GSL RMSE < 20 days on average for all stations) and mapped spatial distributions (GSL 230–260 days sensitive to elevation) contribute to a better understanding of temperature-driven vegetation dynamics and provide insight into potential shifts in phenology under changing climate conditions. This study highlights the potential of DTRT as a simple yet effective approach for vegetation seasonality assessment, offering a temperature-based alternative for monitoring growing season dynamics in Serbia. The findings are relevant for climate change impact studies, agricultural planning, and ecological modeling, supporting the development of efficient agrometeorological applications.

Keywords: Phenology, Growing Season, Normalized Daily Temperature Range (DTRT), Normalized Difference Vegetation Index (NDVI), Phenology Trends

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Dynamics of proleptic and sylleptic shoot development at some new peach and nectarine cultivars under Vertical Axis and Trident canopies

Alexandru Bucur[1*], Ana Cornelia Butcaru[2], Cosmin Alexandru Mihai[1], Florin Stănică[1,2]

[1]Faculty of Horticulture, [2]Research Center for Studies of Food Quality and Agricultural Products, University of Agronomic Sciences and Veterinary Medicine of Bucharest, Bd Mărăști nr.59, Bucharest, Romania

**bucuralex1994@gmail.com*

In 2022–2024, this study analyzed the dynamics of proleptic and sylleptic shoot development in 14 peach and 16 nectarine cultivar/rootstock combinations trained under Trident (1,250 trees/ha - 3,750 axis/ha) and Vertical Axis (1,666 trees/ha - 1,666 axis/ha) canopy in the Bucharest area, characterized by a temperate continental climate. The objective of this research was to evaluate the influence of canopy training systems, cultivar, and rootstock on vegetative growth patterns and orchard management efficiency in peach and nectarine. The results indicated that vegetative growth was strongly influenced by both the cultivar and the canopy system, with significant differences recorded between the two training methods for most evaluated parameters. The rate and length of sylleptic shoots were primarily influenced by the cultivar and the intensity of summer pruning rather than by the canopy structure. Sylleptic shoots were valuable for compensatory pruning after winter frost damage, enhancing orchard sustainability and resilience. The Trident canopy system demonstrated notable economic advantages due to its lower initial investment per tree, as it required fewer trees per hectare. Additionally, it optimized vertical space utilization, enhanced light interception, and reduced tree vigor, making it particularly suitable for vigorous cultivar/rootstock combinations. However, canopy formation in the Trident system was more complex than in the Vertical Axis system. A tailored pruning strategy based on tree responses will be developed to enhance fruiting potential and improve orchard management for each cultivar/rootstock combination. Three different rootstocks: GF677, Adesoto, and Mirobolan29C, were used for some cultivars, contributing to variability in growth responses.

Keywords: production, canopy, pruning strategies, high-density planting, orchard management

Herbaceous plants on earth berms as an effective biofilter of particulate matter and trace elements

Adam Nawrocki[1]*, Robert Popek[1], Arkadiusz Przybysz[1]

Centre for Climate Research, Warsaw University of Life Sciences, Nowoursynowska St. 166, 02-787 Warsaw, Poland.

**adam_nawrocki@sggw.edu.pl*

Air pollution is a significant environmental issue affecting urban areas across Europe and globally. Among the most harmful atmospheric pollutants to human health is particulate matter (PM), which can contain toxic trace elements (TE). According to the World Health Organization, exposure to PM is responsible for over seven million premature deaths annually, with many more individuals suffering from chronic respiratory and cardiovascular diseases. In urban environments, road traffic is a primary source of PM and a major contributor to noise pollution. As a result, highways are often equipped with noise-reducing infrastructure, such as earth berms, which are frequently vegetated with herbaceous plants. However, little is known about the ability of these plants to accumulate airborne pollutants. This study investigates the potential of herbaceous plants growing on an earth berm along Highway No. 8 in Warsaw, Poland, to accumulate PM and TE. The research was conducted over the course of one year, covering the four seasons: spring, summer, autumn, and winter. Above-ground biomass (leaves and stems) was collected from various heights on both sides of the berm. PM accumulation on the leaves was quantified using a gravimetric method, which involved washing the leaves with water and chloroform, followed by filtration of the resulting solution through PTFE filters with pore sizes ranging from 0.2 to 10 μm. The concentration of TE in the ground plant material was analyzed using a handheld X-ray fluorescence (XRF) spectrometer (Olympus Vanta Element-S). The results demonstrate that herbaceous plants growing on the earth berm effectively accumulated both PM and TE. The highest concentrations of pollutants were found in plants located on the side of the berm closest to the roadway, while plants on the opposite side accumulated lower levels of pollutants. Seasonal variations were observed, with the highest accumulation occurring in summer and the lowest in spring. Notably, during the autumn-winter period, despite reduced plant activity and partial senescence, higher pollutant concentrations were recorded compared to spring. These findings are particularly relevant in temperate climates, where many plants lose their leaves during the colder months, thus reducing their ability to filter airborne pollutants. The results suggest that herbaceous vegetation on earth berms can play a significant role in mitigating local air pollution and improving urban air quality.

Keywords: Earth berms, roadside plants, air pollution, particulate matter (PM), trace elements (TE)

Application of GIS and AHP for selecting constructed wetland locations: Case study of Vojvodina Province, Serbia

Sanja Antić[1]*, Boško Blagojević[1], Jovana Bezdan[1], Milica Stajić[1]

[1] University of Novi Sad, Faculty of Agriculture, Department of Water Management, Novi Sad

**sanja.antic@polj.edu.rs*

With the intensification of urbanization, coupled with the expansion of industrial capacities and agricultural areas, an increase in wastewater volume has been observed. Ensuring the preservation of water resource quality necessitates the implementation of effective wastewater treatment strategies. Among the most efficient and cost-effective approaches are Constructed Wetlands (CWs), which have demonstrated significant potential in wastewater treatment applications. The objective of this study is to identify the most suitable locations for the implementation of CWs in Vojvodina Province, Serbia, by applying Geographic Information Systems (GIS) and the Analytic Hierarchy Process (AHP). Selecting appropriate locations for the establishment of these systems is a complex task due to the need to consider multiple criteria. In this study, AHP was applied to determine the weights of criteria and sub-criteria based on the assessments of six experts. The obtained weight values were integrated into GIS, which enabled spatial analysis and the creation of a suitability map for the implementation of CWs in Vojvodina. The selection of suitable locations was based on the assessment of six main criteria: distance from settlements, distance from recipients, land use, elevation, presence of embankments, and floodplain characteristics. Each criterion was further divided into sub-criteria to enable a more detailed spatial analysis. For the criteria "distance from settlements" and "distance from recipients", two buffer zones were defined: 0–500 m and 500–1000 m. The land use criterion included the following sub-criteria: agricultural areas, forest and semi-natural areas, wetlands, and water bodies. Elevation was categorized into two classes: areas with an altitude lower than or equal to the settlement altitude and areas with an altitude higher than the settlement altitude. The presence of embankments was assessed by distinguishing between areas with and without embankments. Floodplain areas are classified as flood-prone or non-flood-prone zones. Through the analysis of criteria and sub-criteria, a suitability map was developed, showing that the first and second classes representing the most suitable locations for the implementation of CWs cover approximately 80% of the total area. The third class, representing moderately suitable locations, accounts for 15% of the area, while the fourth and fifth classes, indicating the least suitable locations, comprise the remaining 5%. The results suggest that the majority of Vojvodina's territory is highly suitable for CW implementation, facilitating efficient wastewater treatment planning. These findings provide valuable guidance for future decisions regarding the construction of CWs in Vojvodina and contribute to the sustainable management of wastewater, further enhancing environmental protection in the region.

Keywords: wastewater treatment, constructed wetlands, geographical information system, analytic hierarchy process, Vojvodina Province, suitability

Application of drones with multispectral cameras for sustainable agriculture

Filip Vasić[1*], Aleksandar Sedlar[1], Jan Turan[1], Lazar Turšijan[1]

[1]Faculty of Agriculture, Novi Sad, Serbia

**filip.vasic@polj.edu.rs*

The use of drones with multispectral cameras has significantly advanced precision agriculture by enabling advanced crop monitoring and sustainable land management. This study explores how multispectral imaging supports early disease detection, precise crop monitoring, and the development of variable rate application maps, contributing to more efficient resource use and a potentially lower environmental impact.

One of the key benefits of drones with multispectral cameras is their ability to detect plant stress before visible symptoms appear, allowing for early intervention and targeted pesticide application. Such techniques not only reduces excessive pesticide use but also minimizes environmental contamination while maintaining crop health. Additionally, multispectral cameras provide valuable insights into vegetation indices, such as the Normalized Difference Vegetation Index (NDVI), which reflect plant vigor and growth status throughout the vegetation cycle. Continuous monitoring of these indices helps farmers make timely decisions regarding fertilization, irrigation, and other agronomic practices, which is crucial for successful agricultural production.

Beyond disease detection and crop monitoring, drones with multispectral cameras facilitate the creation of variable rate maps for site-specific management. By analyzing both elevation data and vegetation indices collected during UAV flights, it is possible to generate site-specific management maps. These precision maps guide variable rate seeding and fertilization by identifying field zones with differing soil properties or crop needs, thereby optimizing nutrient distribution and enhancing yield efficiency. More precise resource application also leads to more efficient use of agricultural machinery, reducing the number of tractor passes across the field. This, in turn, lowers fuel consumption, decreases greenhouse gas emissions, and reduces the carbon footprint of agricultural production.

By integrating drones with multispectral cameras into modern farming systems, producers can enhance productivity, reduce costs, and improve environmental sustainability. This study highlights the potential of drone-assisted precision agriculture to contribute to food security and reduce ecological impacts.

Keywords: drones, multispectral cameras, precision agriculture, crop monitoring, disease detection

Akebia, schisandra and *diospyros,* species with rich nutraceutical values

Emanuela Diana Lorentz (Crintea)[1*], Ana Cornelia Butcaru[2], Cosmin Alexandru Mihai[1], Florin Stănică[1,2]

[1] Faculty of Horticulture, University of Agronomic Sciences and Veterinary Medicine of Bucharest, Bdul Mărăști no. 59, Bucharest, Romania

[2] Research Center for the Study of Quality Food Products, University of Agronomic Sciences and Veterinary Medicine of Bucharest, Bdul Mărăști no. 59, Bucharest, Romania

**emanuela-diana.crintea@doctorat.usamv.ro*

Fruit growing has been practiced in Romania for centuries, being rooted in the agricultural tradition of the country, with an emphasis on both native and introduced fruit species. The temperate climate and fertile soils support a cultivation of wide variety of fruit species. Some of the most important traditional fruits include: apple, plum, cherry, pear, walnut and quince. The growing interest in plants with nutraceutical values and the desire to reduce pesticide use make Romania a suitable area for the introduction of new species. In this regard, fruit species such as *Ficus carica, Asimina triloba, Ziziphus jujuba, Pistacia vera, Olea europaea, Akebia quinata, Akebia triloba, Schisandra chinensis, Diospyros kaki, Actinidia arguta,* and *Actinidia chinensis* have been introduced.
Akebia quinata, Akebia triloba, and *Schisandra chinensis* have recently been introduced and cultivated, for the moment, as ornamental plants. *Diospyros kaki* has also been recently introduced in Romania, being cultivated in family gardens.
The cultivation of species from the genera *Akebia, Schisandra* and *Diospyros* in Romania presents an interesting opportunity for agricultural diversification, economic development and increasing dietary diversity and human health. In addition, these species are of considerable importance due to their notable nutritional and medicinal properties. Known in traditional Asian medicine, *Akebia, Schisandra* and *Diospyros* are rich in bioactive compounds with nutraceutical and pharmaceutical potential, making them valuable for human health. Considering these aspects, as well as the fact that they do not require insecticides and other chemical treatments, the mentioned species can play an important role in fruit growing.
The study was conducted by consulting the specialized literature regarding the research of the biochemical compounds of the mentioned species. The data were collected using ScienceDirect. Keywords: *Akebia* biochemical compounds, *Schisandra* biochemical compounds, *Diospyros* biochemical compounds.
For *Akebia*, the Science Direct database generated 185 results (71 - review articles, 87 - research articles, 21 - book chapters, and 6 - short communications) for the period 1986 - 2025. For *Schisandra,* the Science Direct database generated 857 results (269 - review articles, 457 - research articles, 106 - book chapters, and 25 - short communications) for the period 2000 – 2025. For *Diospyros,* the Science Direct database generated 699 results (190 - review articles, 307 - research articles, 190 - book chapters, and 12 - short communications) for the period 2001 – 2025.
Studies have shown that *Akebia* sp. is a rich source of triterpenoid saponins, phenolic compounds and lignans, which have antioxidant, anti-inflammatory and anticarcinogenic properties. The species is used in traditional Asian medicine for detoxification, diuresis and reduction of inflammation.
Schisandra sp. contains lignans (e.g. schisandrin, gomisin A) with adaptogenic, hepatoprotective and neuroprotective effects, helping the body to cope with stress, improving physical and mental performance.

Diospyros sp. is rich in nutrients, vitamins (A, C, E), minerals (potassium, magnesium), phenolic compounds, carotenoids and dietary fiber, which support cardiovascular health, immune function and digestive health.
By integrating these plant species into agricultural systems, we provide a rich natural source of bioactive compounds for functional foods, dietary supplements and herbal medicines.

Keywords: *Akebia, Schisandra, Diospyros*, biochemical compounds, human health

Cereal crop responses to abiotic stress: from gene expression to yield stability

Borislav Banjac[1]*, Sofija Petrović[1], Teodora Feher[1], Mirela Matković Stojšin[2], Rada Šućur[1], Milana Čurčić[1],Velimir Mladenov[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

[2]Institute Tamiš, Pančevo, Serbia

**borislav.banjac@polj.edu.rs*

Abiotic stress influences plants in various ways, often leading to overlapping physiological and biochemical responses. The effects of one stress factor may amplify or reduce the impact of another, resulting in diverse responses across species. Some stressors are difficult or even impossible to control, and their unpredictable nature further complicates efforts to maintain stable crop production. These challenges necessitate the development of adaptive mechanisms that enable plants to endure and perform under adverse conditions.
Soil salinity is a major constraint in cereal production. Plant salt tolerance refers to its ability to prevent, reduce, or withstand the harmful effects of soluble salts in the root zone. There are two main strategies to mitigate salinity effects. The first is soil reclamation, which is costly, time-consuming, and often provides only temporary relief. The second approach involves breeding and utilizing tolerance varieties, which are more cost-effective, durable, and efficient, but require a longer development period. Evaluating grain yield and its components provides essential insights into genotype adaptation to saline environments. A multi-year study highlighted the complexity of phenotypic variation in response to salinity. The experiment was conducted under controlled conditions with two levels of solonetz soil repair. The following traits were monitored: ear mass, grain mass per ear, and grain yield, using 12 genotypes – 11 wheat cultivars and 1 triticale cultivar. Wheat and triticale cultivars demonstrating stable responses across varying agroecological conditions were identified. The most stable genotypes were Rapsodija and Renesansa, while only 40.3% and 45.1% of their genetic yield potential was expressed under the abiotic stress compared to the normal conditions. Additionally, local populations and old wheat varieties may serve as valuable genetic resources for enhancing genetic diversity and improving specific adaptations to high-salinity conditions.
In addition to physiological and agronomic responses, plants adapt to abiotic stress through molecular adjustments in gene expression. When exposed to stress, plants activate signaling pathways that regulate gene expression, allowing them to modify growth, metabolism, and defense mechanisms. These adaptations involve increased production of specific mRNA, enhanced translation efficiency, protein stabilization, and modifications in protein activity. These molecular changes help plants maintain cellular function, improve stress tolerance, and sustain growth and reproductive success under adverse environmental conditions.

Keywords: abiotic stress, adaptation, salt tolerance, gene expression, soil salinity

Precision food

Bojana, Blagojević[1]*

[1]Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, 2100 Novi Sad, Serbia

**bojana.blagojevic@polj.edu.rs*

For food to be claimed as healthy, the most important criterion is "For whom?" Every human is unique, and so is their response to food. Even if two persons eat the same meal, their bodily responses can be highly different. Therefore, the traditional *one-size-fits-all* approach is not an option anymore. Human response to food depends on a range of factors, including genetics, epigenetics, gut microbiota, age, sex, health condition, lifestyle, living environment, and personal preferences. Identifying and understanding the influence of such factors is being investigated in the field of precision nutrition, the discipline developed under the umbrella of precision medicine. One of the main obstacles in deciphering the personalized response to food is that it is a two-way street – our body carries the information on how we are going to digest and process the food, but reversely, food components and digestion products modulate the behaviour of our body. Additionally, the food matrix, structure, processing techniques, and ingredients' interactions cause the different behaviour of the same nutrients.

Our preliminary findings show that human response to bioactive plant secondary compounds, such as polyphenols, can greatly vary. Depending on gut microbiota composition, the same compound with different people can be metabolised to different final metabolites, thus leading to diverse physiological activities. Until recently, this was not known and was completely ignored in most of the previous research, leading to mis-conclusions and inadequate health claims.

Our mission is to develop a strategy for creating *Precision Food* – food tailored to individual needs and specific population groups. Creating *Precision Food* products needs to start by taking into account the interindividual differences and integrating them into food composition. That is achievable only by leveraging accumulated knowledge and future achievements in all aforementioned disciplines, together with biosensors, AI technologies, and predictive modelling techniques.

Such an approach can result in *Precision Food* products, that can finally enable us to "*use our food as our medicine*" or instead of the medicines. *Precision Food* can help regulate our body's functions, activate beneficial genes, snooze or deactivate the harmful ones, modulate our microbiome, thus preventing or controlling the development of certain diseases. This approach has the potential to help us feel better, think better, live better, and stay healthy.

Keywords: precision food, nutrigenetics, epigenetics, gut microbiota, polyphenols

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Effects of spermidine seed priming on wheat germination and early seedling growth

Maria Gal[1], Milena Mandić[1], Rada Šućur[1], Velimir Mladenov[1], Bojana Blagojević[1]*

[1]Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, 2100 Novi Sad, Serbia

**bojana.blagojevic@polj.edu.rs*

Spermidine is a polyamine molecule known for many beneficial effects on plants, animals, and humans. In agriculture, it is mainly explored for exogenous applications for plant protection, specifically as an immune-boosting molecule for stress tolerance. Facing global challenges of climate change and its direct effects on plant growth under harsh conditions, we need healthy, adaptable, and sustainable approaches. Spermidine completely fits these needs as a natural, non-toxic, and healthy solution.
Our goal was to assess the potential of using different spermidine concentrations as seed-priming agent for wheat. Seeds of two genetically distant wheat cultivars, Simonida and KWS Marvel, were soaked in spermidine solutions (0.1 mM and 1 mM) for different time periods (4 h, 8 h, and 12 h). The control was soaked in distilled water for the same time periods. After soaking, the seeds were dried to a constant mass. The germination test was performed by the International Rules for Seed Testing Association (ISTA). Two pieces of filter paper, with a diameter of 15 cm, were placed in petri dishes and 100 seeds were placed in each petri dish for germination testing. Plants were grown under 22°C (day) / 18°C (night) temperatures and a 10 h light / 14 h dark cycle. Each test was done in triplicate. Germination index and germination percentage were manually determined by counting germinated seeds on days 4 and 8, respectively. If the length of the radicle and coleoptile reached the full and half length of the seed, respectively, the seed was defined as germinated. On day 8, coleoptile length and radicle length were also measured.
The results showed multifaced effects of spermidine. In general, spermidine treatment did not significantly alter the germination, but its effects on coleoptile and radicle lengths varied significantly depending on soaking time, applied concentration, and wheat cultivar. For cultivar KWS Marvel, the longest seedlings were obtained by applying 0.1 mM spermidine concentration and a 4-hour soaking time, whereas for cultivar Simonida the superior treatment was 1 mM spermidine with a 12-hour soaking time.
Before proceeding with field examinations, further experiments, including more wheat cultivars are needed for evaluating the optimal concentration and soaking time of spermidine for seed priming.

Keywords: spermidine, wheat, seed priming

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Physics-informed and biology-informed neural networks in precision farming – possible avenues for application

Branislava Lalić[1*]

[1]Group for Meteorology and Biophysics, Faculty of Agriculture, University of Novi Sad,

Novi Sad, Serbia

**branislava.lalic@polj.edu.rs*

Precision farming relies on accurate modelling of complex agricultural processes to optimize resource use, improve yields, and minimize environmental impact. In this review presentation, we highlight the possibilities and importance of integration of machine learning with domain-specific scientific knowledge through approaches such as Physics-Informed Neural Networks (PINNs) and Biology-Informed Neural Networks (BINNs), which enhance predictive modeling by incorporating fundamental principles of physics and biology, respectively.

PINNs are a class of neural networks that embed partial differential equations (PDEs) or other physical laws directly into the learning process. Unlike traditional deep learning models, which rely purely on data, PINNs leverage known physical principles to constrain and guide learning. This makes them particularly useful for solving problems where data is sparse or noisy, such as soil moisture prediction, climate modeling, and crop growth simulations. In precision farming, PINNs can model water flow in soil, optimize irrigation strategies, and predict pest dispersal patterns.

BINNs, on the other hand, incorporate biological constraints and mechanistic models into neural networks. These networks are designed to learn from biological systems by embedding metabolic pathways, gene regulatory networks, or ecological interactions within their structure. BINNs are particularly useful in areas such as pest control, livestock management, and plant disease modeling, where biological processes dictate system behaviour. For example, BINNs can improve predictions of plant responses to environmental stress or optimize breeding programs by integrating genetic and environmental data.

By integrating physics- and biology-based knowledge, PINNs and BINNs bridge the gap between empirical machine learning models and mechanistic agricultural theory. Their ability to combine domain knowledge with data-driven learning allows for more accurate, interpretable, and efficient models in sustainable agriculture. This review explores the current state of research and applications of PINNs and BINNs in agriculture, highlighting their role in enhancing predictive accuracy and decision-making. One practical example of their application in simulating mosquito population dynamics, crucial for pest control and vector-borne disease management, will be presented (Cuong et al., 2024; Lalic et al., 2024).

Keywords: Physics-Informed Neural Networks, Biology-Informed Neural Networks, hybrid models, digital agriculture, precision farming

Literature

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Assessment of waterlogging hazard in agricultural areas of the Vojvodina Region, Serbia

Atila Bezdan[1*], Jovana Bezdan[1], Boško Blagojević[1], Andrea Salvai[1], Nikola Santrač[1], Sanja Antić[1], Milica Stajić[1]

[1]University of Novi Sad, Faculty of Agriculture, Department of Water Management, Novi Sad, Serbia

**atila.bezdan@polj.edu.rs*

In the context of global climate change, waterlogging is a severe agricultural meteorological disaster, causing substantial crop yield losses. It results from heavy rainfall, floods, and phreatic rise, leading to excess water accumulation on the surface or seeping through porous soil. In Vojvodina region, Serbia waterlogging primarily occurs due to significant precipitation in the non-vegetation period or heavy spring rainfall. This study assessed waterlogging hazard in Vojvodina using soil water balance during the non-vegetation period and maximum daily precipitation in spring (March to May). Data from 1971 to 2021 from eight principal meteorological stations were used. Thiessen polygons defined proximal regions around these stations, assigning meteorological parameters across each polygon. Monthly soil water balance was calculated by considering the difference between precipitation and evapotranspiration, using the FAO-56 Penman-Monteith method and taking into account soil water reserves. Soil water reserves were computed based on solum depth and available water, which varies from 10 mm to 150 mm across the area. Next, time series of soil water balance and maximum daily precipitation in early spring were modeled using the Generalized Extreme Value (GEV) distribution function, a common choice in hydrological analyses. The goodness-of-fit for the GEV distribution was tested using the Anderson-Darling test (significance level 0.05). The GEV distributions were fitted to empirical data using the R package 'fitdistrplus', and critical values for the Anderson-Darling test were calculated via Monte Carlo bootstrap simulations using the 'nsRFA' R package. In the Vojvodina region, drainage systems are generally designed based on the relevant amount of excess water with a return period of 10 years. Therefore, for this study, the amount of excess water in the soil water balance during the non-vegetation period, as well as the maximum daily spring precipitation, both with a ten-year return period, were calculated for all analyzed meteorological stations. The waterlogging hazard map was developed by combining the waterlogging hazard assessments based on the amount of excess water during the non-vegetation period with those based on the maximum daily precipitation in spring. It is estimated that the areas facing the highest waterlogging hazards, which constitute about 30% of Vojvodina's territory, are primarily located in the central, eastern, and southeastern parts of the region. The methodology presented for assessing waterlogging hazard provides a clearer understanding of its spatial distribution, enabling the implementation of measures to improve the planning, management, and maintenance of drainage systems, thereby enhancing prevention and mitigation of its negative impacts. This research was conducted within the Drought and Excess Water Management Centre, established through the Interreg-IPA CBC Hungary-Serbia project (HUSRB/1602/11/0057): WATERatRISK.

Keywords: waterlogging, hazard, water management, mapping, generalized extreme value

Variability of morphological characteristics of *Rosa rugosa* Thunb. populations under different light conditions in urban environment

Jelena Čukanović[1*], Mirjana Ljubojević[1], Sara Đorđević[1], Radenka Kolarov[1], Magdalena Pušić Devai[1], Djurdja Petrov[2], Mirjana Ocokoljić[2]

[1]Faculty of Agriculture University of Novi Sad, Novi Sad, Serbia

[2]Faculty of Forestry University of Belgrade, Belgrade, Serbia

**jelena.cukanovic@polj.uns.ac.rs*

Rosa rugosa Thunb., a shrub species from the genus *Rosa* L. and the family *Rosaceae* Juss, is native to eastern Asia and southeastern Siberia. Introduced to Europe in the 19th century for ornamental purposes, it is now widely used for urban greening due to its high adaptability to urban environment, drought and heat tolerance, and high resistance to pests and diseases. This study examines the impact of different light conditions—full sunlight, partial shade, and shade—on the biological characteristics of *Rosa rugosa* Thunb. secondary populations in urban environments and the morphological characteristics of fruits.
The studied *Rosa rugosa* Thunb. groups are located in a linear planting on the landscaped part of a large riverbank, along the quay in Novi Sad, Serbia extending east-west, with varying light exposures. Biometrical analysis identifies a total of 145 individuals: 116 in full shade, 15 in partial shade, and 14 in full sunlight. The growth type was uniform across all investigated groups, classified as a shrub with a semi-upright growth habit. Plant height ranged from 0.5 m (full sunlight) to 0.8 m (partial shade). No damage or diseases were observed, and vitality and decorative scores of the investigated plants reached maximum values.
The plants were consistently positioned just 0.5 meters from the nearest paved surface, a proximity typically considered extremely close and potentially harmful to plant health. However, no notable deviations were observed in the typical growth patterns, flowering (including timing, abundance, and duration), or fruiting, indicating that *Rosa rugosa* is a remarkably resilient species, able to tolerate the conditions associated with proximity to paved surfaces and roads. Distance from the bicycle path ranged from 0.5 up to 3 meters, contributing to the quality of recreational green spaces and positively impacting user's well-being.
The average values of the measured morphological parameters of the fruits were 3.5 g for fruit weight, 1.55 cm for fruit length, 2.17 cm for fruit width, 1.11 cm for length of the fruit's petiole, while the average sepal length was recorded at 1.57 cm. The values of the number of achenes at the population level range from 31 to 120. The measured morphometric parameters for individual fruits show that the values for achenes length and width ranged from 0.2 to 0.7 cm and from 0.1 to 0.5 cm, respectively. The highest variability was shown in the parameters for fruit weight, length of the fruit's petiole, sepal length, number of individual fruits and weight of achenes. The fruit parameters indicated that variations in light, including shade, partial shade, and full sun exposure, affect morphology. Based on the results obtained, the use of *R. rugosa* seedlings in urban environments is recommended, particularly in various categories of green spaces for linear planting and under different light conditions such asfull sunlight, partial shade, and shade. This species plays a crucial role in enhancing climate resilience within urban settings.

Keywords: Rugosa rose, fruit parameters, resilience, adaptability, sun exposure

Black Locust (*Robinia pseudoacacia* L.) on Farmsteads: Invasive Threat or Functional Resource?

Sara Đorđević[1*], Jelena Čukanović[1], Lazar Pavlović[1], Radenka Kolarov[1], Olivera Kalozi[1], Saša Orlović[1,2]

[1]Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia

[2]Institute of Lowland Forestry and Environment, University of Novi Sad, Novi Sad, Serbia

**sara.djordjevic@polj.edu.rs*

Black locust (*Robinia pseudoacacia* L.), often mistaken for a native species in Serbia, was introduced from North America to Europe in the 17th century and later brought to Vojvodina, Serbia through the Habsburg Monarchy. Due to its adaptability and robust root system, it became a vital component of lowland landscapes, particularly for the afforestation of swampy and erosion-prone terrains, as Vojvodina once was. Traditionally, it was planted on farmsteads (*salaši*) in Vojvodina due to its multifunctional properties. Despite its numerous ecosystem services, black locust is classified as an invasive species, raising concerns about its impact on native biodiversity. This study examines its role in rural landscapes, focusing on ten traditional farmsteads in Bačka, Vojvodina. Through literature review and field research, the study aims to: 1. Identify historical and current uses of black locust on traditional farmsteads, 2. Map black locust trees on representative farmsteads using LocusGIS 3. Assess its abundance and relative share compared to the total number of individuals and species, 4. Calculate Shannon and Simpson biodiversity indices to evaluate species diversity and dominance, 5. Assess the ecosystem services that black locust provides on farmsteads and 6. Compare the distribution of black locust forests in Vojvodina over the last 35 years. Results indicate that black locust forests in Vojvodina have decreased by 10.45% over the last 35 years. On farmsteads, black locust is among the most frequent species present on all studied sites. It provides key provisioning and regulating ecosystem services, including timber and fibre production, wind protection, honey production, pollination, and erosion control. Biodiversity indices, with an average Shannon index of 1.67 and an average Simpson index of 0.66, which are within typical ranges, indicate a diverse composition of woody species on the farmsteads. On seven out of ten farmsteads, black locust represents less than 50% of the total individuals, suggesting a minimal threat to the presence of other species. Considering Vojvodina's low forest cover and increasing agricultural challenges, such as soil degradation, biodiversity loss, and erosion, the benefits of black locust outweigh its disadvantages. This study highlights its potential as a valuable resource in addressing ecological and agricultural challenges in the region.

Keywords: agricultural landscape, lowland landscape, rural landscape, ecosystem services, woody species

Green invaders: understanding and addressing the opportunities and challenges of predominant wooden plant species in Serbian urban landscapes

Radenka Kolarov[1*], Dejan Prvulović[1], Jelena Čukanović[1], Sara Đorđević[1], Mirjana Ocokoljić[2], Đorđe Malenčić[1]

[1]Faculty of Agriculture University of Novi Sad, Novi Sad, Serbia, [2]Faculty of Forestry University of Belgrade, Belgrade, Serbia

**radenka.kolarov@polj.uns.ac.rs*

As urbanization continues to reshape landscapes, the prevalence of invasive species in cities has become a growing concern. However, a shift in perspective is emerging, recognizing the ecosystem services of harnessing these invasive species for various urban applications. This study aims to analyze the dual impact of invasive plant species, considering both their ecosystem disservices and potential ecosystem services in urban landscapes, and suggest innovative approaches that enable ecosystem services to prevail over ecosystem disservices. Invasive species, known for their adaptability, can contribute to urban tree canopies and provide shade, thereby aiding in the mitigation of the urban heat island effect. One of the most present in Serbia's urban landscapes are false indigo and black locust which have nitrogen-fixing capabilities that may benefit soil quality, making it a potential candidate for sustainable urban farming. Boxelder maple and tree of heaven are highly spread in Serbia and considered of the top 40 invasive species in the world, known for their tolerance to various soil conditions, can be utilized to absorb pollutants and improve soil quality in areas where other species aren't an option. This application helps address soil degradation and stabilizes land in urban areas undergoing redevelopment or facing environmental challenges not only in Serbia. While the repurposing of invasive species in cities presents promising opportunities, it is crucial to acknowledge and address associated challenges and ecosystem disservices. As invasive species establish themselves, they can alter ecosystem structure and disrupt the balance of native plant and animal communities, potentially leading to the extinction or decline of indigenous species. Nevertheless, with innovative and sustainable planning, urban ecologists can explore ways to harness these species for environmental benefit. In addition to physical ecosystem functions, many invasive species also possess significant biochemical potential. In this study, the antioxidant capacity of *A. fruticosa*, *R. pseudoacacia*, *A. altissima*, and *A. negundo* was assessed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay. Plant material (leaves and bark) was collected from urban areas in Novi Sad, air-dried, ground, and extracted with 70% methanol. Extracts at concentrations of 0.5–5 mg/mL were mixed with DPPH solution and incubated in the dark for 30 minutes. Absorbance was measured at 517 nm. DPPH inhibition was calculated and expressed as a percentage. The results showed strong antioxidant potential: *A. fruticosa* exhibited 60–85% inhibition, *R. pseudoacacia* 50–80%, while *A. altissima* and *A. negundo* showed inhibition in the range of 45–75%, depending on concentration and plant part. These findings suggest that invasive species, when properly managed, could offer added value in urban bioremediation, green infrastructure, and even phytochemical applications. By embracing a proactive and sustainable mindset, urban planners, ecologists, and policymakers can explore ways to harness the strengths of invasive species for the betterment of urban environments while safeguarding native ecosystems.

Keywords: invasive species, urban ecosystems, soil restoration, ecosystem services, ecosystem disservices

Potential of beneficial yeast strains against phytopathogenic *Fusarium* isolates originating from onion bulbs

Jozef Gašparovski[1*], Mila Grahovac[1], Tatjana Dudaš[1], Dobrila Radić[1], Milica Meseldžija[1], Dragana Budakov[1], Marta Loc[1]

[1]Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, 21102 Novi Sad, Serbia
**jozef.gasparovski@polj.edu.rs*

Fusarium spp. represents a group of pathogenic fungi that cause significant economic losses in agriculture and the food industry, being one of the primary culprits of onion diseases. These fungi are widespread and have adaptive traits that allow them to survive in various environments, making their management challenging. Beyond damage in the field, these fungi can also affect onions in storage, causing bulb rot and increasing the risk of mycotoxin contamination.

A major challenge of the disease control is that infected bulbs often appear healthy at harvest, reach the storage and the spread of latent infection in warehouses, making the detection of disease and mycotoxins even more difficult. Global demands for chemical pesticides reduction have driven to development of new sustainable plant protection strategies. The aim of this study was to evaluate the inhibitory potential of six yeast strains on the growth of *Fusarium* isolates obtained from diseased onion bulbs. Onion bulb samples with rot symptoms were collected from fields and storages in Serbia and isolations of the causal agents were performed. Morphological and molecular analysis of the obtained isolates, based on ITS, β-tubulin and TEF gene analysis, enabled identification at species level, suggesting that the isolates belong to species *F. proliferatum, F. verticillioides, F. graminearum, F. acuminatum.* Pathogenicity of the isolates was confirmed on onion bulbs. The inhibitory potential of yeast strains was evaluated using the dual culture method on potato dextrose agar (PDA). The *Fusarium* isolates and yeast cultures were pre-cultivated on PDA medium for seven days. The dual culture method involved placing 3 mm mycelial discs from *Fusarium* isolates on PDA in sterile Petri dishes. Biocontrol agents were positioned at a distance of 3 cm from the fungal fragment using a microbiological loop, forming a 5 cm long streak. Cultivation was performed in triplicate for each *Fusarium* isolate and each biocontrol agent. In control plates, no yeast inoculation was performed. After five days of incubation at 25±2 °C, the radial growth of *Fusarium* isolates mycelium was measured and inhibition rate was calculated compared to the control. The results showed that after five days of incubation, certain biocontrol agents exhibited an inhibitory effect on *Fusarium* isolates, while others stimulated their growth, indicating specific interactions between non-pathogenic yeast strains and phytopathogenic fungi. After seven days, all tested yeast strains inhibited the mycelial growth of the isolates compared to the control. The results revealed significant variability in the activity of the tested yeast strains. The most effective strains reducing *Fusarium* growth by more than 55%.

The results demonstrated that non-pathogenic yeast strains can effectively inhibit mycelial growth of *Fusarium* spp. isolated from onion bulbs, highlighting their potential as promising biocontrol agents. Further research will focus on assessing yeast antifungal activity *in planta* on onion bulbs, molecular characterization of the most active yeast strains and exploring their potential contribution to sustainable plant protection approaches.

Keywords: *Fusarium*, biocontrol, onion, yeasts

Effectiveness of *Bacillus subtilis* BS10 strain in the control of postharvest apple fruit rot

Aleksandra Janković[1*], Mladen Petreš[1], Dragana Budakov[1], Mila Grahovac[1], Marta Loc[1], Tatjana Dudaš[1], Vera Stojšin[1]

[1]Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia

**aleksandra.jankovic@polj.edu.rs*

Apples (*Malus* × *domestica* Borkh.) are the third most produced fruit in the world associated with a healthy lifestyle, due to their nutritional value. However, during the storage period, many fungal pathogens cause postharvest apple fruit rot, leading to significant economic losses. Even though chemical treatments are considered the primary method used to control the disease incidence, bioagents have become increasingly important in the control of postharvest apple disease due to their human safety and environmentally friendly advantages. Numerous *Bacillus*-based products have been developed, with *Bacillus subtilis* being the most commonly used. This study aimed to determine the presence of pathogens that caused apple fruit rot, and to evaluate the potential of different concentrations of *Bacillus subtilis* strain BS10 (cultivation liquid with 6×10^{10} cfu/ml) as a biocontrol agent against postharvest apple fruit rot pathogens. The trial was conducted at two localities in Serbia (Titel and Tavankut) in orchards on the apple cultivar Golden delicious. Three concentrations of *B. subtilis* strain BS10 (0.5, 1, and 2%) were tested and compared with standard fungicide trifloxystrobin. An untreated plot served as a control. The treatment was applied seven days before harvest. After harvest, apple fruits were stored in ULO storage for three months. The effect of the tested bioproduct was estimated based on the intensity of apple fruit rot infection three weeks after removal from ULO storage. The results indicate that *Alternaria* sp. was the most prevalent fungi causing apple fruit rot. Rot incidence caused by this fungi ranging from 59.92 % (locality Tavankut) to 78.63% (locality Titel) of the total decayed apple fruits. The presence of *Penicillium* spp., *Mucor* sp., *Fusarium* spp., and *Neofabraea* sp. was also detected. According to the results, *B. subtilis* strain BS10, applied at a concentration of 1%, was the most effective in the control of postharvest apple fruit rot, with efficacy ranging from 26.38% (locality Tavankut) to 78.06% (locality Titel). In conclusion, this study shows that a bioproduct based on *B. subtilis* strain BS10 at a concentration of 1% could be an effective and eco-friendly alternative or addition to chemical fungicide treatment for postharvest apple rot control. In the order to evaluate effectiveness of the *B. subtilis* strain BS10 against postharvest apple rot pathogens, further research to improve formulation, and assess duration of its protective effect under storage conditions is desired.

Keywords: *Bacillus subtilis,* biocontrol, postharvest, apple rot

Policy challenges for agroforestry implementation in Czech Republic in comparison with Europe

Jakub Slávik[1*], Martin Slávik Csc[1], Tomáš Bucha[1]

[1]Czech University of Life Sciences Prague,Czech Republic, Prague National Forest Centre, Zvolen, Slovakia

*slavikjakub@pef.czu.cz

The abstract explores the multifaceted policy challenges hindering agroforestry (AF) implementation in the Czech Republic, contextualized within broader European trends. Drawing from the AFINET thematic network and recent EU CAP recommendations, it highlights persistent technical, economic, educational, and policy barriers that restrict the development of agroforestry. In the Czech Republic, these challenges manifest as limited public awareness, fragmented land ownership, restrictive land-use policies, and the absence of dedicated support under the national CAP Strategic Plan. Compared to Western Europe, where practices like silvopasture and alley cropping have progressed due to coherent CAP support and active local initiatives, agroforestry in the Czech Republic remains marginal. Educational and advisory gaps further exacerbate this disparity, as few institutions offer agroforestry-focused curricula or field-based extension services.
To strengthen the analysis, the presentation will include selected examples from national policy instruments and stakeholder interviews that illustrate these systemic hurdles. It will also offer a more detailed examination of how existing EU policy tools could be adapted to local needs, including options for eco-scheme integration and multiactor innovation networks. Specific policy interventions, such as cooperative land-use models to mitigate land fragmentation and subsidy reform to promote multifunctional land management, are proposed. These recommendations align with EU priorities on biodiversity and climate adaptation and aim to stimulate agroforestry's role in sustainable rural development. Additionally, the need to integrate cross-disciplinary agroforestry data and compare system performance across diverse pedoclimatic zones is emphasized. Facilitating access to such data for farmers, foresters, researchers, and policymakers is essential to build consensus on the ecosystem services AF provides. The paper concludes by advocating for a European agroforestry strategy that formally acknowledges these services and supports the sector's integration into rural development planning.

Keywords: agroforestry definition, agroforestry practices, biodiversity, ecosystem services, agroforestry adoption

Control of the European grapevine moth (*Lobesia botrana*) on grapevine using deltamethrin

Antonije Žunić[1*], Slavica Vuković[1], Dragana Šunjka[1], Sanja Lazić[1], Miloš Petrović[1], Nikola Laćarac[1], Jelena Ećimović[1], Aleksandra Šušnjar[1]

[1]University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, Novi Sad, Serbia

**antonije.zunic@polj.edu.rs*

The grapevine (*Vitis vinifera*) is one of the most economically significant species in Europe, particularly in countries around the Mediterranean Sea. Despite favorable conditions for its growth in the Republic of Serbia, many pests, including the European grapevine moth (*Lobesia botrana* Denis and Schiffermüller, 1775), make the cultivation and development of viticulture more difficult. *Lobesia botrana* is one of the economically most important pests of grapes, causing significant damage when not controlled. The caterpillars feed on the stamens from the outside of the flowers and damage the berries, feeding on their contents until only the seeds and skin remain. This study aimed to determine the efficacy of a deltamethrin-based insecticide in suppressing *L. botrana* in vineyards, on two localities in the Vojvodina, Serbia. During 2023, the experiments were conducted in Petrovaradin and Susek, in Afus Ali and Hamburg grape varieties following the standard EPPO methods. The experiment type was a randomized block system with four replications. The deltamethrin (25 g a.i./L, EC) was applied at a concentration of 0.07% when the grapevine was in the BBCH 73-75 stage. The treatment was carried out using a backpack mist blower (Solo 423). The insecticide efficacy was determined based on the number of damaged grape clusters by the second generation of grape moths (50 bunches per replication). The obtained results were processed using one-way ANOVA and LSD test, while efficacy was determined according to Abbott. The efficacy for deltamethrin, seven days after treatment, ranged from 86.5% to 91.3%, while 15 days after treatment, efficacy ranged from 85.2% to 89.4%, depending on the locality. In both assessments and localities, the number of damaged bunches was significantly lower in the insecticide treated variant compared to the control, indicating the sensitivity of *L. botrana* populations to deltamethrin. This allows its further use while adhering to all anti-resistance strategy recommendations.

Keywords: grapevine, *Lobesia botrana*, deltamethrin, efficacy

Superfecundation and superfetation in dogs and cats – phenomena, questions and storylines

Ivan Galić[1*], Ivan Stančić[1], Jovan Spasojević[1], Ivan Butković[2],

Vuk Vračar[1], Zorana Kovačević[1]

[1]University of Novi Sad, Faculty of Agriculture, Department for Veterinary Medicine, Novi Sad, Serbia

[2]University of Zagreb, Faculty of Veterinary Medicine, Clinic for Reproduction and Obstetrics, Zagreb, Croatia

**ivan.galic@polj.uns.ac.rs*

Reproductive phenomena are closely linked to the functioning of the reproductive system. All reproductive processes are important for understanding its functioning, its response to various external factors, with the aim of producing healthy offspring. Reproductive physiological phenomena can be studied in both human and veterinary medicine. One phenomenon that occurs in dogs and cats is superfecundation. Superfecundation occurs when two or more eggs are fertilized by different males during the same estrus cycle (multiple fertilization). Females that have multiple eggs and often have larger litters (dogs and cats) can have litters with different males. This means that the offspring of the same mother can have different biological fathers, but each individual puppy or kitten has only one father. The reasons for this vary from species to species, but it is usually the result of the female's ability to mate with multiple males during the fertile period. In contrast to superfecundation, this phenomenon is called superfetation when the eggs are fertilized in different periods of the estrus cycle. This phenomenon occurs when an already pregnant animal manifests estrus, and the mating in this estrus is fertile. Superfetation or superfetation-like pregnancies have been observed in numerous animal species, including humans, livestock, pets and rodents. Superfetation is often inferred to occur because there are no other explanations for reproductive disorders. There are many pathological conditions (findings of differently developed foetuses) during gestation in domestic animals that are often indistinguishable from these phenomena in reproduction, so one should be very careful in making a definitive diagnosis. Since the establishment of the Veterinary Clinic (Faculty of Agriculture, University of Novi Sad, Republic of Serbia), one case of these phenomena in the reproduction of pets has been recorded. This case was published in an international journal last year.
If veterinarians and researchers know and understand the reproductive physiology phenomena, they can manage the reproduction of animals so that a timely diagnosis can be made and reproductive diseases and disorders can be treated more quickly.

Keywords: Reproduction, Puppy, Kitten

Nature-based solutions in climate adaptation as a holistic response to environmental and societal challenges in Vojvodina Province, Serbia

Jasna Grabić[1]*, Milica Vranešević[1], Srđan Šeremešić[1], Maja Meseldžija[1]

[1]Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia

**jasna.grabic@polj.uns.ac.rs*

Climate changes that have become more pronounced, especially during the past two decades have been causing changes in our environment. Although natural ecosystems have the ability to keep their homeostasis and buffer a certain range of intensity of stressors, prolonged exposition to such conditions can lead to slow but inevitable changes. Agro-ecosystems are not excluded from the impacts described. The fact that about 70% of Vojvodina's territory has been converted into arable land with the constant pressure of intensive crop production, indicates that agriculture is the most significant factor leading to environmental degradation. At the same time, protected areas are represented by remains of native vegetation distributed sparsely in patches and covering less than 7%. Another important feature is a dense hydrological network comprised mostly of canals and rivers with long embankments, where human interference is crucial in preventing undesirable flooding and waterlogging of arable land. A concept of Nature-based Solutions (NbS) offers a more harmonized and environmentally friendly approach relying on using natural goods and processes to address diverse socio-environmental issues. For this reason, NbS can also be applied to the agricultural landscape. The paper aims to investigate, in which segment of the agricultural landscape the application of NbS, within the region of Vojvodina, would be the most promising solution. To achieve the goal, literature review was conducted and statistical data analyses, to facilitate spatial analyses and mapping with GIS tools. Preliminary results indicated that organic and regenerative agriculture represents promising options for NbS application in agriculture. Areas under organic agriculture are rapidly increasing, e.g. in 2011, there were nearly 3000 ha, while in 2023 it turned to more than 9000 ha, according to the database of the Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia. The role of grazing in future should be further promoted, as a measure that is particularly favourable for managing weeds and invasive vegetation in wetland areas, especially for parts of protected areas and waterway banks. So far positive examples of grazing have already been achieved in Special Nature Reserve (SNR) Ludas Lake, SNR Obed Pond and Nature Park Bosut Forests. Currently, the application of NbS is still in its infancy in Vojvodina Province, but to achieve the goal of broader implementation, it is necessary to open a wider social debate and to intensify efforts for raising awareness towards accepting the idea of NbS implementation as many as possible stakeholders at different levels, from farmers, nature protection assets managers, NGOs, to local communities, municipalities and regional government. Therefore, to successfully implement NbS over Vojvodina's rural landscape, a holistic approach is needed for future action planning, articulated within the intersection of academia, society and economy.

Keywords: climate changes, agriculture, nature protection, stakeholders

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Effect of co-inoculation of *Bradyrhizobium* and *Trichoderma harzianum* T1 on growth and development of soybean (*Glycine max* L.): Boosting of nitrogen content in soybean by encapsulation technique

Lana Živković[1*], Sanja Kajić[2], , Boris Lazerević[3], Petra Borovec[2], Adrijana Novak[4], Botagoz Mutaliyeva[5], Marko Vinceković[1]

[1]Department of Chemistry, University of Zagreb Faculty of Agriculture, Svetošimunska cesta 25, Croatia, [2]Department of Microbiology, University of Zagreb Faculty of Agriculture, Svetošimunska cesta 25, Croatia, [3]Department od Plant Nutrition, University of Zagreb Faculty of Agriculture, Svetošimunska cesta 25, Croatia, [4]Centre for Plant Protection, Croatian Agency for Agriculture and Food, Gorice 68b, 10000 Zagreb, Croatia, [5]Biotechnology Department, M. Auezov South-Kazakhstan University, Tauke-Khan, Shymkent 160000, Kazakhstan

***** *lzivkovic@agr.hr*

Soybean (*Glycine max* L.) is a very important legume in the human diet as well as a fodder crop. Previous studies have reported how simultaneous encapsulation might improve the synergistic benefits of *Trichoderma harzianum* T1 and *Bradyrhizobium spp*., two beneficial microorganisms, promote symbiotic nitrogen fixation efficiency, increase plant nitrogen content, and reduce the occurrence of soybean diseases, thus reducing pesticide use and protecting the environment. Encapsulation techniques were used to transfer these advantageous microorganisms to soybean roots using a formulation of biodegradable microparticles. Given their established capacities to stimulate plant development, improve nutrient availability, and offer defense against soil-borne diseases, *Bradyrhizobium spp*. and *Trichoderma harzianum* T1 were thought to enhance plant nitrogen uptake. A greenhouse experiment was set up using two factors based on a completely randomized block design with three replications. The microparticles loaded with both microorganisms were applied to the seeds of the soybean cultivar Gabriela. There were six plants per pot. At the flowering stage, plants were collected and afterward nodule number, nodule dry mass, aboveground dry biomass, total N, and chlorophyll content index in each plant were measured to estimate the symbiotic efficiency of indigenous strains. Analysis of variance was performed using JMP 17Pro. Significant single effects of *T. harzianum* T1 inoculation treatments and *Bradyrhizobium* strains were found for plant nitrogen content, whereas plant DW and nodule DW were affected by a significant interaction between *T. harzianum* and *Bradyrhizobium* treatments. The highest plant DW for both T- and T+ was found for plants inoculated with S3 (B. diazoefficiens), S4 (B. ottawaense), and S5 (B. japonicum), and the lowest for S6 (B. japonicum) and S0 plants. Inoculation with *T. harzianum* T1 increased DW in S6 (B. japonicum) and S1 (B. japonicum) plants. Similarly, *T. harzianum* T1 inoculation increased nodule DW in plants treated with the S6 (B. japonicum) strain. *T. harzianum* T1 inoculation increased average plant nitrogen content (2.8%) compared to non-inoculated plants (2.6%). On average, the highest N content was found in plants inoculated with S1 B. japonicum (3.5%), followed by S2 B. japonicum (3.31%) and S3 B. diazoefficiens (3.28%). In contrast, the lowest N content was found in S6 B. japonicum (1.31%) and S0 (1.41%). According to this study, encapsulating synergistic microbial consortia in microparticles presents a viable method for enhancing nitrogen fixation, lowering fertilizer consumption, and promoting sustainable soybean production.

Keywords: co-inoculation, soybean, *Bradyrhizobium*, *Trichoderma*, encapsulation

Antimicrobial stewardship in veterinary medicine: Collaborative initiatives from international guidelines to cost-benefit analysis in practice

Zorana Kovačević[1]*, Dragana Tomanić[2], Miodrag Radinović[1], Zoran Ružić[1], Jovan Stanojević[1], Katarina Pajić[1], Ivan Galić[1]

[1] University of Novi Sad, Faculty of Agriculture, Department of Veterinary Medicine, Trg Dositeja Obradovića 8, Novi Sad 21000, Republic of Serbia, [2] University of Novi Sad, Institute of Food Technology, Bulevar Cara Lazara 1, Novi Sad 21000, Serbia

**zorana.kovacevic@polj.edu.rs*

Antimicrobial resistance (AMR) is a global health threat affecting both humans and animals, largely driven by the inappropriate antimicrobial use (AMU) in human and veterinary medicine. The concept of antimicrobial stewardship (AMS) encompasses the diverse and dynamic strategies required to maintain the clinical effectiveness of antimicrobials. These strategies focus on optimizing drug selection, dosage, duration and route of administration while minimizing resistance development and other adverse effects. AMS promotes responsible AMU at individual, national and global levels, bridging human, animal and environmental health. AMR is a serious economic challenge. According to World Bank estimates, by 2050, AMR could result in a 3.8% reduction in global GDP, with the potential to push 28 million people into extreme poverty while in agriculture it could lead to a reduction in livestock production by up to 7.5%. These projections underline the urgency of integrating AMS programs to reduce the economic burden while safeguarding both animal and human health. This paper reviews collaborative AMS initiatives, emphasizing the role of international guidelines in shaping responsible AMU, development of antimicrobial alternatives and education of all healthcare professionals on AMS. Beginning with key recommendations from organizations such as the World Health Organization (WHO), the World Organization for Animal Health (OIE), and the Food and Agriculture Organization of the United Nations (FAO), the translation of these guidelines into national policies and practical frameworks for veterinarians and producers was explored. Also, the implementation of AMS practices through collaborative projects was assessed. A significant focus is placed on the application of cost-benefit analysis to evaluate the economic viability of these interventions. By examining data from case studies, it was demonstrated how responsible AMU not only mitigates the risk of AMR but also leads to improved animal health outcomes and economic savings. European project, the COST Action ENOVAT (the European Network for Optimization of Veterinary Antimicrobial Treatment, CA18217) summarized existing and developed new AMU guidelines to help veterinarians optimize AMU and improve animal care as a good example. In line with such European initiatives, the Department of Veterinary Medicine is conducting scientific projects, including collaborations with innovative companies, where alternatives to antibiotics could be tested and developed within the framework of AMS. Moreover, these efforts include organizing scientific and professional conferences, targeting not only scientists and veterinary practitioners but also doctors and pharmacists through the One Health concept. This comprehensive analysis highlights the importance of multidisciplinary collaboration in achieving sustainable AMS in veterinary practice to combat AMR.

Keywords: antimicrobial resistance, antimicrobial use, FAO, WHO, World Bank

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Exploring endangered plant species in Montenegro using the 'rredlist' package

Milena Lakićević[1*], Milan Gazdić[2], Sandra Bijelić[1]

[1]University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia

[2]Environmental Protection Agency of Montenegro, IV Proleterske 19, 81000 Podgorica, Montenegro

**milena.lakicevic@polj.edu.rs*

The R programming language is a powerful tool commonly used in agriculture and environmental protection. It offers numerous packages that simplify coding and data analysis. One such package, 'rredlist', was utilized in this research to support environmental data processing and species conservation efforts. Namely, the paper investigates vascular plant species in Montenegro using the latest version of the 'rredlist' package, classifying them according to the IUCN Red List categories. The categories Least Concern (LC), Data Deficient (DD), and Not Evaluated (NE) were excluded from this research. The results indicate that none of the species are classified as Extinct (EX) or Extinct in the Wild (EW). Instead, the analyzed plant species fall into the Endangered (EN), Vulnerable (VU), and Near Threatened (NT) categories. Among woody plants, the Common Ash (*Fraxinus excelsior* L.) is Near Threatened, with a declining population, likely due to habitat loss and disease. The Balkan Pine (*Pinus peuce* Griseb.), a high-altitude conifer endemic to the Balkan Peninsula and a tertiary relict, has an uncertain population status and is also listed as Near Threatened. Among herbaceous plants, the Bladderwort (*Aldrovanda vesiculosa* L.), an aquatic carnivorous plant, is classified as Endangered with a declining population. Additionally, Queen Olga's Snowdrop (*Galanthus reginae-olgae* Janka) is Vulnerable, though its population trend remains unknown. The Common Snowdrop (*Galanthus nivalis* L.), Dalmatian Scilla (*Scilla litardierei* L.), the Balkan Yam (*Dioscorea balcanica* K. Kochand), and the Carpathian Glossy Pink (*Dianthus nitidus* Wulfen) are Near Threatened and experiencing population decline. These findings underscore the urgent need for conservation efforts to address the decline of these vascular plant species and protect Montenegro's rich biodiversity. In this regard, the 'rredlist' package proves to be a valuable tool for assessing and monitoring species conservation status.

Keywords: R programming language, IUCN, Red list, vascular plants

The challenges of using drones to estimate red deer (*Cervus elaphus*) population density in Serbia

Miroslav Urošević[1*], Jovan Mirceta[2], Samantha Wisely[3], Dejan Beukovic[1]

[1]University of Novi Sad, Faculty of Agriculture, Dep. of Animal Science Novi Sad, Trg Dositeja Obradovica 8; Novi Sad, Serbia, [2]PE Vojvodinasume, Preradovićeva 2, Petrovaradin-Novi Sad, Serbia, [3]University of Florida – Cervidae Health Research Initiative, 110 Newins-Ziegler Hall, Gainesville, FL, USA

**miroslav.urosevic@stocarstvo.edu.rs*

Population and species monitoring are important elements in the management and conservation of wild game animals. Estimating population density is also a critical component to managing species with disease threats. Estimation methods use data from ground-based transect surveys, faecal density counts, and images from camera traps. Ground-based transects are time consuming and may be biased by low detectability, especially for game species that may avoid people, are active at night and have visual camouflage. For example, it is known that red deer are more easily detectable compared to roe deer because they are larger-bodied and feed in open pastures. Although there is not much research on the use of UAV (Unmanned Aerial Vehicles, i.e. drones) to monitor cervid populations, most of these results suggest that these aircrafts have the potential to increase the reliability of the data used to estimate population density. Nonetheless, there are challenges to consider such as legal restrictions, weather conditions, and seasonal differences in detectability. Because there is generally a lack of available data about red deer (Cervus elaphus) counting methods in Serbia, this was the motivation to conduct a short analysis about possible use of UAV in the estimation of red deer population density in Serbia. In this work we investigated the major future challenges of red deer population estimation on 17 hunting grounds comprising 108,988.00 ha managed and owned by in Public Enterprise (PE) Vojvodinasume. The total area of enclosed hunting grounds is 25,552.00 ha or 23.50% of the total area under hunting grounds. Red deer habitats in the area managed by the PE Vojvodinasume are mainly the flat forest land, along the rivers Sava and Danube but also encompass mountains from the sea level to 600m. These habitats present challenges to both ground-based and UAV-based data collection methods as follows: lacking of previous scientific reports about the use of UAVs for red deer estimation in South East Europe generally, do we have experienced people (staff) in using of UAVs in wild range nature or we need to find them abroad, how to harmonise current methods of hunting managers with new technologies incl. reliable comparison of two or three different counting techniques. Therefore, we should simultaneously work on basic and continuing education about the use of UAVs to all stakeholders in hunting, which would be solved by writing some kind of guide book user friendly instructions. All these activities require time, persistence and of course the unity of all stakeholders, which currently is not easy to manage. It should be kept in mind the different geographical areas in the territory of Serbia: the plains, the banks of the Danube River, mountains from 500 to 2000 m above sea level, as well as the borders of several countries around without natural obstacles. We can conclude that UAV-based thermal imaging surveys can offer a non-invasive but potentially very accurate and precise surveying approach to estimate red deer population numbers, sex ratios and possibly breeding success in Serbia. Our preliminary estimation has shown that deer counting in 17 hunting grounds under optimal conditions could reduce personnel engagement costs (man-hour) by more than 80% in comparison with ground-based transects. The accurate counts of stags should include flights in early summer, corresponding to when vegetation growth is still reduced and antler growth is developed. We will not carry

out surveys in mid or late summer when canopy cover and vegetation would be at their densest because we have an a priori assumption that both the availability and perceptibility of deer to the drones would be lower due to full or partial concealment by the tree canopy, and so resources will be focused on testing seasonal effects outside of this period. Some flights have to be aborted mid-flight due to precipitation (rain and snow) which impairs lift and risks the drone stalling. Flights cannot be conducted when fog is present in the areas to be observed. Continuing education about the use of UAVs to all stakeholders in hunting could include drafting a guide for the estimation of red deer population density with detailed instructions. To address staff training gaps, we propose establishment of a certificate training program for "UAV" operators in close collaboration with The Hunting chamber of Serbia in Belgrade which is the only authority for issuing licenses in hunting generally.

Keywords: Wildlife ungulates, counting gaps, hunting, nature

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Spatial risk assessment of land salinization in the Bačka Region using GIS and PAPRIKA method

Boško Blagojević[1*], Radoš Zemunac[1], Nikola Santrač[1], Sanja Antić[1], Amela Greksa[1], Milica Stajić[1]

[1]Faculty of Agriculture, University of Novi Sad, Serbia

**bosko.blagojevic@polj.edu.rs*

This paper presents methodology for defining spatial risk of land salinization in the Bačka Region (Serbia). While previous studies have predominantly focused either on expert-based assessments or GIS-based spatial analyses, there remains a lack of integrated approaches that combine these two approaches. This study specifically addresses that gap by proposing a framework that incorporates expert-derived weights of criteria within a spatial decision-making context, thereby aiming to enhance both the robustness and applicability of the analysis. Based on previous works and the available data, the group of agricultural experts identified criteria that play an important role in land evaluation for salinization risk. The selected criteria are not sufficient on their own, because policy-makers need spatial information on where the most vulnerable land is located. This is analyzed by using a combination of the geographic information system (GIS) and PAPRIKA (Potentially All Pairwise RanKings of all possible Alternatives*)* method – a sub-discipline of Conjoint analysis, which is a survey-based statistical technique used in market research that helps determine how people value different attributes (or criteria) that make up an individual product or service. The objective of conjoint analysis is to determine the influence or weights of a set of attributes on respondent choice or decision making. The PAPRIKA method is a decision-support approach that requires the decision-maker to respond to a series of comparative assessments between two hypothetical alternatives, each defined by two criteria or attributes at a time. In each comparison, the criteria levels are structured to establish a trade-off, enabling the systematic elicitation of preferences. PAPRIKA is recognized as a form of adaptive conjoint analysis and adaptive choice-based conjoint analysis**,** as it dynamically adjusts the sequence of trade-off questions based on the respondent's previous answers. The primary objective of PAPRIKA is to minimize the number of required comparisons while ensuring that all pairwise rankings of hypothetical alternatives, each defined on two criteria, are systematically established. This adaptive approach enhances efficiency and consistency in preference elicitation, making it a robust tool defining weights of criteria**.** In this study, GIS is utilized to represent all criteria as spatial layers, while PAPRIKA is applied to determine the relative importance (weights) of each criterion. Since criteria are of heterogeneous types (qualitative and/or quantitative), different forms (continuous or discrete), and different domains of measurement, it is crucial to standardize all criteria layers by bringing them into a common domain of measurement. Therefore, different ratings (values) were assigned to each cell on a scale from 0 (low risk) to 1 (very high risk) according to experts' judgments. Also, all layers need to be identically geo-referenced and with the same pixel resolution, which enables GIS overlay analysis. Then, the cell values in each of the criteria layers are multiplied by the corresponding weights of the criteria and summarize weighted cell values using raster calculator in GIS software. In this way, the final land salinization risk map is generated and can be used by policy makers for comprehensive risk assessment.

Keywords: land salinization, PAPRIKA method, geographic information system (GIS)

Efficacy of *Trichogramma brassicae* for control of European corn borer applied via unmanned aerial vehicle

Tamara Popović [1], Mihaela Kavran [2], Anja Đurić [3], Filip Franeta [3], Kristina Petrović [4], Aleksandar Ivezić [1]

[1]BioSense Institute, University of Novi Sad, Dr Zorana Đinđića, 21000 Novi Sad, Serbia, [2]Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, 21102 Novi Sad, Serbia, [3]Institute of Field and Vegetable Crops, Maksima Gorkog 30, 21000 Novi Sad, Serbia, [4]Maize Research Institute "Zemun Polje", Slobodana Bajića 1, 11185 Belgrade, Serbia

**tamara.popovic@biosense.rs*

Maize is one of the most important arable crops in Serbia, accounting for one-third of the country's total production area. Among insect pests in corn, the most significant in Serbia is the European corn borer, *Ostrinia nubilalis* Hübner, 1796 (Lepidoptera: Crambidae). As an eco-friendly and sustainable alternative to chemical insecticides, the biological control of *O. nubilalis* using the parasitoid wasp *Trichogramma brassicae* Bezdenko (Hymenoptera: Trichogrammatidae) has emerged as a promising solution. Numerous studies have demonstrated the high efficacy of *T. brassicae*, highlighting its potential in controlling *O. nubilalis*. However, the application of parasitoid wasps in field conditions, particularly in large-scale maize production, remains challenging. Manual application of *Trichogramma* wasps is highly labor-intensive, time-consuming, and cost-prohibitive for large-scale maize fields. Therefore, implementing new technologies represents a viable solution to this issue. This study investigates the use of commercially available unmanned aerial vehicles (UAVs) equipped with an adapted doser for the application of capsules containing *Trichogramma* wasps. The primary objective of this study was to evaluate the suitability of UAVs for the application of capsules containing *T. brassicae* and to assess the efficacy of the treatment. Pupae of *Trichogramma* wasps inside host eggs were packed into capsules, each containing approximately 2,000 adults. The capsules, imported from France, were produced by Bioline Agrosciences. The experiment was conducted on two maize hybrids, NS6000 and NS640, with each experimental plot covering an area of 1 ha, and with a control of approximately 0,1 ha where capsules were not applied. A total of 125 capsules were applied per treated plot, ensuring precise distribution of parasitic wasps across the field. The experiment was conducted in the year 2024. in the experimental field of the Institute of Field and Vegetable Crops at Rimski Šančevi in Novi Sad, Serbia. The application was carried out on 25th July, targeting the second generation of *O. nubilalis.* Treatment was performed according to Integrated Pest Management (IPM) principles when 10% of plants were infected with *O. nubilalis* egg clusters. The effectiveness of *Trichogramma* was assessed based on a number of parasitised egg clusters. Assessment of egg parasitism was performed five days after application of parasitoid wasps. For every hybrid, 100 plants were inspected, and all egg clusters were counted and collected. Egg clusters were assessed daily for color change, as an indicator of parasitism. The percentage of parasitized egg clusters after treatment in both maize hybrids was 86% and 96%, respectively. These results demonstrate higher effectiveness compared to the control plots, where the percentage of parasitized eggs was 0% and 18%, respectively. The results of this trial indicate that the use of UAVs for applying *T. brassicae* capsules is highly effective. The findings suggest that new agricultural technologies, such as UAVs, are highly efficient and represent a promising tool for integrating biological control into pest management strategies.

Keywords: biological control, *Ostrinia nubilalis*, maize, *Trichogramma*, unmanned aerial vehicle

Chemical composition and antimicrobial potential of *Mentha* × *piperita* L. and *Origanum vulgare* L. essential oils against bovine mastitis pathogens

Dragana Tomanić[1], Ljubiša Šarić[1], Ivana Čabarkapa[1], Olja Todorić[1], Miodrag Radinović[2], Jovan Stanojević[2], Zorana Kovačević[2]*

[1]Institute of Food Technology, University of Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia, [2]Department of Veterinary Medicine, Faculty of Agriculture, University of Novi Sad, 21000 Novi Sad, Serbia

**zorana.kovacević@polj.edu.rs*

Bovine mastitis is a widespread disease in dairy herds, affecting 15-20% of dairy cows annually, with significant impacts on both animal health and welfare. Due to the diverse range of pathogens involved, antibiotics are the standard treatment, accounting for nearly 60% of all antimicrobials used in bovine veterinary care. However, excessive antimicrobial use contributes to resistance, raises concerns over milk residues, and increases treatment costs and mortality rates, posing risks to both human and animal health. These challenges have driven research into alternative, sustainable solutions like plant-derived compounds to manage mastitis. Our research aimed to evaluate the potential of selected essential oils (EOs) as alternative therapies, based on their antibacterial properties and chemical composition. The EOs of peppermint (*Mentha x piperita* L., Lamiaceae) and oregano (*Origanum vulgare* L., Lamiaceae) evaluated in the present study were purchased from a certified manufacturer in Serbia. The pathogens were isolated from milk samples of Holstein-Friesian dairy cows diagnosed with clinical and subclinical form of mastitis. The chemical profiles of the EOs were analyzed using an HP-5MS capillary column (30 m × 0.25 mm; film thickness, 0.25 μm) on an Agilent 6890B GC-FID instrument coupled with an Agilent 5977 MSD, while the microdilution method was employed to assess their antibacterial activity, determining minimal inhibitory concentrations (MICs) and minimal bactericidal concentrations (MBCs). Of the 30 milk samples, 25 isolates (83.33%) were obtained, with *Staphylococcus* spp. being the most prevalent (33.33%), followed by *Escherichia coli* (16.66%) and *Streptococcus* spp. (20%). Besides, coagulase-negative *Staphylococcus* spp. was found in 6.66% of samples, while β-haemolytic *Streptococcus* spp. and *Klebsiella oxytoca* were each present in one sample (3.33%). In the oregano EO, a total of 25 compounds were detected, with aromatic oxygenated monoterpenes as the predominant class, and carvacrol being the major component (80.35%). In contrast, the peppermint EO consisted of 38 compounds, with menthol as the most abundant (37.69%), followed by menthone (9.76%), isomenthone (23.84%), and menthofuran (9.23%), all belonging to oxygenated monoterpenes group. Oregano EO showed stronger antibacterial activity than peppermint EO, with lower MIC (0.39–6.25 mg/mL) and MBC (0.78–12.5 mg/mL) values for most pathogens. In contrast, peppermint EO had much higher MICs and MBCs, especially for *E. coli* and coagulase-negative *Staphylococcus* spp. (>100 mg/mL). In conclusion, oregano EO demonstrates superior antibacterial activity compared to peppermint EO, making it a more effective non-antibiotic option for managing mastitis-associated pathogens and possible ingredient of EOs based pharmaceutical formulation.

Keywords: bovine mastitis, essential oils, oregano, peppermint

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Comparative assessment of largemouth bass and gibel carp as biomarkers of heavy metal accumulation

Marko Damjanović[1*], Darko Guljaš[1], Miroslava Polovinski-Horvatović[1], Borislav Iličić[1], Saša Krstović[1], Marko Vukadinović[1], Kristijan Cokoski[2], Dejan Beuković[1]

[1]Faculty of Agriculture, University of Novi Sad – 21000 Novi Sad, Trg Dositeja Obradovića, 8, Serbia, [2]Hans Em Faculty of Forest Sciences, Landscape Architecture and Environmental Engineering, Ss. Cyril and Methodius University in Skopje - 1000 Skopje, 16 Makedonska brigade, 1, Republic of North Macedonia
**marko.damjanovic@stocarstvo.edu.rs*

The Nature Park Begečka jama, a branch of the Danube River, represents a significant natural asset, serving as a habitat and breeding ground for various fish species, and other aquatic and terrestrial organisms. It is located in an environment of intensive agriculture, where there is a potential issue of watercourse pollution with heavy metals originating from phosphate fertilizers and pesticides. Since heavy metals are major water pollutants that accumulate in sediments, water, and the aquatic food chain, their presence in this ecosystem could pose a serious threat to aquatic organisms and, consequently, to human health. Since no data are available on metal contamination levels in fish on this location, the aim was to investigate the occurrence of two metals (cadmium (Cd) and lead (Pb)) measured in two organs (gills and liver) from two fish species that illustrate different ecological niches: largemouth bass (*Micropterus salmoides*) and gibel carp (*Carassius gibelio*). The selection of these species was based on differences in feeding and behavior during winter. Gibel carp, an omnivore, burrows into sediment during winter, increasing exposure to pollutants, while carnivorous largemouth bass slows its metabolism and retreats to deeper, warmer waters with minimal feeding activity. A total of 22 fish were analyzed, with 11 individuals from each species. Since two organs were examined per fish, this resulted in a total of 44 samples, which were analyzed by graphite furnace atomic absorption spectrometry. The concentration of Pb in the liver of largemouth bass was below the LOQ in 81.81% of samples, with only two positive detections (45.8 and 78.03 µg/kg) while in gibel carp, it ranged from 47.38 to 669.1 µg/kg (100% detected), with a median level of 263.1 µg/kg. In the gills, Pb concentration in largemouth bass varied from 15.39 to 3640 µg/kg (63.64% was below LOQ), whereas in gibel carp, it ranged from 211.8 to 612.6 µg/kg (100% detected), with a median level of 398.5 µg/kg. There was no significant difference in Pb levels between the organs of gibel carp ($p>0.05$). Regarding Cd, its concentration in the liver of largemouth bass ranged from 23.74 to 43.14 µg/kg, with a median level of 28.18 µg/kg and 54.55% of samples below LOQ, while in gibel carp, it ranged from 15.82 to 401.7 µg/kg, with a median level of 96.99 µg/kg and 36.36% of samples below LOQ. In the gills, Cd was detected only in largemouth bass, with a concentration of 56.77 µg/kg, whereas all gibel carp samples had Cd levels below LOQ. The results show that Pb accumulation was proportionally higher in gibel carp compared to largemouth bass, suggesting that gibel carp may serve as a more reliable biomarker for Pb contamination. On the other hand, findings indicate that the liver is a better biomarker for chronic cadmium exposure, since Cd showed a different distribution, with a higher detection frequency in the liver of both species. The observed metal concentrations are in agreement with previous analyses of water and sediment from the studied locations, which showed that Cd and Pb levels in water were below the LOQ, while in sediment, Pb ranged from 0.47 to 30.5 µg/kg and Cd was either below the LOQ or detected up to 0.37 µg/kg.

Keywords: cadmium, fish, GFAAS, lead, Serbia
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Influence of low temperatures on physiological indices in rabbits

Ion Balan[1]*, Mihail Moroz[1], Dmitrii Matencu[1], Elena Ceban[1], Valeriu Cociu[1], Nicolae Starciuc[1], Eugen Voinitchi[1], Viorica Gurdis[1]
Technical University of Moldova, Chisinau, Republic of Moldova
**balanion@rambler.ru*

Heat stress is a factor that affects the welfare of all animals, especially rabbits. The current study investigated the effect of low temperature on physiological indicators in rabbits under certain maintenance conditions.

The research carried out on New Zealand rabbits included 15 males, divided into three batches, 5 rabbits for each experimental series, each animal kept in individual cages. Prior to the experiments, the pre-experimental period of training and adapting the animals to new maintenance conditions took place within 30 days. Subsequently, experimental periods I and II followed, within 30 days each. Low maintenance temperatures of 0-3 ^{o}C and +6-8 ^{o}C were applied to the animals from experimental batches I and II (LE-I, LE-II). The animals from the control batch (LM) were maintained in thermal conditions of 16-18 ^{o}C. Throughout the experimental period, the animals were monitored by daily clinical examination, morning and evening, with evidence of heart and respiratory rate.

The temperature action of 0-3 ^{o}C increased heart rate in both experimental groups up to 258.8±3.95 and 252.6±2.87 contr/min, corresponding for LE-I and LE-II compared to 217.3±4.07 contr/min in LM ($p<0.05$). Exposure to low temperatures was perceived as a stressor, and the response to stress was an increase in heart rate, i.e. it triggered a reaction of adaptation of the body to hypothermic conditions of the environment. At the same time at low temperatures, there is also the mechanism of vasoconstriction of peripheral blood vessels that can influence the heart rate to maintain blood pressure. The influence of the temperature of +6-8 ^{o}C, conversely, decreased the heart rate of the animals in the corresponding LE-I and II, up to 144.5±3.02 and 183.4±2.88 contr/min, compared to the LM which recorded a frequency of 208.2±3.47 contr/min ($p<0.05$). This possible process was caused by a lower metabolic rate that caused a decrease in the oxygen requirement of the tissues and, respectively, a reduction in heart rate.

The frequency of breathing at the action of low temperatures evolves, practically, according to the same principles as the heart rate, but with some exceptions. At 0-3 ^{o}C only in LE-I the frequency of respiration increased (54.8±2.54 resp/min) compared to LM (48.2±1.91 resp/min) ($p<0.05$). At temperature +6-8 ^{o}C the frequency of respiration also decreased only in LE-I up to 38.9±2.35 resp/min compared to LM – 46.4±1.83 resp/min ($p<0.05$). Variations in increasing and decreasing the frequency of respiration, in general, represent the body's response reaction by increasing energy metabolism and, correspondingly, by decreasing oxygen levels under the influence of low temperatures.

Therefore, the application of low temperatures (0-3 ^{o}C and +6-8 ^{o}C) on the experimental herd of rabbits leads to an increase and decrease in the values of the studied indices. Low temperatures as stressors influence the heart rate and breathing rate in rabbits through physiological reactions of adaptation to new maintenance conditions while maintaining homeostasis and animal health.

Keywords: rabbit, thermoregulation, heart rate, respiration.

Impact of *Aspergillus awamori* strain on distillery byproducts polyphenols and antioxidant activity amount

Gina-Maria Cucuiet[1], Adrian Gheorghe Martău[1,2], Dan Cristian Vodnar[1,2], Floricuța Ranga[1], Adriana Păucean[1], Răzvan Odocheanu[1], Maria-Simona Chiș[1]*

[1]Faculty of Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania

[2]Institute of Life Science, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania

**simona.chis@usamvcluj.ro*

The aim of the present study was to increase the bioactive potential of Food Industry Byproducts, plum and sour cherry pomace, through fermentation with *Aspergillus awamori (A. awamori).*

The fermentation process was carried out for 15 days, with samples withdrawn at t0, t3, t6, t9, t12, and t15 (t0 represents the time immediately after inoculation, while t3, t6, t9, t12, and t15 represent the number of days post-inoculation). Before fermentation, samples were grounded to powder and coded as follows: PPP - plum pomace powder and SCPP - sour cherry pomace powder. The fermentation process was initiated by mixing culture of *A. awamori* (as spore suspension) with plum and sour cherry pomace. Total polyphenols (TPC) were determined by Folin-Ciocalteu method, while HPLC-DAD-ESI-MS system with an Agilent 1200 HPLC equipment, DAD detector, a quaternary pomp, autosampler, and coupled to an MS-detector single-quadrupole Agilent 6110 (Agilent-Technologies) was used to identify individual polyphenols amount. A column (Kinetex XB C18, 4.5x150 mm) was used for compounds separation and spectral values were recorded in the range 200-600 nm for all peaks. Antioxidant activity was determined by two methods: DPPH and ABTS. The results obtained from samples were compared with the control sample, represented by the same type of pomace, conventionally fermented without the addition of *A. awamori* (C-control sample).

With respect to the TPC content for PPP, an increase of 1.43 mg GAE/g dw was recorded up to t15, while a higher increase of 1.89 mg GAE/g dw was observed for SCPP compared to C.

As for the level of individual polyphenols content in PPP, the following classes of compounds were identified: hydroxybenzoic acids (with the highest concentration recorded for 3-hydroxybenzoic acid, at 2.07 mg/g dw at time point t12), hydroxycinnamic acids (with the maximum level observed for criptochlorogenic acid, 5.15 mg/g dw at t15), and flavonols (with the highest concentration detected for catechin, 0.66 mg/g dw under condition C). In terms of individual polyphenol content in SCPP, the following classes of compounds were identified: hydroxybenzoic acids (with the highest concentration recorded for 4-hydroxybenzoic acid, 1.47 mg/g dw at time point t12); hydroxycinnamic acids (with the highest concentration recorded for criptochlorogenic acid, 7.76 mg/g dw at t12); flavonols (with the maximum value recorded for procyanidin dimer B1, 1.07 mg/g dw under condition C); and anthocyanins (with the highest concentration recorded for pelargonidin-(malonyl-glucoside), 0.15 mg/g dw under condition C).

With respect to DPPH, an increase in antioxidant activity was observed after 15 days of fermentation, with a rise of 2.95 μM TE/g dw for PPP and 20.38 μM TE/g dw for SCPP, compared to C.

Similarly, ABTS analysis showed an increase of 23 μM TE/g dw for PPP and 21.35 μM TE/g dw for SCPP.

Fermentation with *A. awamori* produced significant modifications in the polyphenol content and antioxidant activity of the analyzed byproducts. A greater increase in these parameters was observed, particularly in SCPP samples, highlighting its high potential for application in the food industry as a functional ingredient. These findings support the feasibility of utilizing fermentation as a strategy to enhance the bioactive value of food industry byproducts, thereby contributing to waste reduction and the development of value-added products.

Keywords: *Aspergillus awamori*, antioxidant activity, polyphenols

Challenges in research and education in agriculture and life sciences

Branko Ćupina[1*], Mila Grahovac[1], Mirjana Đukić Stojčić[1], Ivan Pavkov[1], Dragan Milić[1], Nenad Magazin[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

**branko.cupina@polj.uns.ac.rs*

Current situation, trends and challenges, ambitions and measures in research and education in agriculture and life sciences are taken into consideration. As the world has changed during the past 50 years, agricultural research continues to confront new challenges, from food security and ecological concerns to land use issues. Research and education have to be developed in a direction that makes agricultural research more responsive to changing societal demands. Global, regional and local socio-economic environments support a comprehensive approach in the research and development of courses designed to provide students with knowledge in environmentally friendly agricultural production which should be socially acceptable and economically feasible. The multidisciplinary nature of agriculture and life sciences requires broad knowledge of natural, social and applied sciences. As world population and food production demands rise, keeping soil healthy and productive is of paramount importance task in agriculture. By using soil health principles and systems that include different cropping systems such as diverse rotations, no-till, cover cropping, farmers are increasing soil's organic matter, diversity of soil organisms, reduce soil compaction and improve nutrient storage and cycling. In addition, fully functioning, healthy soils absorb and retain more water, making them less susceptible to runoff and erosion. A new approach in agriculture considers the soil, air, water, plants, animals and humans as interconnected pieces of one whole system and aims to improve, that whole system. Agriculture is very sensitive to weather and climate because it relies heavily on land, water, and other natural resources that climate affects. Thus new approach is needed in order to adapt to a changing climate. On the other hand, the agriculture sector also emits greenhouse gases into the atmosphere that contribute to climate change. Due to increasing global urbanisation, materials and waste are shifting in a large scale and the quality of the ecosystem (soil and water) is under pressure. The flow of nutrients, residue and waste is becoming concentrated in populated urban areas while elsewhere soil is becoming depleted. The application of digital technologies in agriculture can increase farm performance by enhancing sustainability, productivity and resilience. Agricultural data, especially if widely available to many farms, is economically important not only for farmers, but also for the entire value chain, e.g. for market forecast, product development, and insurance. Research in agriculture and life sciences should take place through various disciplines that are combined in different research groups. In both, research and education, there is a need to work together with power and leading partners worldwide and the aim is to be recognised locally, nationally and internationally as a wide-ranging, multidisciplinary institution that delivers inventive and outstanding research. There is a need to innovate educational concept and provide high-quality, effective and research-based education to a large number of students with emphasises on small-scale approach.

Keywords: research based education, agriculture, life science, ecology

Reaction of sugar beet genotypes to *Macrophomina phaseolina*

Dobrila Radić[1], Milica Meseldžija[1], Teodora Mihaljfi[1], Jozef Gašparovski[1], Mladen Petreš[1], Dragana Budakov[1], Vera Stojšin[1]

[1]Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia

**dobrila.kovacevic@polj.edu.rs*

Macrophomina phaseolina causes charcoal root rot of sugar beet. Since inoculum is present in our soil, damage can occur every year, especially during extremely warm and dry season. Soil-borne diseases are difficult to manage and there is no universal solution for their prevention. However, one of the most effective disease management strategies could be selection of tolerant or resistant genotypes. Since development of resistant genotypes is time consuming and difficult to combine with desired commercial traits, testing of sugar beet commercial varieties as well as parental lines could give more information on their response to the infection with *M. phaseolina*. The objective of this study was to assess the reaction of 28 sugar beet genotypes in *in vitro* trials. In the line with the aim which was to identify differences in the susceptibility of tested genotypes, it is expected that differences in disease intensity will allow preliminary selection of genotypes for resistance to sugar beet charcoal root rot.

The inoculum was prepared by inoculating sterile, autoclaved sorghum seeds with *M. phaseolina* isolate ŠR5/12 from Ečka, Serbia. Sugar beet plants of the 28 genotypes, in 3-4 leaf stage, were replanted into labelled pots containing a mixture of sterile sand and inoculated sorghum seeds (3:1 v:v). Plants were incubated in a humid growth chamber at 28°C and disease symptom development was monitored daily. The experiment was terminated once intense disease symptoms, including wilting and decay of leaf tissue, were observed on the most susceptible genotype on more than 50% of plants. All plants were removed from the substrate, and their roots were carefully washed to assess the development of symptoms on the hypocotyl and root using the scale (0 - healthy root, 1 - up to 25% necrosis of the hypocotyl and root, 2 - up to 25-50% necrosis of the hypocotyl and root, 3 - up to 50-70% necrosis of the hypocotyl and root, 4 - more than 75% necrosis of the hypocotyl and root).

Analysis of variance showed that the genotype had a significant effect on the intensity of charcoal root rot in sugar beet, since significant differences in disease intensity were observed among the tested genotypes. Disease ratings ranged from 0.5 for the most resistant genotype, to 2.75 for the most susceptible ones. This research shows the potential to improve the protection of sugar beet from charcoal root rot, indicating the importance of genotype selection in sugar beet production.

Keywords: beet, charcoal root rot, *Macrophomina phaseolina*

Estimation of energy value of maize silage from Vojvodina Province using two different methods

Marko Vukosav[1], Mirko Ivković[1]*, Igor Jajić[1], Dragan Glamočić[1]

[1]Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia

**mirkomivkovic@gmail.com*

Precise estimation of the energy value of feed is crucial for proper formulation of dairy cow diets, as the energy from feed directly affects milk synthesis and overall production, which has led to the development of various methods over the years that enable its estimation. Based on data from studies conducted at the end of the 20th century, the National Research Council (NRC, 2001) model has long been used as the standard for estimating the energy value of animal feed. National Academies of Sciences, Engineering, and Medicine (NASEM, 2021) is an updated version of the National Research Council (NRC, 2001) model, developed based on more recent findings related to nutrient digestibility and utilization. In addition to the previously used contents of dry matter (DM), crude protein, crude fat, ash, neutral detergent fiber (NDF), acid detergent fiber (ADF), and lignin, this method also includes starch content when estimating the energy value of feed. Maize silage is one of the main sources of energy in dairy cow nutrition, providing a large part of their daily energy requirements. Therefore, accurately determining its energy value is essential for optimal diet formulation. The aim of this study was to compare the energy value of maize silage samples estimated using two different methods. To determine the energy value of the maize silage samples, laboratory analysis of the nutritional composition of 26 samples (collected from the territory of AP Vojvodina, Republic of Serbia) was performed at the Laboratory for the quality control of animal feed and animal products, at the Faculty of Agriculture, University in Novi Sad. Based on the results of the laboratory analysis, the energy values of the maize silage samples were then calculated using software developed according to the models for estimating the nutritional value of feed for dairy cows from the NRC 2001 and NASEM 2021 publications, and these values were then compared. The results showed that there is a significant difference between the average energy values of the maize silage samples, estimated using two different methods. According to the NRC (2001) method, the average energy value of maize silage was 5.94 MJ/kg DM, while according to the NASEM (2021) method, it was 6.78 MJ/kg DM, meaning that the NASEM (2021) model estimated the 0.84 MJ/kg DM higher average energy value for the maize silage. When this difference is multiplied by the average daily silage intake of 8 kg DM per cow, the total difference in the estimated energy value amounts to 6.72 MJ per day. This energy would be enough to produce 2.1 kg of milk. The results indicated a significant change in estimating the energy value of maize silage, which can have an important impact on the formulation of dairy cow diets.

Keywords: energy value, maize silage, NRC, NASEM, dairy cow nutrition

Estimation of evapotranspiration using artificial neural networks

Milica Stajić[1*], Boško Blagojević[1], Atila Bezdan[1], Sanja Antić[1], Jovana Bezdan[1], Dejan Mirčetić[2,3]

[1] University of Novi Sad, Faculty of Agriculture, Department of Water Management, Novi Sad, Serbia

[2] The Institute for Artificial Intelligence of Serbia, Novi Sad, Serbia

[3] University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia

**milica.stajic@polj.edu.rs*

The estimation of reference evapotranspiration (ET_0) is essential for effective water resource management, irrigation scheduling, and environmental monitoring. Although the FAO-56 Penman-Monteith (PM) equation is the most widely accepted method for ET_0 estimation, its application is frequently constrained by the limited availability of required meteorological variables. To overcome these limitations, machine learning models, capable of providing accurate estimates even with reduced input data, have attracted increasing attention in recent research. In this study, artificial neural networks (ANN) were used as a machine learning method for predicting ET_0, with meteorological data from the Novi Sad station in Vojvodina, Serbia, serving as input variables. The dataset contained eight key variables essential for the assessment of evapotranspiration, and the analysis determined that each of them contributes to the assessment to a different extent. In order to comprehensively evaluate their impact, ANN models specifically adapted for this task were developed. The datasets used for training and testing included various combinations of eight daily meteorological variables for the period 1950-2023, including maximum temperature (T_{max}), minimum temperature (T_{min}), mean temperature (T_{mean}), relative humidity (RH), wind speed (WS), global radiation (GR), precipitation (P), and mean sea level pressure (SLP). The performance of the developed models was evaluated using the FAO-56 PM equation as a reference method. Model accuracy was assessed using several quantitative metrics including coefficient of determination (R^2), Nash-Sutcliffe efficiency (NSE), root mean square error (RMSE), and mean absolute error (MAE). The best results were achieved when all available input variables were included in the model, which is expected given that the ANN then had access to the largest amount of information. The highest accuracy was obtained using an architecture with three hidden layers, each containing 256 neurons, with R^2, NSE, RMSE, and MAE values of 0.98, 98.01%, 0.24 mm day^{-1}, and 0.17 mm day^{-1} on the test set, respectively.

Keywords: evapotranspiration, machine learning, artificial neural networks, FAO-56 PM

Variations in plant resistance to drought are associated with plant functional group and soil substrates

Faisal Anggi Pradita[1]*, Maria Janicka[1]

[1]Agriculture Institute, Warsaw University of Life Sciences (WULS-SGGW), Warsaw, Poland

**faisal_pradita@sggw.edu.pl*

Increasing global temperature worldwide has led to a water table decrease and drought conditions in natural habitats including in Lowland Hay Meadows. The threat of biodiversity loss often appears under a lack of water availability and re-introduction of new plants for vegetation recovery requires knowledge of drought resistance for such plants. Moreover, meadows' land use type is composed of different soils affecting variation of plants' resistance against drought. This diversity of adaptive responses is crucial to be understood mainly for plant selection in re-introduction action. Therefore, this study aimed to select preferred group of species based on their resistance to drought and to assess the relationship between germination and growth under drought and control. This study consisted of 23 meadow species classified into three functional groups: forb, grass, and legume. Growing conditions were simulated into drought conditions (40-60% soil water capacity) as the main plot with control (80-100% soil water capacity). Then, the sub-plot was arranged into three types of soil subtrate: universal garden soil, mixed soil from universal garden soil (70%): sand (30%), and acid soil—germination capacity and plant height as the main parameters were analysed by Linear Mixed Models. Drought decreased germination remarkably in all groups, but using universal soil as growing media prevented germination capacity reduction due to lack of water supply. Besides, universal garden soil and mixed soil contributed more positively to plants' height than acid soil with the highest effect shown by grasses. Both findings suggest that multiple effects of drought can express species-specific adaptive mechanisms on different soil structures caused by nutrient content in soil, soil composition, and acidity. Pearson correlation revealed that higher germination capacity was in line with height with specificity control conditions having higher positive correlation than drought. Additionally, legumes showed the strongest correlation under both conditions indicating higher nutrient storage on seeds supporting seedlings' emergence. According to these findings, biodiversity under drought may be recovered by grasses, as the highest proportion of meadows with consistent adaptability. After that, forbs and legumes may help grasses to maintain stability of ecosystem resilience.

Keywords: Drought, Restoration, Lowland Hay Meadows, Adaptation, Meadow Species

Germination and seed quality traits in five crops: insights from multivariate analysis

Teodora Feher[1]*, Sofija Petrović[1], Borislav Banjac[1], Velimir Mladenov[1], Rada Šućur[1], Milana Čurčić[1]

[1]University of Novi Sad, Falcuty of Agriculture, Serbia, Novi Sad

**teodora.feher@polj.edu.rs*

As the foundation of crop production, seeds are essential in raw and processed food industries. High-quality seeds exhibit rapid and uniform germination across various conditions, ensuring stable agricultural productivity. This study examined the germination characteristics of the five common crops in Serbia (maize, wheat, soybean, oilseed rape, and sunflower). In this study, germination energy, germination percentage, protein, and oil content were examined. Using Duncan statistical tests, it was determined that the same species can belong to two distinct statistically different groups when judged on the same criterion, depending on the purpose the specific genotype was bred for. For example, confectionery grade and oil sunflower are split into two groups for oil content, as per the Duncan test, despite being the same species. The confectionary-grade sunflower was measured to have an oil percentage of 22,34%, whereas the oil-grade sunflower had an oil percentage of 41,24%.
Principal component analysis (PCA) showed that germination had the greatest impact on variation, followed by germination energy, while protein content contributed the least. Oil content was dominant in the second principal component, with different sunflower genotypes positioned distinctly in the biplot according to their usage. A positive correlation was observed between germination and germination energy, while these two vectors did not show a connection with oil content. The absence of a correlation between protein content and germination suggests that protein alone does not ensure the presence of key enzymes required for germination vigor. Further research into these interactions could enhance seed quality optimization.

Keywords: Seed quality, germination, oil content, protein content, PCA

Green manure as a sustainable solution: analysing seasonal variability of soil physical properties and yield across different agricultural practices

Luka Brezinscak[1*], Dalibor Jurina[2], Igor Bogunovic[1], Ivica Kisic[1]

[1]University of Zagreb Faculty of Agriculture, Svetosimunska 25, Zagreb, Croatia

[2]Family farm Dalibor Jurina, Veliki Zdenci, Croatia

**lbrezinscak@agr.hr*

Green manure is a time-honored agricultural practice that is gaining renewed interest due to its environmental benefits. It enriches the soil with organic matter, binds nutrients, reduces leaching and prevents erosion. Farmers select green manure crops based on their compatibility with crop rotations and specific soil and climate conditions. Often selected legumes are particularly effective in improving soil organic matter, porosity, water retention and soil C:N ratios. While many studies confirm the biochemical benefits of green manure, more research is needed on their effects on soil physical properties (e.g. soil bulk density (BD) and soil particle density (PD)) in specific production areas. A multi-year study, conducted from 2020 to 2023, aimed to assess the changes in some soil physical properties and yields under different land use practices, including fallow, green fallow (where short vegetation siderates were sown in autumn and incorporated into the soil in the spring) and crop production with and without siderates. The crops included are typical for the trial location (maize, soybean, potato). The trial was conducted on the family farm of Dalibor Jurina in Veliki Zdenci, Bjelovar-Bilogora County (Croatia), in a randomized block design with four replicates on 10 x 35 m plots. The study comprised four treatment variants: (F) fallow, (F+GM) fallow with green manure, (CC) crop cultivation and (CC+GM) crop cultivation with green manure. Sampling was carried out in two different seasons (spring and fall) in each trial year; nine undisturbed soil samples were collected per treatment (18 in total). The BD value of all treatments in autumn was significantly higher in 2021 and 2023 then other treatments in spring while also having the highest significant value on CC+GM treatment in 2021 autumn measurement compared to the other treatments in that period. In 2023, all treatments in spring had significantly lower values than the treatments in autumn. PD values were significantly lower in treatments F+GM and CC in the autumn compared to spring in 2021, while in 2023 the lowest significant PD value was measured in treatment F compared to CC+GM in autumn period. Yield was compared between treatments CC and CC+GM. There were no significant differences in the yield for the duration of the experiment. These results provide a detailed understanding of the complex relationship between land use, seasonal variation and physical soil properties and serve as a scientific basis for sound land management strategies aimed at maintaining the sustainability of crop production.

Keywords: green manure, soil bulk density, soil particle density, yield, sustainability

Circular food production in urban and peri-urban areas: catalyzing innovation and strengthening the bioeconomy

Maja Radišić [1]*, Olivera Stojilović Trivunić[2], Kristina Savić[2], Mladen Radišić[3], Dragana Novaković[1], Dragan Milić[1]

[1]Faculty of Agriculture, University of Novi Sad, Serbia, [2]Foodscale Hub, Novi Sad, Serbia, [3]Faculty of Technical Sciences, University of Novi Sad, Serbia

**maja.radisic@polj.edu.rs*

Urban and peri-urban areas in Africa are increasingly vulnerable to climate change, rapid urbanization, and resource scarcity, exacerbating food and nutrition insecurity (FNS). Current city-region food systems struggle to provide safe, affordable, and nutritious food while maintaining environmental sustainability and climate resilience. The subject of this research is the analysis of the implementation of circular technologies within the INCiTiS-FOOD project, a 4-year Horizon Europe initiative, focusing on agri-food systems such as hydroponics, aquaponics, and insect farming for fertilizer in urban and peri-urban areas of Africa. This study aims to evaluate the effectiveness of these systems in reducing reliance on land, water, and energy, while also exploring their potential in enhancing food security and promoting the sustainability of urban food systems. These concepts are validated through 8 Living Labs across 6 African regions: Kenya, Ghana, Nigeria, Sierra Leone, Cameroon, and Gabon that are fully operational testing and co-creation sites. This approach to innovation not only improves FNS but also create economic opportunities, aiming for technological (TRL-7), societal (SRL-7), and business (BRL-5) readiness. A key pillar of INCiTiS-FOOD is bridging the agro-economy and bioeconomy by strengthening the agri-value chain through financial and technical support for innovation through proven socio-economic methods. The project's financial support to third parties' mechanism, backed by a €1,000,000 Cascade Fund for equity-free funding, provides targeted funding for Local Innovation Hubs (LIHs) and Independent Innovators, fostering entrepreneurship and technological advancements in the bioeconomy sector. In the Open Call for LIHs, a total of €940,000 in funding to support eight winning LIH consortia will be allocated with each LIH aiming to engage 100 to 125+ entrepreneurs and innovators through its network, all organized into legal entities forming a consortium. These consortia typically consist of 2–3 legal entities, such as civil society organizations (including NGOs and cooperatives), secondary schools (for students aged 16+), vocational institutions, technical universities and colleges in agriculture and fisheries, and special needs schools or organizations. While applying independently, these consortia also represent the interests of their broader ecosystems, including stakeholders like start-ups and SMEs. From the first Open Call, a total of 65 applications were received, with 57 advancing past the eligibility check, representing 33 countries. The distribution of farming systems among the applicants included aquaculture (6), aquaponics (13), hydroponics (16), insect farming (17), and other systems (6).

By incentivizing circular bioeconomic models and integrating them into city-region planning—while decentralizing technological innovation from isolated projects to broader initiatives—INCiTiS-FOOD fosters inclusive growth, creates economic opportunities, and builds resilient, sustainable urban food systems in African cities. Furthermore, the project aligns with global policy frameworks, including the Milan Urban Food Policy Pact, contributing to evidence-based policy transformation. This paper, also, presents the main concepts of innovation support mechanisms within the project.

Keywords: Aquaponics, Cascade Fund, Innovation, Circularity, peri-urban and urban

Induced and residual egg sterility of the Asian Tiger Mosquito achieved by sterile insect technique

Nađa Kukić[1], Aleksandra Ignjatović Ćupina[1]*, Mihaela Kavran[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

**aleksandra.cupina@polj.edu.rs*

The Asian tiger mosquito (*Aedes albopictus* Skuse 1894) is a widespread invasive mosquito species. It is a potent vector of over 26 different arboviruses, including Chikungunya, Dengue and Zika viruses, which makes it a species of high medical and veterinary significance. Since the confirmation of *Ae. albopictus* permanently established populations (in 2017), the rapid spreading of the species has been recorded in Serbia.

Control of vector mosquitoes is the key strategy for the prevention of virus transmission. Conventional mosquito control methods do not result in satisfactory levels of effectiveness for Asian tiger mosquitoes. Successful control of the species can be achieved by introduction of the sterile insect technique (SIT) into integrated mosquito control. SIT is based on the mass rearing, sterilization, and release of sterile males into the environment to compete with wild males. After mating of released sterile males and wild females, no offspring is produced, leading to population reduction.

With the support of International Atomic Energy Agency (project RER5026), the pilot study on control of the Asian tiger mosquito control by implementation of SIT was conducted in Novi Sad in 2023. The released males were reared and sterilized in Centro Agricoltura Ambiente "Giorgio Nicoli" (Crevalcore, Italy). Sterile males were released for eight consecutive weeks at 45 selected sites within the city area of 20 ha. Over this period, approximately 800,000 male mosquitos were released. As a method of quality control for the SIT, the difference in the number of eggs laid in the treated zone, compared to the control and buffer zone was determined, along with the level of egg sterility within those zones. In 2023, the population and induced sterility of the Asian tiger mosquito in Novi Sad was monitored using oviposition traps from May to November. While in 2024, the population was monitored, using the same method, from April to June, in the sense to determine the effect of SIT on residual sterility at area treated during previous year. Eggs were collected from the oviposition traps in weekly intervals and left to dry for seven days to complete embryogenesis. Then the egg chorion was bleached in a drop of disinfectant bleach based on sodium hypochlorite and observed under magnification, to detect the presence or absence of the embryo.

In 2023, during the release period, a lower average number of eggs was recorded in the traps compared to the control and buffer zones (27.6; 54 and 33.3 eggs per trap, per sampling period, respectively). Induced sterility ranged from a minimum of -46,4%, observed when the number of fertile eggs exceeded the number of sterile eggs, to a maximum of 51.6%, with an average of 12.4%. In 2024, lower average number of eggs was registered in the treated area compared to the control and buffer zones (9.6; 16.3 and 22.8; eggs per trap, per sampling period, respectively). The residual sterility ranged from a minimum of -26.11%, to a maximum of 42.78%, with an average of 9.89%. The results of this study indicated the possibility of successful Asian tiger mosquito control by implementation of SIT in integrated mosquito control.

Keywords: *Aedes albopictus,* SIT, induced and residual sterility

Lactobacillus spp. biocontrol potential against powdery mildew on zucchini

Snežana Rajkov[1*], Simone Sello[2], Cristina Sudiro[2], Francesco Vuolo[3], Mila Grahovac[1], Dragana Budakov[1], Marta Loc[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia, [2]Landlab Srl Società Benefit, Via Quintarello 12/A, 36050 Quinto Vicentino, Italy

[3]Sacco s.r.l, Via Alessandro Manzoni 29/A, 22071, Cadorago, Italy

**snezana.rajkov@polj.edu.rs*

Powdery mildew, caused by the phytopathogenic fungi from the phylum *Ascomycota, Podosphaera xanthii* (*syn. Sphaerotheca fuliginea*) and *Golovinomyces cichoracearum* (*syn. Erysiphe cichoracearum*), represents one of the most economically significant diseases affecting zucchini (*Cucurbita pepo* L.). With the increasing production of zucchini worldwide, the need for conventional pesticides for disease control has risen. As a result, pathogens are developing resistance to chemical fungicides, leading to a reduced efficacy, and consequently leading to lower yields. To effectively control powdery mildew of zucchini, research should focus on finding alternative protection strategies, such as biofungicides. Due to their nature, this class of products should lead to slower evolution of pathogen resistance, resulting in many advantages. The objective of this study was to evaluate the effect of six selected *Lactobacillus* strains, in combination with a reduced application rate of a sulphur-based fungicide, to control powdery mildew (*Podosphaera xanthii*) on zucchini plants in open field. The reduced rate of the sulfur-based fungicide was varied by application, using 40% or 65% of the full application rate, to achieve an average 50% reduction in sulphur use across all six applications. The tested treatments included combinations of *Lactobacillus* strains with a reduced rate of the sulphur-based fungicide (600-1000 g/ha), compared with a reduced rate (600-1000 g/ha) alone and full application rate of a sulphur-based fungicide (1500 g/ha). Experimental *Lactobacillus* products were formulated as wettable powder with an application rate of 300 g/ha for all strains, except for strain 6, which was applied at 500 g/ha. Disease incidence (% of infected leaves per plant) and severity (% of infected area on leaves with disease, ranging from 1% to 100%) were assessed six times, after each treatment, in order to evaluate the effects of the different combinations during the growing season. Under the highest disease pressure, the highest disease incidence and severity were observed when using the reduced rate of sulphur-based fungicide combined with *Lactobacillus* strains 3 and 4. On the other hand, considering the incidence and severity of entries treated with strains 1, 2, 5 and 6 in combination with the reduced rate of sulfur-based fungicide, showed similar or even lower values than the full sulphur-based fungicide treatment. The best result was obtained with the reduced rate of sulphur-based fungicide (600 g/ha) combined with *Lactobacillus* strain 1 (300 g/ha), which significantly reduced both disease incidence and severity to 0.49 % and 0.05 %, respectively. Similar outcome was achieved by *Lactobacillus* strain 2 (300 g/ha) in combination with reduced rate of sulphur-based fungicide (600 g/ha). In general, all strains, except *Lactobacillus* strains 3 and 4, demonstrated significant positive effects, indicating that the application of certain *Lactobacillus* strains provides effective control of zucchini powdery mildew, in particular when applied in combination with sulphur-based fungicides.

Keywords: zucchini, *Lactobacillus,* powdery mildew, biocontrol, integrated control

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Repellent efficacy of icaridin on adult *Ixodes ricinus* ticks (Acari: Ixodidae)

Ana Lazić [1], Aleksandra Petrović [1], Dušan Marinković [1], Ivana Ivanović [1], Aleksandra Popović [1], Jovana Šućur Elez [1], Dejan Supić [2]

[1] University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia

[2] University Educons, Faculty of Ecological Agriculture, Vojvode Putnika 87, 21208 Sremska Kamenica, Serbia

**aleksandra.petrovic@polj.edu.rs*

Chemical repellents, particularly those based on synthetic and bioactive compounds, remain a primary means of tick bite prevention; however, standardized efficacy evaluations are essential. Icaridin (picaridin), a synthetic repellent structurally related to natural compounds, has demonstrated broad-spectrum efficacy against various arthropods, warranting further assessment under controlled laboratory conditions as well as in natural environments. This study was conducted under laboratory conditions to assess the repellent efficacy of a preparation containing 15% icaridin as a function of time against adult *Ixodes ricinus*, both male and female. Repellence was calculated using two types of tests, each performed in five replicates: (1) application of the preparation to filter paper in Petri dishes and (2) direct application to the skin of the examiner's forearm. The aim of this study was to compare the repellent efficacy of the preparation regarding the type of the experiment and the elapsed time, from the moment of application up to eight hours. The average repellence during the experiment in Petri dishes was 96.8% for *I. ricinus* females and 98.4% for males. During the tests conducted on the examiner's skin, the repellent efficacy was 95.11% for females and 94.11% for males. While efficacy remained high under all test conditions, further investigations should assess formulation stability, field performance, and user safety under diverse environmental exposures. Studies designed to precisely calculate repellent efficacy require continuous methodological improvements to create economically viable and widely available commercial preparations that are harmless to human health, especially to children. Furthermore, standardized and verified methodologies for repellent testing should be continuously refined to improve reliability, facilitate regulatory approvals, and ensure optimal protection against ticks and other arthropods, which are proven significant vectors and reservoirs of various pathogens.

Keywords: tick repellents, *Ixodes ricinus*, icaridin, repellent efficacy

Digestibility of yellow mealworm fed two different diets using lignin as a digestibility marker

Marko Vukadinović[1*], Miroslava Polovinski Horvatović[1], Miloš Petrović[1], Nikola Laćarac[1], Saša Krstović[1], Dejan Beuković[1], Aleksandra Popović[1], Igor Jajić[1]

[1]University of Novi Sad, Faculty of Agriculture, Department of Animal Science, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia

**marko.vukadinovic@stocarstvo.edu.rs*

Yellow mealworms (*Tenebrio molitor*) are a promising alternative protein source for animal feed. To optimize their growth performance and nutritional composition, it is essential to understand their dietary digestibility and nutritional requirements. In this study, mealworms were fed wheat bran and oat flakes, two readily available and affordable diets from the local market. The trial was conducted under controlled experimental conditions with both groups (four replicates each) receiving equal amounts of feed per week (25 g), while water was supplied through agar. Growth performance parameters, including feed conversion, feed intake, and overall growth were monitored throughout the experimental period. A digestibility study was conducted using an indirect method with lignin as a marker to determine the digestibility coefficients of dry matter, organic matter, ash, crude protein, crude fat, neutral detergent fiber (NDF), acid detergent fiber (ADF), hemicellulose, and cellulose. Lignin, unlike cellulose and hemicellulose, is highly resistant to enzymatic degradation, making it a reliable marker for digestibility studies in animal nutrition. Growth parameters were similar for both diets, with slightly better results observed in the oat flakes group. The feed conversion ratio was 2.16 for wheat bran and 2.00 for oat flakes, with an average weight gain of 46.37 g and 50.30 g, respectively. The digestibility trial, using lignin as a marker, revealed significantly higher digestibility for oat flakes. The average digestibility coefficients for oat flakes were as follows: dry matter (0.82), organic matter (0.84), crude protein (0.57), and crude fat (0.88). In comparison, wheat bran had lower digestibility coefficients: dry matter (0.49), organic matter (0.50), crude protein (0.32), and crude fat (0.88). Both diets can successfully meet the nutritional needs of yellow mealworm larvae. However, oat flakes provide better growth performance and digestibility results, making them a more efficient dietary option.

Keywords: *Tenebrio molitor*, feed conversion, feed intake

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Manganese supplementation of dairy cows in the Republic of Serbia in light of new nutritional recommendations

Marko Vukosav[1], Mirko Ivković[1], Ivan Pihler[1], Igor Jajić[1]

[1]Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia

**mirkomivkovic@gmail.com*

Optimal manganese intake is essential for the health and productivity of dairy cows, particularly in terms of reproduction and skeletal development. According to the latest dairy cow nutrition standard (NASEM, 2021), the manganese requirements of these animals have significantly increased compared to the previous recommended values established in the NRC (2001), leading to the question of whether dairy cow premixes available on the Serbian market supply adequate amounts of this element. The aim of this study was to evaluate the manganese content in commercial premixes for dairy cows available on the Serbian market and determine their alignment with the requirements calculated according to the NASEM (2021) standard. Samples were analyzed at the Laboratory for quality control of animal feed and animal products, at the Faculty of Agriculture in Novi Sad, and included premix samples from two time periods (2008–2013 and 2014–2023), with one-percent premixes (46 samples) and multi-percent premixes (69 samples) analyzed. The results show that manganese concentrations in one-percent premixes, over the last observed decade, have significantly increased, and have been aligned with the latest recommendations, even surpassing the recommended values. A similar trend was observed in the average manganese content of multi-percent premixes, although some producers showed significant deviations, which resulted in a lower average manganese concentration over the last observed decade. However, this may not necessarily reflect the overall market situation but rather the findings of this study. It was concluded that, despite the fact that Serbian regulations do not define required manganese concentrations in one-percent and multi-percent premixes for dairy cow nutrition, the actual concentrations found in practice align with the recommendations of the latest standards and, on average, significantly exceed them. Therefore, it is necessary to align national regulations with the latest standard and modern feeding practices to prevent potential manganese deficiency in dairy cow diets and metabolism.

Keywords: manganese, premixes, dairy cows, nutritional standards

Efficiency of insecticides based on cyantraniliprole and formetanate-hydrochloride in the control of thrips species in pepper production in Serbia

Milica Meseldžija[1]*, Antonije Žunić[1], Dobrila Radić[1], Jozef Gašparovski[1], Aleksandra Konjević[1], Dragana Budakov[1], Slavica Vuković[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad

**milica.meseldzija@polj.edu.rs*

Pepper production is a significant sector in agriculture in Serbia, both in terms of the cultivated area and its economic value. During cultivation, farmers face numerous challenges, with one of the most critical being pest and disease management. *Capsicum annuum* (sweet pepper) is highly susceptible to various pests, which not only degrade fruit quality but also reduce yields. In addition, insect infestations can indirectly damage plants, through secondary infections and virus transmission. This study aimed to evaluate the effectiveness of two insecticides, cyantraniliprole and formetanate-hydrochloride, which are currently registered in Serbia for controlling *Thrips* spp. in pepper fields. The target pest species were *Frankliniella occidentalis* (western flower thrips) and *Thrips tabaci* (tobacco thrips), both from the family Thripidae. The experiment was conducted in the Kovilj locality, following standard OEPP methods: PP 1/152 (4), 2012 and PP 1/85 (3). The insecticides were applied via drip irrigation (cyantraniliprole 200 g/L, SC) in quantity of 375 ml/ha (cyantraniliprole 200 g/L, SC) and foliar spraying (formetanate-hydrochloride 582 g/kg, SP) in quantity of 1 kg/ha. Four evaluations were made, based on the number of adults on 2 leaves of 25 plants per repetition: immediately before treatment; two, seven, and 11 days after treatment. The efficacy (E%) was determined according to Henderson and Tilton. Pre-treatment assessments determined an average of 12.0 to 13.5 adult thrips (*Thrips* spp.) per variant. Two days after the application the efficacy was 70.5-83.1%, while after seven days it was 78.5-84.8%, depending on the applied product. Eleven days after treatment, the number of adult thrips was significantly lower in the insecticide-treated variants compared to the control, where the average number of adult thrips was 23. Cyantraniliprole achieved an efficacy of 73.1%, while formetanate-hydrochloride demonstrated 71.1% efficacy. Thrips are particularly challenging to manage due to their fast development, high reproductive rates, and the widespread resistance to insecticides across multiple classes. To address these challenges, future research could focus on implementing integrated pest management strategies, such as rotating insecticides with different modes of action, using biocontrol agents, and developing more ecotoxicologically favorable insecticides. These approaches could be crucial for ensuring sustainable long-term pest control in pepper production.

Keywords: vegetables, *Thrips tabaci*, *Frankliniella occidentalis*, insecticide

Refining raw data into FAIR data for plant protection: A case study on codling moth (*Cydia pomonella* L.)

Milena, Marcic[1,2], Branislava, Lalic[2], Ana, Firanj-Sremac[2]*

[1]Forecasting and Warning Service in Plant Protection of Serbia, Novi Sad, Serbia

[2]Group for meteorology and biophysics, Department of Field and Vegetable Crops, Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia

**ana.sremac@polj.edu.rs*

Effective plant protection requires precise and reliable data on harmful organisms, host plants, and meteorological conditions. A key tool in pest management is the phenological model. Forecasting and Warning Service in Plant Protection of Serbia (PIS) is a national decision support system that utilizes phenological models to generate recommendations for plant protection. These models predict the timing of key developmental events in a pest's life cycle, primarily based on accumulated Celsius Degree Days (CDD). It is crucial to determine the temperature thresholds for individual developmental stages, the required sum of degree days and the moment of the beginning of the moth's flight (biofix) from which the degree days accumulations starts. If any of these factors are incorrectly determined, the entire phenological modelmay be flawed. When using an already established model, the biofix remains the only critical model parameter, as meteorological elements act as independent variables rather than model parameters. Due to the importance of biofix in phenological models, we addressed the impact of meteorological factors on biofix determination. In this study, the weather conditions, that could delay the biofix of the codling moth, were analysed. From the first catch of moths on pheromone traps and seven days back, air temperature, relative humidity, amount and intensity of precipitation, wind gusts and atmospheric pressure were analyzed from year 2012 to 2023 on 45 locations throughout Serbia, creating 137 data inputs. These data were processed through multiple stages, including raw data collection, cleaning, shaping, processing and coupling to comply with FAIR (Findable, Accessible, Interoperable, and Reusable) data principles. To quantify the impact of adverse weather conditions on biofix, we introduced the term of biofix uncertainty. A measure of uncertainty is the number of days between the day of the first catch on the pheromone trap and the closest day before that when weather conditions were favorable for moth flight. Depending on the selected threshold values of meteorological parameters that were considered unfavorable and the designed scenarios, uncertainty was determined in 27%, 42,3% and 29,9% of cases of the biofix data and ranged from two to over seven days. After the implementation of uncertainty in the phenological model and the correction of the biofix, differences of up to ten days in the simulated values of the occurrence of key biological events in relation to the observed biofix were determined. These differences indicate the practical importance of uncertainty when making decisions about the application of chemical protection measures, especially considering the low tolerance threshold of damaged fruits (less than 0,5%). Since codling moth larvae can bore into apple fruit in as little as 20 minutes, even a one-day delay in insecticide application can result in significant crop losses.

Keywords: biofix, codling moth, FAIR data, phenological model, uncertainty

Pre-harvest foliar calcium application as a strategy for improving apricot fruit quality

Maja Milović[*1], Nenad Magazin[1], Žarko Kevrešan[2], Biserka Milić[1], Jelena Kalajdžić[1], Gordana Barać[1], Jovica Gošić[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

[2]University of Novi Sad, Institute of Food Technology, Novi Sad, Serbia

**maja.milovic@polj.uns.ac.rs*

Calcium plays a crucial role in maintaining cell wall structure and delaying the ripening process. Since foliar application allows direct nutrient absorption, we hypothesized that calcium-based treatments could improve the quality of apricot fruits of the cultivar 'NS6.' Over two years (2016–2017), the foliar fertilizer Wuxal® Calcium was applied three times per growing season at fruit diameters of 11 mm, 21 mm, and 30 mm, at a concentration of 0.1%. The treatment was applied once (Ca 1x) to six trees, twice (Ca 2x) to another six, and three times (Ca 3x) to a final group of six trees, with each tree representing a single replication. Fruits were harvested at the pre-climacteric stage based on the I_{AD} index (0.4–0.8), meaning that measured parameters for soluble solid content (SSC) and total acids (TA) may differ from those at technological maturity. Foliar calcium application increased fruit weight. In the first year, Ca 3x led to a 63% increase in fruit weight compared to the control, while in the second year, Ca 2x resulted in a 37% increase. Calcium-treated fruits also had larger dimensions in both years. Fruit firmness increased by 10% to 45% in treated apricots compared to untreated ones. SSC was lower in calcium-treated fruits in both years, except for Ca 1x treatment in 2017. TA levels decreased in the first year, whereas in the second year, they remained the same or increased compared to the control. Given that fruit weight, dimensions, and firmness are key quality parameters, pre-harvest foliar calcium application is recommended for intensive apricot production to enhance fruit quality, with the calcium treatments applied two and three times demonstrating particularly notable effects.

Keywords: stone fruit, 'NS6', fruit dimensions, firmness, chemical composition

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Approaches in mitigating climate changes in the region of Pannonian Biogeographical Area - ClimaPannonia

Velimir Mladenov[1*]

[1]University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, Srbija

**velimir.mladenov@polj.edu.rs*

ClimaPannonia - *Building climate resilience via large-scale uptake of systemic solutions in agricultural ecosystems in the Pannonian region* is a 6M Horizon Europe project that started on the 1st of March 2025 and will offer many solutions to the climate changes in the Pannonia region through four agricultural sectors. ClimaPannonia is the coordinated effort of key Pannonian Biogeographical Area (PBA) stakeholders toward strengthening the resilience of the agricultural sector and the region's community against climate change's disastrous effects. This will be achieved by enabling the widest possible uptake of tested and validated climate-neutral solutions for four agriculture subsectors: (i) water-food nexus, (ii) agroforestry, (iii) organic crop production, (iv) cattle production. ClimaPannonia aims to support the PBA agriculture sector in drastically improving its climate resilience. By implementing innovative systemic solutions and fostering collaboration among the six countries within the PBA – Hungary, Serbia, Croatia, Romania, Czechia, and Slovakia – ClimaPannonia will pave the way for a more sustainable and resilient agriculture. By harnessing the knowledge and expertise of leading experts in PBA and leveraging the knowledge of partners from countries such as Germany, Italy and France, ClimaPannonia seeks to ensure that the solutions implemented are innovative not only at the PBA level but also at the European scale. Solutions from the four agricultural sectors will be tested in four different environments and the same technology will be transferred and replicated across eight environments. Business models and digital solutions will be considered final outcomes.

Keywords: climate change, ClimaPannonia, drought, resilience, technology transfer

Water footprint labelling could empower food consumers to make water-conscious decisions

David John Okoronkwo[1,2]., Simon Chidera Ugwoke[1*], Zorica Srđević[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

[2]Schwarzman College, Tsinghua University, Beijing, China

**maximillianchidera@gmail.com*

Water scarcity remains a pressing humanitarian crisis, exacerbated by climate change, population growth, and unsustainable water usage practices. Despite growing awareness of the problem, the public is still largely unaware of the significant water footprint associated with their everyday agri-food commodities. This study focused on the water footprints of urban agricultural households differentiating them between rural agricultural households based on geographical location, population density, economic activities, infrastructure, and administrative definitions. A multistage sampling technique selected 64 households (31 rural, 33 urban) from Enugu State, Nigeria, in Western Africa between 1st June and 30th June, 2024. A linear regression model, with socioeconomic characteristics as independent variables and total water footprint as the dependent variable was used to examine the relationship between socioeconomic characteristics and the total water footprint of agricultural households. Data analysis involved descriptive statistics (frequency, percentage, mean score) and inferential methods (Pearson's correlation, ordinary least squares regression) using Microsoft Excel and IBM SPSS was deployed. Our findings reveal that rural households' monthly water footprint (17,088.2 m^3) is 6.6% lower than that of urban agricultural households (19,516.9 m^3). It also shows that total green water consumption (water incorporated in food) of urban households of 17,976.1 m^3 per month is statistically different (6.0% excessive) from the total green water footprint of rural agricultural households at 15,764.3 m^3 per month. The study suggests that strategic interventions, such as importation of water intensive agricultural products rather than cultivating at urban areas, and implementing water footprint labelling on food products, could significantly influence consumer behaviour and reduce water demand. Empowering consumers with transparent information about the water footprint of agri-food products offers a viable pathway to fostering more sustainable water usage practices and mitigating the impacts of water scarcity on global food systems.

Keywords: water footprint, sustainability, agricultural households

Microplastic-induced behavioral changes in *Eisenia fetida* adults (Oligochaeta: Lumbricidae): a six-chamber avoidance assay

Aleksandra Petrović[1*], Vojislava Bursić[1], Ivana Ivanović[1], Ana Lazić[1], Dušan Marinković[1], Dejan Prvulović[1], Aleksandra Tubić[2]

[1] University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia

[2] University of Novi Sad, Faculty of Sciences, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia

**aleksandra.petrovic@polj.edu.rs*

Microplastic pollution has become an emerging environmental concern, with significant consequences for soil ecosystems and their key organisms, such as earthworms. *Eisenia fetida* (Oligochaeta: Lumbricidae), widely used as a bioindicator in soil ecotoxicology, plays a crucial role in soil structure formation and nutrient cycling, making it an ideal model species for assessing the impact of microplastic contamination. To evaluate the impact of polyethylene microplastic particles on the behaviour of adult *Eisenia fetida* in soil, a six-chamber avoidance test was conducted to calculate the avoidance coefficient according to SRPS EN ISO 17512-1. The results demonstrated that the highest avoidance percentage (45.78%) occurred at a concentration of 0.75% polyethylene microplastic particles mixed with 200 g of soil. This concentration also resulted in the highest mortality rate, with an average of 9.6 dead individuals. Statistical analyses revealed a significant difference between treated and untreated chambers ($p = 0.000000$ for $p < 0.01$); however, no statistically significant differences were observed among the different microplastic concentrations (0.25%, 0.5%, and 0.75% w/w) ($p = 0.965142$ for $p < 0.05$). The absence of a clear dose-response relationship may be attributed to the heterogeneity of microplastic distribution in the soil matrix, physical soil-microplastic interactions, and possible threshold effects where even low concentrations induce biological stress. The findings indicate that microplastic contamination in soil induces avoidance behaviour and increases mortality in *Eisenia fetida*, potentially disrupting critical soil functions such as organic matter decomposition, aeration, and nutrient cycling. Such disruptions can compromise soil health and threaten the sustainability of agroecosystems, ultimately affecting agricultural productivity and ecosystem resilience. Future studies should focus on long-term exposure effects, microplastic degradation processes, and their interactions with other soil contaminants to better understand the ecological risks of microplastic pollution and its potential implications for human health.

Keywords: microplastic pollution, *Eisenia fetida*, earthworm bioindicators, avoidance behavior, soil ecotoxicology

Remote crop monitoring and the application of twin-nozzles in wheat protection

Lazar Turšijan[1]*, Aleksandar Sedlar[1], Jan Turan[1], Dobrila Kovčin[1], Filip Vasić[1], Vladimir Višacki[2]

[1]Faculty of Agriculture, University of Novi Sad, Serbia

[2]Institute of Lowland Forestry and Environment

**lazar.tursijan@polj.uns.ac.rs*

This study presents a focused investigation on integrating twin-nozzle pesticide application and remote sensing for wheat crop management. The primary goal was to compare different types of spray nozzles and evaluate their impact on pesticide deposition, drift reduction, and crop health monitored through multispectral drone imagery. The field trial was conducted on a 1-hectare wheat plot in Selenča. UAV flights were performed using a DJI Mavic 3M drone equipped with multispectral (Green, Red, Red Edge, NIR) and RGB cameras, at an altitude of 70 meters and a flight speed of 11 m/s, achieving a ground resolution of 2.15 cm/pixel. Experimental results showed that the ATP twin-nozzle achieved 78.8% higher pesticide deposition compared to the ST single-nozzle and 57.6% more than the ID nozzle. Statistical analysis using ANOVA confirmed highly significant differences between nozzle types ($p=0.000004$). Remote sensing analysis, based on NDVI indices, indicated healthier plants in areas treated with more efficient spray systems. NDVI monitoring throughout four growth stages revealed a consistent advantage in vegetation indices for twin-nozzle applications. Although twin-nozzle systems required a 10% higher initial investment, this was compensated by improved deposition uniformity and potential pesticide savings. This highlights twin-nozzle systems as a promising approach for sustainable wheat production. The study demonstrates how the integration of advanced nozzle technology with UAV-based monitoring can contribute to more efficient pesticide usage, healthier crops, and overall production optimization. Potential limitations include the need for precise calibration and initial equipment costs, suggesting that broader adoption would benefit from support programs promoting precision agriculture.

Keywords: Precision agriculture, twin-nozzle, pesticide application, remote sensing, UAV, NDVI index

Exploring *Leuconostoc citreum* DSM5577 sourdough as a natural approach to sugar reduction in muffins

Maria-Florina Roșca[1], Simona Maria Man[1], Maria Simona Chiș[1], Carmen Rodica Pop[1], Andreea Pușcaș[1], Laura Stan[1], Floricuța Ranga[1], Dorina Simedru[2], Vlad Mureșan[1] and Adriana Păucean[1*]

[1]Faculty of Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, Romania , [2]INCDO-INOE2000, Subsidiary Research Institute for Analytical Instrumentation, Cluj-Napoca, Romania

**adriana.paucean@usamvcluj.ro*

Leuconostoc citreum, a heterofermentative bacteria, generates mannitol, a low-calorie sugar substitute suitable for low-sugar diets. Sourdough converts fructose to mannitol and produces lactic acid, acetic acid, CO_2 and aromatic compounds, making it an adequate source for healthier, reduced-sugar foods.

This study investigates the potential of *Leuconostoc citreum* DSM 5577 to naturally reduce sugar in muffins by producing mannitol through sourdough fermentation.

Sourdough was prepared by mixing wheat flour and water in a 1:1 ratio, supplemented with 10% fructose and inoculated with 10% *Leuconostoc citreum* DSM5577 (10^8 cfu/ml) cultured in MRS broth at 28˚C. Sourdough samples were collected at 0, 24 and 48 hours of fermentation and were analyzed for physicochemical, microbiological and rheological properties. Muffins were produced by incorporating 30% and 50% sourdough, fermented for 24 and 48 hours, into a batter made of wheat flour, eggs, yogurt, grapeseed oil, baking powder and 50% sugar in five out of ten muffin variations. The other five muffin variations were completely sugar-free.

The sourdough analysis revealed that pH ranged from 5.99 to 3.50 while total titratable acids (TTA) varied between 1.2 and 15 mL NaOH. The identified carbohydrates included maltose with levels ranging from 8.48 to 11.12 mg/g and mannitol, which varied from 0 to 6.27 mg/g. Acetic acid and lactic acid concentrations increased with fermentation time, reaching up to 2.25 mg/g and 4.60 mg/g, respectively.

The muffins were evaluated for texture, moisture content, color and physical properties, as well as for sensory characteristics, carbohydrate composition, organic acids and mannitol content. The highest mannitol concentration (3.56 mg/g) was found in muffins containing 50% sourdough fermented for 48 hours. The structure of different muffins was analyzed using SEM to visualize change in microstructure due to the addition of sourdough. FTIR analysis was also used for both sourdough and muffins, providing strain-specific spectra that revel the chemical composition of bacterial cell components, including fatty acids, proteins, polysaccharides and nucleic acids. The color of muffins was analyzed based on L*, a* and b* values, revealing only minor differences between the sugar-containing and sugar-free formulations. The incorporation of sourdough with *Leuconostoc citreum* DSM5577 resulted in significant sugar reduction without compromising the sensory quality of the muffins. Samples containing 50% sugar were rated slightly higher than those made only with sourdough, according to the Hedonic Test results.

In conclusion, *Leuconostoc citreum* DSM5577 demonstrated it's potential to produce mannitol through sourdough fermentation. The study suggests that incorporating sourdough could be a viable approach for reducing sugar in muffins while maintaining their quality.

Keywords: *Leuconostoc citreum* DSM5577, mannitol, sourdough, sugar-reduced muffins

Total phenolic, flavonoid, and anthocyanin content in *Rubus idaeus* pomace

Sara Hourani[1], Ružica Ždero Pavlović[2*], Boris Popović[2]

[1]Faculty of Technology, Novi Sad, Serbia; [2]Faculty of Agriculture, Novi Sad, Serbia

**ruzica.zdero@polj.uns.ac.rs*

A significant horticultural crop found in temperate regions across the world, particularly in the Americas and Europe, is the raspberry (*Rubus idaeus* L.). Raspberries are perennial plants with biennial canes that can grow over 1.8 meters tall. When ripe, raspberries cannot be harvested mechanically; the great majority of raspberries are picked by hand. Furthermore, because of its high respiration rate, short shelf life, and loss of firmness and freshness, only small amounts of ripe raspberries are consumed locally fresh. The majority are frozen and/or processed into products like juice, wine, jam, and extracts. Russia, Poland, the United States, Serbia, and Mexico are the world's top producers of raspberries. Raspberries are known as rich sources of vitamins, minerals, and bioactive compounds, such as phenolic acids, flavonoids and anthocyanins. These compounds protect the plant against disease, infection, UV radiation and insect damage. Due to its chemical composition, raspberry is classified as a functional fruit with strong antioxidant, anti-inflammatory, antimicrobial, and antiproliferative activities. Even its leaves and seeds, often by-products in industry, are rich in polyphenols and could serve as an alternative source of bioactive compounds in human nutrition.

Serbia, as one of the world's largest raspberry producers, generates a large amount of waste during processing due to the short shelf life of fresh fruit. Raspberry pomace, a by-product of industrial juice production, retains valuable bioactive compounds from fruit. Aim of this study was to investigate antioxidant potential of raspberry pomace obtained from local producer (RAUCH, Koceljeva, Serbia). Lyophilized raspberry pomace was extracted using 50% ethanol, and the dry extracts were adjusted to a concentration of 100 mg/mL. The analysis revealed a total phenolic content of 88.03 ± 3.42 mg galic acid equivalent per gram of dry extract, total flavonoid content of 8.38 ± 0.36 mg catechin equivalent per gram of dry extract, and total anthocyanin content of 21.01 ± 4.31 mg cyanidin 3-glucoside equivalent per gram of dry extract. Antioxidant capacity was assessed using 2,2-diphenyl-1-picrylhydrazyl (DPPH) and ferric reducing antioxidant power (FRAP) assays. The IC_{50} value of raspberry extract in the DPPH assay was 0.36 ± 0.02 mg/mL, indicating strong free radical scavenging activity. In the FRAP assay, the antioxidant potential was determined to be 85.86 ± 8.61 mg ascorbic acid equivalents per gram of dry extract. These results suggest that raspberry pomace is a valuable source of bioactive compounds, highlighting its potential for further utilization in food and pharmaceutical industries.

Keywords: bioactive compounds, by-products, polyphenol, pomace, raspberry

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Influence of broiler strains on bone quality

Sava Spiridonović[1*], Lidija Perić[1], Mirjana Đukić Stojčić[1], Dragan Žikić[1], Slobodan Stojanović[2], Dragoljub Marić[2]

[1]University of Novi Sad Faculty of Agriculture, Department of Animal Science, Novi Sad, Serbia

[2]University of Novi Sad Faculty of Agriculture, Department of Veterinary Medicine, Novi Sad, Serbia

**sava.spiridonovic@stocarstvo.edu.rs*

Broiler strains can significantly influences production performance and possibly other important factors in broiler production, such as bone quality. Different final body weights and growth rates among different broiler strains can lead to certain issues in bone quality. The aim of this study was to determine the effect of two different fast-growing strains on body weight, morphometric parameters (weight, length, and width of the tibiotarsus), maximum force, and breaking force of tibiotarsus. For the purpose of the experiment, a total of 1,200 chicks were reared for 42 days, with 600 Ross 308 broilers and 600 Cobb 500 broilers. Broilers were divided into two treatments with 15 replications, with 40 chicks per pen. Four commercial feed mixtures were used in the experiment: starter (1–10 days), grower 1 (11–21 days), grower 2 (22–31 days), and finisher (32–42 days). After 42 days, at the end of the trial, 10 male chicks from each strain were sacrificed. Samples of the left tibiotarsus were collected and frozen until analysis. Before morphometric measurements, the bones were left in a refrigerator at 4°C for 24 hours to thaw. Prior to morphometric analysis, the tibiotarsus were deboned, and all soft tissues were removed. The length and width of the tibiotarsus were measured using a digital caliper with precision of 0.01mm, while the weight was measured using a digital scale with a precision of 0.01g. The breaking force analysis was performed using a three-point bending INSTRON material tester. Maximum force (N) and breaking force (N) were determined. The bone samples were placed on a 4 cm support from both sides with a loading speed rate of 50 mm/min. The average body weight at 42 days was 3.100 g for Cobb 500 and 2.970 g for Ross 308 ($P<0.05$). Differences were found in tibiotarsus weight between Ross 308 and Cobb 500 (20.74g vs. 23.06g) and length (105.43mm vs. 111.05 mm) ($P<0.05$). No significant difference ($P>0.05$) was found between strains in diaphysis diameter. The results showed that Cobb 500 exhibited greater bone strength, however, no significant effect of the strain was established ($P<0.05$). The maximum breaking force in Cobb 500 was 456.43 N, while in Ross 308, it was 439.93 N. In addition to maximum force, Cobb 500 also had a higher breaking force, with 384.74 N in Cobb 500 and 345.92 N in Ross 308. Based on the presented results, it can be concluded that strain significantly influenced final body weight, tibia length and weight. However, strain did not have a significant effect on diaphysis diameter. Additionally, no strain effect was found on maximum and breaking force of tibiotarsus.

Keywords: broilers, strain, bone quality, tibiotarsus breaking force

Agri-food value chains with intercropping technology - challenges and perspectives

Srđan Šeremešić*, Svetlana Vujić, Đorđe Krstić, Bojan Vojnov, Ksenija Mačkić, Velimir Mladenov, Branko Ćupina

University of Novi Sad, Faculty of Agriculture Novi Sad, Sq. Dositeja Obradovića 8, 21000 Novi Sad, Serbia

**srdjan.seremesic@polj.edu.rs*

The introduction and acceptance of intercropping is now emerging as one of the key solutions to the various challenges facing agriculture. As part of the EU IntercropVALUES project, a workshop was organized in Novi Sad to identify the main constraints and barriers in intercropping under local food value chains. As part of project activities, local stakeholders were invited in a workshop in order to better elucidate the potential of this technology in Serbia. The most important barrier to the uptake of intercropping is the lack of awareness, both among farmers and consumers, and the clear differentiation from other certified/controlled production systems. Additional training for farmers and promotion to customers can help solve this problem. Moreover, retail chains have not recognized this agri-food segment as a potentially useful model for increasing their visibility and recognition in the market and such product has not yet gained market presence. Similarly, the lack of demonstration plots as a showcase for the general public and the lack of positioning in the field have prevented further expansion. As a result, intercropping has not become part of any strategic document or incentives in Serbia. A significant constraint on intercropping is the lack of production profitability data. Increased investment in production and purchase of equipment for intercropping can significantly increase costs. In addition, separate or additional storage space, seed cleaning and increased labor requirements lead to higher product prices, variability in quality and reduced farmers interest. Climate change has an increasingly negative impact on agriculture and is seen as one of the main challenges for intercropping. The influence of the climate is mainly seen through the influence on the main crop (yield and quality) or on the soil (drought), which can be significantly extended in the presence of intercrops. Unfavorable conditions create a stressful environment for the main crop or the intercrop (e.g. legumes) and favor other more resistant plant species (weeds) or impose the need to adjust crop technology. This is reflected in the increased competition between plants to grow and in the inability to meet production targets. Therefore, the technology of intercropping has to be adapted to the system of cultivation of both crops and compromises have to be made and it is therefore imperative for farmers to go beyond the traditional routine. In addition, application of intercropping may lead to the introduction of additional measures (e.g. sowing time adjustment, desiccation, seed cleaning), or to the creation of an inadequate crop rotation system. Although it is considered one of the key technologies for diversification, intercropping in our agro-ecological conditions is still seeking its place and confirmation by practice and science. Intercropping areas are still small and inadequate. In order for them to be accepted and expanded, it is necessary to remove a number of existing barriers that stem from conventional thinking and the pursuit of maximizing production. The way to accept intercrops can be through the introduction of value chains based on sustainable production systems, local gastronomy or principles of environmental protection, giving them a clear role and function that they clearly deserve in the agriculture of the 21st century. The outcomes of this workshop are a better understanding of the implications of intercropping in food value chains and a clarification of the role of each stakeholder in their further expansion.

Keywords: agri-food value chain, intercropping, sustainability, agroecology

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Improving germination and seedling growth of *Ocimum basilicum* using bacterial biostimulators

Dragana Stamenov[1*], Simonida Đurić[1], Timea Hajnal Jafari[1]

[1]Department of Field and Vegetables Crops, Faculty of Agriculture, Novi Sad, Serbia

**dragana.stamenov@polj.uns.ac.rs*

The aim of this study was to evaluate the use of effective microorganisms (EM) as promoters of germination and seedling growth of basil (*Ocimum basilicum*).
In this study, isolates from the genera *Bacillus* (B1, B2 and B3), *Azotobacter* (A1), and *Streptomyces* (S1) were used. These isolates are from the collection of the Laboratory for Microbiological Research of the Department of Field and Vegetable Crops at the Faculty of Agriculture, University of Novi Sad. The experiment was conducted *in vitro*. A total of 100 basil seeds were inoculated by submerging them in a bacterial suspension (10^9 CFU/ml) for 30 minutes. Control seeds were submerged in a sterile nutrient broth instead of the bacterial inoculum. The seeds were then placed on filter paper and incubated at 22°C for germination. Germination rates were recorded after four and seven days. Shoot and root lengths of seedlings were measured on days seven, fourteen, and twenty-one. The vigor index was assessed after seven days and calculated using the following formula: VI = (mean root length + mean shoot length) × germination %.
Four days after basil seed inoculation, the germination rate significantly increased in all variants compared to the control. The highest germination rate (75%) was observed with the application of the S1 isolate, while the lowest effect on germination (48%) was recorded with the A1 isolate. After seven days, isolate S1 exhibited the highest germination rate at 76.5%, whereas the control variant had the lowest at 43.5%.
Seven days after inoculation, a statistically significant increase in seedling root length was observed in the variants treated with the B3 (10.4 mm), A1 (10.1 mm), and S1 (12.7 mm) isolates compared to the control (6.1 mm). While other isolates also promoted root growth, the increase was not statistically significant. Seedling stem length significantly increased in all variants compared to the control, with the S1 treatment showing the most pronounced effect (26.2 mm) versus the control (9.5 mm). The highest vigor index values were observed in the variants treated with the S1 (2975.8), B2 (1708), and B3 (1641.1) isolates. Fourteen days after inoculation, root length significantly increased in all variants except for B2, where the increase was not statistically significant. Stem length was also significantly greater in all inoculated variants compared to the control (7.3 mm), with the A1 (26.2 mm) and S1 (25.2 mm) treatments having the greatest effect. Twenty-one days after inoculation, compared to the control, seedling root length was significantly greater in all variants except B2, where the increase was not statistically significant. Stem length was significantly greater in all inoculated variants compared to the control, with treatment S1 providing the most noticeable improvement.
The use of effective microorganisms can positively impact basil cultivation. In this study, the B3, A1, and S1 isolates demonstrated the highest effectiveness. These isolates could serve as a basis for further research and the development of a microbial-based formulation to enhance production and improve the yield quality of various medicinal plants, with a particular focus on basil.

Keywords: *Bacillus*, *Azotobacter*, *Streptomyces*,effective microorganisms, medicinal plants

Bacterial seed priming enhance germination and initial seedling growth of *Salvia sclarea*

Dragana Stamenov[1*], Dino Hasanagić[2], Ružica Ždero Pavlović[1], Timea Hajnal Jafari[1], Simonida Đurić[1]

[1]Department of Field and Vegetables Crops, Faculty of Agriculture, Novi Sad, Serbia

[2]Faculty of Natural Sciences and Mathematics, Banja Luka, Republic of Srpska

**dragana.stamenov@polj.uns.ac.rs*

Seed priming has become a widely adopted commercial technique to enhance germination speed and promote uniform seedling growth across various crops. However, research on the interaction between plant growth-promoting bacteria (PGPB) and medicinal plant seeds remains limited.
In this study, nine bacterial strains were isolated from the rhizosphere of nettle (*Urtica dioica* L.), including three from the genus *Bacillus* (Bac1, Bac2, Bac3), one from the genus *Azotobacter* (Azb1) and one actinobacteria from genus *Streptomyces* (Act1). The experiment was conducted under controlled laboratory conditions. A total of 100 sage seeds were placed on a sterile filter paper disc that had been previously placed in Petri dish. After that, 10 ml of inoculum of one bacterial isolate, titer 10^9 CFU/ml, was added to the Petri dish. The procedure was repeated for each isolate. Control seeds underwent the same procedure but instead of inoculum, a sterile medium was added. Following inoculation, the Petri dishes were placed at 22°C for seeds germination. Germination rates were assessed on the third and seventh days, while seedling shoot and root lengths were measured on days seven, fourteen, and twenty-one. The vigor index was determined after seven days using the formula: VI = (mean root length + mean shoot length) × germination %. Three days after the experiment was set up, a statistically significant increase in germination was found in all variants compared to the control. The highest germination (96.5%) was recorded with the application of Act1, and the weakest effect was with the application of Bac1 (55%). After seven days, the highest percentage of seed germination was recorded in the variant with the applied Act1 (100%), while the lowest germination rate was in the control variant, only 46.5%. Bacterial inoculation significantly enhanced sage seedling root and shoot growth. After seven days, compared with the control variant (13.7 mm), root length increased in all treatments, with Act1 showing the greatest effect (42.2 mm) and Azb1 the weakest (19.7 mm). Similarly, all applied isolates had a significant impact on sage shoot length. After 14 days, sage root length increased significantly across all inoculation treatments, with Act1 showing the greatest effect (47.3 mm). Similarly, all isolates positively influenced shoot length compared to the control, with Bac3 (32.5 mm) demonstrating the greatest impact. By the end of the three weeks, the most significant increases in root and shoot length were observed with the Bac2 and Act1 isolates. The control variant exhibited the lowest vigor index (986), whereas the highest value was observed in the treatment with actinomycetes (6220). The application of microorganisms isolated from the nettle rhizosphere, particularly the Act1 isolate enhanced sage seed germination and positively influenced the assessed initial growth parameters. These results suggest that microorganisms can effectively promote sage growth.

Keywords: *Bacillus, Azotobacter,* actinomycetes, medicinal herbs, inoculation

Study on the microbial abundance in figs pickled in vinegar

Moisescu Emilia[1*], Oana Boiu Sicuia[2]

[1]Faculty of Horticulture, [2]Faculty of Biotechnologies, University of Agronomic Sciences and Veterinary Medicine, Bucharest, Romania

**emilia_moisescu@yahoo.com*

The figs are extremely perishable and have a very short shelf-life. Therefore, they are usually sold as dried fruits and other processed products rather than fresh fruits. Additional value-added products should also be considered to harness this valuable fruit. The production of pickles from figs is a response to the interest of producers in capitalizing on these fruits. This study focuses on the possibility of obtaining marketable fig pickles. Pickles are foods that, through the fermentation process, lower their pH and increase their acidity, allowing them to be preserved for a longer time. Pickling was achieved by acidification with vinegar. Beneficial microorganisms participate in food preservation and actively participate in the fermentative process of pickling vegetables or fruits. The study aimed to provide an optimized technological process for the production of fig pickles and to assess their quality and acceptability. As raw material figs from two genotypes were used. To determine lactic acid and acetic bacteria, we used agar media: Man-Rogosa-Sharpe for lactic acid bacteria and Hestrin-Schramm for acetic acid bacteria.. For determination of *E. coli* and coliform bacteria the Coliform Chromogenic agar was used. It was found a relatively high load of microbial in fig pickles: 34.400 UFC/mL lactic bacteria and 76.000 UFC/mL acetic bacteria. This research revealed that figs can be pickled successfully, providing valuable information regarding the applied pickling process. This process can still be further refined to better meet consumer demand.

Keywords: acetic bacteria, lactic bacteria, coliform bacteria, fermentation

Advancing green transitions in biofuel production through early-phase LCA and S-LCA

Maja Radišić[1], Sunčica Vasiljević[2], Marina Arnaut-Stefanović[3], Gordana Racić[4], Olivera Stojilović Trivunić[3]*, Mladen Radišić[2]

[1]Faculty of Agriculture, University of Novi Sad, Serbia, [2]Faculty of Technical Sciences, University of Novi Sad, Serbia, [3]Foodscale Hub, Novi Sad, Serbia, [4]Tamiš Research and Development Institute, Pančevo, Serbia

**olivera@foodscalehub.com*

The SUNFUSION is a four-year Horizon Europe project, that aims to demonstrate a novel pathway for producing advanced biofuels by integrating microalgae and oleaginous yeasts cultivation with a continuous hydrothermal liquefaction (HTL) process powered by concentrated solar energy. By aligning with the EU Green Deal and the REPowerEU plan, this initiative aims to reduce reliance on fossil inputs, increase efficiency in the conversion of solar to bio-based energy, and minimize overall waste. A defining aspect of the project is the reintegration of HTL by-products into biomass cultivation, pushing toward a near-zero-waste operation. Throughout a pilot phase of at least 12 months at temperatures above 350 °C, SUNFUSION strives to achieve a 50% solar-to-biocrude energy efficiency, thus delivering meaningful quantities of proof-of-concept biofuel.

While demonstrating technological feasibility and scaling toward higher technology readiness levels remains the project's central mission, Life Cycle Assessment (LCA) and Social LCA (S-LCA) serve as critical, interlocking components. By considering all stages—from feedstock growth and conversion to the ultimate fuel output—LCA pinpoints high-impact areas of resource use and emissions, informing strategies that can significantly reduce the overall environmental footprint. At the same time, S-LCA spotlights social dimensions, including stakeholder engagement, community acceptance, and potential policy hurdles. Identifying these challenges in early phases allows project partners to refine operations, address potential concerns, and help secure a more equitable and sustainable outcome.

In line with the project's goals, the LCA and S-LCA activities are designed to support the evaluation of SUNFUSION's environmental and social performance as the technology moves toward TRL 4. LCA will contribute to assessing sustainability by quantifying emissions, resource use, and process efficiency – aiming to validate targets such as a 15 % increase in biocrude yield compared to conventional HTL systems and a minimum 52 % solar-to-biocrude conversion efficiency, and the recovery of over 90 % of CO2 from post-HTL gaseous streams. In parallel, S-LCA will focus on mapping stakeholders and identifying potential challenges related to social acceptance, ensuring that insights into societal impact are considered from the early stages of development. Both assessments will provide critical input for guiding improvements and informing long-term strategic planning.

Through this combination of technical innovation, environmental analysis, and social consideration, SUNFUSION offers a forward-thinking template for unlocking the potential of biorenewable resources. By integrating LCA and S-LCA from the outset, the project demonstrates how strategic, life-cycle thinking can steer innovations toward comprehensive sustainability. Such an approach holds particular promise for advancing green transitions, ensuring that the benefits of emerging bio-based solutions extend across multiple sectors while upholding both environmental integrity and social responsibility.

Keywords: Life Cycle Assessment, Social LCA, Biofuels, Microalgae, Sustainability

Resveratrol in grapes: comparing the impact of two production systems

Aleksandra Šušnjar[1]*, Tomaž Polak[2], Andrej Živković[2], Sanja Lazić[1], Slavica Vuković[1], Siniša Mitrić[3], Jelena Ećimović[1], Dragana Šunjka[1]

[1] University of Novi Sad, Faculty of Agriculture, Novi Sad 21000, Serbia, [2] University of Ljubljana, Biotechnical Faculty, Ljubljana 1000, Slovenia, [3] University of Banja Luka, Faculty of Agriculture, Banja Luka 78000, Bosnia & Herzegovina

**aleksandra.susnjar@polj.edu.rs*

Through long-term exposure to environmental fluctuations and stress factors, the grapevine has evolved many adaptive mechanisms that support its survival and development. Among these factors, droughts, soil salinity, lack of nutrients, UV radiation, insect infestations, and infections caused by phytopathogenic microorganisms stand out the most. From the plant protection aspect, the phytopathogenic fungi and the damage they cause attract the greatest attention. Climatic conditions and the plant resistance largely influence their occurrence and the severity of infection, whereby secondary metabolism stands out as one way to overcome or postpone damage. The term "secondary metabolism" refers to the synthesis of many compounds, initiated or intensified in unfavorable conditions for the plant. Secondary metabolites produced by plants in response to phytopathogenic infections are known as phytoalexins. Phytoalexins play a defensive role by inhibiting harmful microorganisms, and their synthesis is triggered when the plant comes into contact with a pathogen, making them a clear indicator of the plant's resistance mechanism. Resveratrol, a natural compound belonging to the stilbene group, holds a key role in the grapevine's immune system. It has been detected in varying amounts across different grapevine varieties, each with its ability to produce and accumulate it. Resveratrol concentration in grapevine is typically low at first, but its synthesis increases sharply once a pathogen appears. The outcome of the infection, whether it is quickly contained or allowed to spread, depends not only on environmental conditions but also on physical properties like skin thickness and leaf surface, along with the amount of resveratrol the plant manages to produce. Since most grapevines are grown in conventional vineyards today, plant protection products are often applied unnecessarily, preventing plants from activating this type of resistance. On the contrary, organic production is designed in such a way that the inputs of agrochemicals are reduced to a minimum, and their timely and well-founded application, preservation of biodiversity, sustainability, and the selection of resistant varieties are put in the foreground. This study aimed to monitor the resveratrol content in grapevine varieties grown under organic and conventional systems, with all varieties grown in both systems, under uniform agroecological conditions. In this way, it is possible to see whether and to what extent the intensive application of plant protection products affects the resveratrol content and to what extent the plant's natural defense mechanism is expressed in the organic system. Sampling was performed during the harvest period, and then the samples were extracted using the solid-phase extraction (SPE) method and analyzed by high-performance liquid chromatography (HPLC-DAD) technique. The obtained results determined that the organically grown varieties were richer in resveratrol. The results show a clear influence of the production system on resveratrol content in grapes, although other factors can also influence the content to some extent. Nevertheless, this research represents a step forward in exploring the potential of natural compounds, enhancing the understanding of their agricultural importance, highlighting the potential of resveratrol and other phytoalexins as possible biological plant protection agents, and supporting sustainable viticulture strategies.

Keywords: stilbene, grapevine, organic, conventional, plant protection

Sodium deoxycholate treatment influences oxidative stress in sunflower inoculated with *Sclerotinia sclerotiorum*

Marina Crnković[1*], Jovana Šućur Elez[1], Mila Grahovac[1], Marta Loc[1], Dragana Budakov[1], Suzana Jovanović-Šanta[2]

[1] University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

[2] University of Novi Sad, Faculty of Science, Department of Chemistry, Biochemistry and Environmental Protection, Novi Sad, Serbia

**marina.crnkovic@polj.uns.ac.rs*

The fungal pathogen *Sclerotinia sclerotiorum* causes major yield losses in sunflower, manifesting as white mold on the sunflower head and stem. Besides sunflower, several other agricultural crops are also affected by this harmful pathogen, such as soybean, oilseed rape and various vegetables. It is necessary to find an environmentally friendly method to control this pathogen. One of the approaches involves the use of bile acids as a priming substance, primarily since they are found in stable manure. In this study, the elicitor activity of sodium deoxycholate (NaDC) was tested on sunflower seedlings, subsequently inoculated by toothpick piercing method with the fungus *S. sclerotiorum*. There were treatments with 5 and 10 mg L^{-1} of NaDC without inoculation, treatments with the mentioned concentrations of NaDC following by inoculation with *S. sclerotiorum*, and there were two types of untreated controls, uninoculated and inoculated. Inoculation was occurred 24 h after the treatment with sodium deoxycholate, and after the first symptoms appeared (after 48 h) leaves and roots were sampled and three parameters of oxidative stress were measured by spectrophotometric methods: suppression of superoxide anion radical ($O_2^{\cdot-}$) production, superoxide dismutase (SOD) activity and the malondialdehyde (MDA) content, as a product of lipid peroxidation. Sodium deoxycholate did not induce statistically significant change in $O_2^{\cdot-}$ production or SOD activity in leaves or roots of treated uninoculated seedlings, but MDA content was significantly higher in seedlings treated with 10 mg L^{-1} NaDC in leaves (40%) and significantly lower with 5 mg L^{-1} in roots (15%) compared to uninoculated control. In the leaves of inoculated seedlings treated with 5 mg L^{-1} NaDC, a decrease in $O_2^{\cdot-}$ production (24%) was observed compared to the uninoculated control. Superoxide dismutase activity in the leaves increased relative to both controls (58% compared to uninoculated and 26% compared to inoculated control), while it decreased in the roots (26% compared to uninoculated and 27% compared to inoculated control). Additionally, MDA content in the leaves was higher (136%) compared to the uninoculated control. In the leaves of inoculated seedlings, treatment with 10 mg L^{-1} NaDC caused significantly higher SOD activity (43%) and MDA content (63%) compared to uninoculated control, while the MDA level was significantly lower (25%) than in the inoculated control. This indicates a good elicitor activity of 10 mg L^{-1} sodium deoxycholate in reducing the level of lipid peroxidation in sunflower leaves. In the roots of inoculated seedlings, both NaDC concentrations caused a reduction in SOD activity compared to both controls, while 10 mg L^{-1} treatment caused a reduction of $O_2^{\cdot-}$ production compared only to inoculated control. From these results can be concluded that 10 mg L^{-1} of sodium deoxycholate was more effective than 5 mg L^{-1} in sunflower leaves, as it mitigated oxidative stress by reducing level of lipid peroxidation. Therefore, sodium deoxycholate derived from manure appears to be suitable priming compound of sunflower seedlings against *S. sclerotiorum.*

Keywords: *S. sclerotiorum*, elicitor activity, lipid peroxidation, superoxide anion radical, superoxide dismutase

The impact of bioregulators on the fruit detachment force and fruit quality of sour cherry

Stefan Gligorić[1]*, Biserka Milić[1], Zoran Keserović[1], Nenad Magazin[1], Maja Milović[1], Jelena Kalajdžić[1], Gordana Barać[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

**stefan.gligoric@polj.edu.rs*

Sour cherry ranks third in Serbia in terms of produced quantities, following apple and plum. Due to the increasing prevalence of mechanized harvesting in recent years, it is essential to regulate tree vigor to ensure that crown dimensions allow for unobstructed mechanized harvesting. Bioregulators could affect booth vigour and pomological characteristics such as fruit detachment force, and various fruit quality parameters. The research was conducted in 2024 on the Oblačinska variety (Prunus cerasus L.), grown on magriva rootstock (*Prunus mahaleb*) and its own root. The aim of this study was to examine the impact of bioregulators on pomological characteriscs, including fruit detachment force, stem length, and fruit quality parameters (fruit weight, shape index, total soluble solids, and total acid content). The experiment was established in 2023 and 2024 at two locations (Manđelos and Gladnoš), with the following treatments applied 10 days after flowering and repeated 14 days later: paclobutrazol through the roots (PBZ-R) at three concentrations (0.4, 0.7, and 1.0 l/ha); paclobutrazol foliar (PBZ-F) at three concentrations (1.0, 1.5, and 2.0 l/ha); and prohexadion-calcium (PRO-Ca-F) at three concentrations (1.0, 1.25, and 1.5 kg/ha). The force of fruit detachment from the stem was lowest in the untreated control, and highest in the PBZ-R treatment for *Prunus mahaleb* rootstock. For trees on *Prunus cerasus* rootstock, the highest force of fruit detachment were observed at lower doses of PBZ-R treatment, while the lowest values were recorded at the highest concentrations of this treatment and PRO-Ca-F treatment. Two years of PBZ-F application (measurements were conducted in 2024 on trees that were treated in both years) on trees on *Prunus cerasus* rootstock induced a statistically significant decrease in fruit weight, while PRO-Ca-F application resulted in a significant increase. For trees on *Prunus mahaleb* rootstock, PBZ-F application at the highest concentrations, and PBZ-R treatments in 2024, resulted in a statistically significant reduction in fruit weight, while lower concentrations of these treatments caused an increase. All treatments resulted in a statistically significant increase in soluble solids content and total acids. Treatment of trees on *Prunus mahaleb* rootstock with PBZ-R and PBZ-F significantly increased fruit shape index values, while PRO-Ca-F treatments led to a decrease in the same parameter. For trees on *Prunus cerasus* rootstock, PBZ-F and PRO-Ca-F resulted in increase in the fruit shape index values, while PBZ-R treatments caused a decrease. Statistically significant increases in pedicel length were observed in *Prunus cerasus* rootstock trees treated with PBZ-F and PRO-Ca-F, while a decrease was recorded in trees treated with PBZ-F in both years. For trees on *Prunus mahaleb* rootstock, a statistically significant increase in pedicel length was noted for PBZ-F and PBZ-R treatments, while a significant decrease was observed with PRO-Ca-F treatments. These results suggest that bioregulators can influence key pomological characteristics and improve mechanized harvesting, while also affecting fruit quality.

Keywords: paclobutrazol, prohexadion-calcium, sour cherry

Ligamentous structure of the hip joint in the dogs

Antonina Dumitriu[1*], Mihail Moroz[1], Sergiu Didoruc[1], Dmitrii Mațencu[1]

[1]Technical University of Moldova, Chisinau, Republic of Moldova

**antonina.dumitriu@sasp.utm.md*

The canine coxofemoral joint has a remarkable human-like structure. Anatomically and topographically, the coxo-femoral region includes a bony base, articular surfaces with ligamentous structures and means of intra-articular as well as extra-articular union represented by muscle mass. The small number of articular ligaments determines the suppleness and high mobility of the dog's movements. Pericapsular ligaments (described by very few authors) are used to connect the intra-articular structures: iliofemoral ligamentum with fixation on the cranial part of the joint capsule; ischiofemoral ligamentum with fixation on the caudal part of the joint capsule and pubofemoral ligamentum with fixation on the ventral part of the joint capsule; which are soft tissue structures, deriving from the joint capsule in the form of bundles of fibers with a role in the connection between the bony surfaces. The femoral head ligament, designated in official nomenclature as Ligamentum capitis capitis ossis femoris (World Association of Veterinary Anatomists, NAV, 2017), is described equivocally and reflects general knowledge. This ligament plays an important role, particularly during the growing period, as a "bridge" for blood vessels, and later not only with a supporting but also a braking role in the movement process. The ligament is quite elastic and can slip with a potential for tearing. After removal of the joint capsule, the femoral head ligament became visible and could be studied anatomically. The transverse acetabular ligament was subsequently removed to allow better visualization of the insertions and continuity of the femoral head ligament. Finally, in the anatomic pieces undergoing preservation, the femoral head ligament was meticulously excised to allow further analysis of its orientation towards the insertions and visualization of its fascicles. On its path toward the acetabulum, the ligament branched to form multiple, partially fused fascicles that attached at the acetabular fossa, at the dorsal edge of the transverse acetabular ligament, and at the origin of the caudal extension of the acetabular crest, with extracapsular extension on the cranioventral surface of the body of the ischium.

Investigating the ligamentous structures of the coxofemoral joint, we found that the described Ligamentum capitis capitis ossis femoris is not the only structure that adjoins the Fossa acetabuli, as generally accepted and described in the literature, but also adjoins the Ligamentum transversum acetabuli and is complemented by a "strong accessory ligament" in accordance with previous findings that runs in a caudal direction to attach to the acetabular crest through the incision and extends extracapsularly on the cranio-ventral surface of the body of the ischium.

The study showed that the hip joint in dogs is a complex structure with morphological variations, essential for mobility and action, but sensitive to changes in stability, which can lead to orthopedic disorders such as coxo-femoral dysplasia.

Keywords: ligament, hip joint, dog

Two-year survey on the occurrence of aflatoxin M1 in milk on the territory of AP Vojvodina

Konstantin Nikolić[1*], Marko Damjanović[1], Darko Guljaš[1], Borislav Iličić[1], Igor Jajić[1], Saša Krstović[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

**kokilaucilose@gmail.com*

Aflatoxins are toxic secondary metabolites commonly found in food and feed. Aflatoxin M1 (AFM1) occurs in milk excreted by ruminants that have consumed feed contaminated with aflatoxin B1 (AFB1). A great hazard to animal and human health is that some of the most commonly contaminated feedstuffs are among the most used in Serbia. The aim of this study was to investigate the occurrence of AFM1 in raw milk from 2023 and 2024 in the Autonomous Province of Vojvodina. The number of samples collected and analyzed in 2023 and 2024 was 112 and 90, respectively. The samples were analyzed using the Enzyme-Linked Immunosorbent Assay (ELISA) technique. Samples collected in 2023 had concentrations of AFM1 ranging from 0.024 to 0.945 µg/kg, whose median value amounted to 0.130 µg/kg and an average concentration of 0.196 µg/kg, excluding one sample with a concentration lower than the limit of quantification (LOQ = 0,005 µg/kg). Concentrations of AFM1 in samples from 2024 ranged from 0.008 to 1.356 µg/kg, with a median value of 0.176 µg/kg and an average value of 0.287 µg/kg, while 3 samples (3.33%) had concentrations lower than LOQ. The highest permitted concentration of AFM1 in milk set by the Serbian regulation (0.25 µg/kg) was exceeded in 30 (27.03%) samples from 2023 and in 35 (38.89%) samples from 2024, while the maximum limit set by the European regulation (0.05 µg/kg) was exceeded in 96 (86.49%) and 76 (84.44%) samples from 2023 and 2024, respectively. According to the Republic Hydrometeorological Service of Serbia, average maximum daily temperature for July of 2023 was 31.55 °C, while the average for July 2024 was more than 1.5 °C higher at 33.12 °C. High air temperatures contribute to the production of AFB1 in feedstuffs, therefore the difference in the average maximum daily temperatures could explain the difference in average concentration of AFM1 in milk. The large number of positive samples indicates that the concentration of AFB1 in feedstuffs is not managed properly. In order to minimize AFM1 occurrence in milk, it is important to control AFB1 contamination in dairy animal feed. The application of good agricultural practice and regular monitoring is crucial for the production safe food and feed.

Keywords: climate change, ELISA, Serbia

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Collaborative resource utilization of forage species in pure and mixed stands

Simon Chidera Ugwoke[1*], Svetlana Vujić[1], Đorđe Krstić[1], Sanja Vasiljević[2], Branko Ćupina[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

[2]Institute of Field and Vegetable Crops, Novi Sad, Serbia

**maximillianchidera@gmail.com*

The environmental consequences of conventional agricultural practices, heavily reliant on monoculture systems, are becoming increasingly unsustainable. This study investigates the biomass yield and quality of diverse forage species grown as pure stands and as mixtures in four growth stages, focusing on their mutualistic relationships and potentials for improving biodiversity. A field trial, arranged in a randomized block design with three replications, included pure stands of field pea (FP), common vetch (CV), phacelia (P), oil radish (OR), spring oat (O), spring barley (B), and mixtures of increasing complexity, ranging from two-species combinations 2C - (CV+B) to six-species mixtures 6C - (CV+B+OR+FP+O+P). The species selection prioritized a diverse range of growth habits, nutrient requirements and potential for positive interspecific interactions where the strengths of each species could complement the others, leading to a synergistic effect in resource utilization. The trial was set up on March 2022 at the Experimental field of the Institute of Field and Vegetable Crops, Novi Sad, Serbia. The first measurement was in the first half of May, while others were done seven days after the previous one. Despite challenges posed by extremely low precipitation, preliminary results showed a consistent increase in biomass yield from the first to fourth measurement in all treatments, with a significant ratio of cereals in the yield of the mixtures contributing a substantial proportion of the total yield in mixtures. The highest green forage yield was recorded in the six-species mixture (6-C), reaching 9617.1 kg/ha at the final growth stage. This dominance influenced forage quality by shifting the nutrient balance particularly reducing crude protein concentration due to the dilution effect from cereal biomass. In conclusion, the study suggests that the observed increase in biomass yield, particularly in mixtures with a higher proportion of cereals, demonstrates the benefits of intercropping, including improved resource use and enhanced nutrient cycling, but also highlights that strategic species selection influences forage nutritional composition, with important implications for animal production systems.

Keywords: forage, resource-use, intercropping, sustainability

Encapsulation of *Bradyrhizobium sp.* and *Trichoderma harzianum* T1: Boosting Nitrogen Levels in Soybean

Marko Vinceković[1*]

[1]University of Zagreb, Faculty of Agriculture, Department of Chemistry, Zagreb, Croatia

**mvincekovic@agr.hr*

The sustainable growth of soybean (*Glycine max*) is vital for agriculture due to its significant role in nitrogen fixation and contribution to soil health. This study investigates the encapsulation of beneficial microorganisms, specifically *Bradyrhizobium* sp. and the fungal species *Trichoderma harzianum* T1, to enhance nitrogen levels within soybean crops. Given the growing pressures of environmental degradation and the demand for organic farming practices, the fusion of microbial biotechnology with traditional agriculture presents an innovative solution. Encapsulation techniques, utilizing biocompatible materials, were explored to protect these microorganisms from harsh environmental conditions while promoting their survival and efficacy in the rhizosphere. The encapsulated formulations were systematically applied to the seeds of soybean plants in controlled experiments to assess their impact on nitrogen content and overall plant health. Preliminary results indicated a significant increase in nitrogen levels within the soybean plants treated with the encapsulated *Bradyrhizobium* sp. and *Trichoderma harzianum* T1. The synergistic effect of these microorganisms not only enhanced nitrogen availability but also improved root biomass and plant growth metrics compared to control groups. Further analysis included evaluating plant physiological parameters, such as chlorophyll content, photosynthetic rates, and stress responses. Enhancing understanding of the underlying mechanisms by which these microorganisms interact with the soybean plant. We will explain the methodology of encapsulation, the results obtained from the experimental trials, and the implications of these findings for sustainable agriculture practices. Ultimately, this study will highlights the potential of using encapsulated microbial systems as a viable strategy for boosting nitrogen levels and improving crop productivity in soybean, paving the way for more environmentally friendly agricultural practices.

Keywords: co-inoculation, soybean, *Bradzrhiyobium sp.*, *Trichoderma Harzanum* T1, encapsulation

Evaluation of growth dynamics of three soil microalgae

Vladimira Žunić[1*], Dragana Stamenov[1], Simonida Djurić[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

**vladimira.seman@polj.edu.rs*

Soil microalgae play a significant role in soil stabilization and carbon sequestration, also exhibiting potential in pathogen biocontrol and bioremediation. However, they are indeed a largely unexplored compared to aquatic microalgae. Cost-effective production of microalgal biomass is crucial for its usage for different purposes. Microalgae with high growth rate and biomass productivity are valuable in a wide range of biotechnological applications including biofuel production, nutrition, cosmetics and phycoremediation. Optical density (OD) correlates with dry weight concentration. OD could provide successfull monitoring of microalgal growth in laboratory or large scale conditions. Three soil microalgae (isolates 7, 12 and 45) were isolated using solid blue-green (BG11) agar plates. Light microscope identification demonstrated morphological compatibility of isolates 7 and 45 with *Chlorella* sp. *Chlorella* cells are spherical and small with bright green chloroplasts. Additionally, morphological observations showed similarities of isolate 12 with species of the genus *Chlorosarcinopsis*, characterizated by spherical, sarcinoid, green cells. Terrestrial microalgae isolates were grown under autotrophic growth conditions. The culture conditions in this study were at room temperature 24±2 °C and natural day:night (14:10) light cycle for a 24 days. Optical density was measured spectrophotometrically at 680nm, daily until the 11th day and then every third day thereafter. The wavelength of 680 nm corresponds to the peak adsorption of chlorophyll and is specific for green microalgae cells. The results indicate significant differences in OD between the tested isolates. In liquid nutrient medium, microalgae go through lag, log, stationary and death phase thus forming a species specific growth rate. The isolates of the *Chlorella* genus (7 and 45) undergo the lag phase for only six days. After the sixth day, the exponential (log) phase begins when these isolates show the most intense growth. After three weeks of cultivation, the stationary phase is observed for isolate 7 at OD of 3.7 and for isolate 45 at an OD of 4.3. In this phase, the number of newly formed cells is equal to the number of dead cells. Microalgal isolate of the *Chlorosarcinopsis* genus (12) is characterized by generally slow growth in liquid BG11 medium. This alga reached a maximum OD of 2.2 after three weeks of cultivation. Larger cells shows lower OD values compared to smaller cells. This occurs because larger cells exhibit less light scattering. Microalgal growth rate dynamics depends on various conditions such as light intensity, temperature, pH, culture depth etc. Future research is needed to determine the optimal conditions for maximizing biomass production.

Keywords: *Chlorella* sp., *Chlorosarcinopsis* sp., optical density

Vegetative and reproductive growth of the invasive species *Koelreuteria paniculata* Laxm. in public green spaces

Magdalena Pušić Devai[1*], Mirjana Ljubojević[1], Jovana Ostojić[1], Milica Grubač[1], Jelena Čukanović[1], Tijana Narandžić[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

**magdalena.pusic@polj.uns.ac.rs*

Previous research on risk assessment of *Koelreuteria paniculata* Laxm., present in the territory of the city of Novi Sad (Serbia), indicated a high level of invasiveness across different types of green areas. Being widely distributed in non-native habitats, the species exhibits strong competitive ability, producing a large number of seeds and tending to outcompete the surrounding vegetation. Therefore, this study aimed to estimate the crown volume and yield of *K. paniculata* in public green areas in Novi Sad, providing insights for future greenery management practices to reduce seed spread and deposition, thus preventing the formation of soil seed banks that lead to the formation of spontaneous growth of seedlings near the mother plants. For the purpose of this three-year study, adult trees were selected based on their adaptability, vitality, and ornamental value, while their fruits and seeds exhibited a high degree of dispersal across different types of green spaces, including parks, street greenery, squares, urban pockets, residential complexes, and other public areas. The parameters measured to calculate canopy volume included canopy height and canopy diameter, along with the determination of the canopy shape index. The acquisition of seeds was performed using a grid of $1m^3$ size, enabling the estimation of total yield and number of seeds produced per plant. Results showed that the average crown volume of *K. paniculata* over the study period ranged from 0.51 m^3 to 964.08 m^3, while the total yield per tree varied from 0.02 kg to 170. 66kg of seeds, based on the estimated crown volume. The estimated number of seeds per crown ranged from 138 to over 1,29 million seeds. The obtained results indicated the significant vegetative and reproductive potential of *K. paniculata* through extensive tree crown development and the production of large quantities of seeds, posing a serious risk to urban ecosystems if the viability rate proves to be high, as demonstrated thus far. This study establishes a basis for new research aimed at harnessing the high invasiveness of investigated species as a novel source of raw materials for producing sustainable green products. Species utilization-rather than eradication, which could disrupt the existing green infrastructure-could prevent the deposition of viable seeds of this ornamental species in green spaces, thereby mitigating its spread in urban environments.

Keywords: biodiversity impact, canopy volume, invasivness, *Koelreuteria paniculata*, yield estimation

Extraction of chitosan from alternative sources and its role in plant protection

Jelena Ećimović[1], Inmaculada Aranaz Corral[2,3], Saeedeh Pouri[3], Rubén Gil-Gonzalo[3], D. Alonzo Durante-Salmerón[2], Sanja Lazić[1], Slavica Vuković[1], Aleksandra Šušnjar[1], Dragana Šunjka[1*]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

[2]Complutense University of Madrid, Pharmacy Faculty, Department of Chemistry in Pharmaceutical Science, Madrid, Spain

[3]Complutense University of Madrid, Pluridisciplinar Institute, Madrid, Spain

**dragana.sunjka@polj.edu.rs*

The growing global population demands an increasing food supply. The use of conventional pesticides has greatly contributed to enabling high-yield crop production, but excessive use of these chemicals raises concerns about food safety and the environment. Getting food of good quality means that, among the other properties, the amount of pesticides in it does not exceed the prescribed maximum residue limits (MRL values). Using chemical pesticides in agriculture can lead to various negative consequences for human health and the environment. Improper application of plant protection products can also lead to the development of resistance of the target organisms, which makes their control more difficult and increases the cost of food production. In addition, respecting the pre-harvest interval is greatly complicated when favorable conditions for phytopathogenic organisms occur just before harvest, making it necessary to introduce new, safer, active substances. Therefore, it is necessary to identify safe substances that can be used against phytopathogenic organisms and pests, which can be applied alone or as a part of integrated pest management. Chitin is one of the most abundant polysaccharides in nature, after cellulose. It is present in organisms such as crustaceans, insects and fungi. Its deacetylated derivative, chitosan, is well-known for its great potential against microorganisms. Chitosan shows desirable properties such as biological activity, biocompatibility, biodegradability and non-toxicity. The effect on various phytopathogenic organisms depends on molecular weight, degree of deacetylation and concentration of applied chitosan, and the species of the target organism and plant. Chemical characteristics of chitosan depend on the source of chitosan, extraction and modification procedures. Chitosan is derived from chitin from various sources, mostly from crustacean shells, under a combination of alkaline and acid conditions, and high temperatures. In light of the green transition, it is necessary to find alternative sources of chitosan as well as extraction methods that minimize the use of strong chemicals. This study aimed to establish the method for chitosan extraction from a baker's yeast, *Saccharomyces cerevisiae*. The directly extracted chitosan yielded approximately 2%, and it was characterized based on its degree of deacetylation and molecular weight. In addition, Fourier Transform Infrared Spectroscopy analysis confirmed functional groups specific for chitosan. The degree of deacetylation (DD%) was more than 90%, while the molecular weight was medium. An extensive study on chitosan in plant protection highlighted its potential for reducing the usage of chemical pesticides. Evaluating chitosan derived from *S. cerevisiae* against phytopathogenic fungi could represent a valuable step towards more sustainable plant protection strategies.

Keywords: biopesticides, biopolymer, *Saccharomyces cerevisiae*, phytopathogenic fungi

Integrating digital agriculture in higher education – TALLHEDA project story

Nenad Magazin[1*], Svetlana Vujić[1], Branislava Lalić[1], Pavel Benka[1], Aleksandar Sedlar[1], Vladimir Ćirić[1], Effrosyni Bitakou[2], Maria Ntaliani[2], Konstantinos Demestichas[2], Constantina Costopoulou[2], Mladen Radišić[3], Olivera Stojilović Trivunić[3], Angeliki Milioti[4], Branko Ćupina[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia, [2]Agricultural University of Athens, Athens, Greece, [3]Foodscale Hub, Novi Sad, Serbia, [4]Smart Agro Hub, Marousi, Greece

**nenad.magazin@polj.uns.ac.rs*

Digital agriculture (DA) is one of the fastest developing research areas in the European scientific ecosystem. Widening countries are also participating in this development, but with substantial lagging behind non-widening countries. Very important parts of local scientific ecosystems are Higher Education Institutions (HEIs) that can be focal points in DA. Collaboration among HEIs from widening and non widening countries is of crucial importance for achieving excellence in research and education in the DA.

The Horizon Widera project TALLHEDA brought together three European universities, Agricultural University of Athens (AUA, Greece), the University of Novi Sad, Faculty of Agriculture (UNSFA, Serbia), and University of Gent (UGent, Belgium) with the intention to share experience mainly in direction from non-widening (Belgium) to widening countries (Greece and Serbia). Research and education is not limited only to HEIs, hence project includes other important national and local participants in the agri-food sector gathered to form an alliance of DA excellence.

In order to identify the current situation and needs of DA education at HEIs, the first research step within project was to develop a comprehensive online questionnaire for HEIs teaching staff in all three project countries. The questionnaire consisted of qualitative and quantitative research question type which gave descriptive insights through open-ended questions. Very valuable contribution to questionnaire preparation was given by diverse group of stakeholders from all project partners, including not only academic staff, but also researchers and industry partners.

Data, consisted of answers, collected from 100 different participants, were analyzed and processed in order to identify crucial trends, weaknesses, challenges and reform of processes necessary for incorporation of DA within HEIs. The findings were reported back to the stakeholders and are currently being used to shape future strategies to firmly implement DA in education process in HEIs.

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Keywords: digital agriculture, agri-food sector, questionnaire, higher education

White grape marc extract with diverse and high polyphenolic content as a potential beneficial feed additive in animal husbandry

Md Affan Parwez[1*], Tibor Kereszteny[1], Corral Orbe Mishell Stephanya[1]

[1]Hungarian University of Agriculture and Life Sciences, Budapest, Hungary

*Affanparwez@gmail.com

The overuse of antibiotics in animal husbandry has fuelled the spread of antimicrobial resistance (AMR), threatening both animal welfare and public health. Multidrug-resistant bacteria, such as *Escherichia coli* and *Staphylococcus aureus*, exacerbate this crisis, necessitating sustainable alternatives. Polyphenolic plant extracts, known for their antimicrobial properties, offer a promising solution. This study evaluates the antimicrobial properties of white grape marc extract a polyphenolic-rich byproduct of winemaking and its potential as a feed additive in animal husbandry, leveraging its economic and environmental benefits as a valorised waste product. Current research on this topic covers antibiotic types, AMR mechanisms, polyphenol chemistry, and prior studies on grape-derived extracts, establishing a foundation for this work. Our research aimed to assess the extract's antimicrobial activity and its impact on resistance development. The study was conducted using *E. coli* and *S. aureus* strains, with antimicrobial efficacy measured via minimum inhibitory concentrations (MIC), IC95, IC90, and IC50 values. Mutation assays compared resistance induction by the extract versus ciprofloxacin, supported by PCR amplification of *gyrA* and *parC* genes in mutants. Results revealed robust antimicrobial activity against both pathogens, with MIC values indicating potency comparable to traditional agents. Tolerance assays showed limited resistance development with the extract, unlike ciprofloxacin, where *gyrA* and *parC* mutations were detected. These findings suggest that white grape marc extract could reduce reliance on antibiotics in the animal feed, mitigating AMR while promoting sustainability. This study highlights its dual role in enhancing animal health and repurposing winemaking byproducts, offering a scalable, eco-friendly feed additive for future agricultural applications.

Keywords: grape marc extract, polyphenols, antimicrobial resistance, feed additive, sustainability

Anatomical response of *Tagetes erecta* L. to drought and high insolation in urban environments: the role of substrate depth and biostimulants

Milica Grubač[1*], Mirjana Ljubojević[1], Tijana Narandžić[1], Magdalena Pušić Devai[1], Jovana Ostojić[1], Anastasija Vujović[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

**milica.grubac@polj.uns.ac.rs*

Urban green spaces are essential for environmental health and quality of life in cities, yet they face challenges like drought, which strains water resources and threatens their sustainability. Drought is considered the primary factor limiting the growth and development of plants in urban environment, emphasizing the need to select plant species suitable for growing within urban compositions, as well as defining strategies to mitigate drought stress. By combining a light substrate (perlite) with the application of biostimulators, a satisfactory supply of water and nutrients is achieved. In this study, we investigated the anatomical response of *Tagetes erecta* L. to drought and high insolation under semi-controlled conditions. The plants were grown in pots with a diameter of 9 and 12 cm, filled with perlite up to 7 and 10 cm, and treated with biostimulators Stim pure (SP) and Wake-up (WU), while the third group of plants was used as a control and was not treated with biostimulators. The analysis of variance showed that the depth of the substrate had a statistically significant effect on half of the tested parameters, namely: stem diameter (SD), stem cross-sectional area (CSA), phloem area (SWA), xylem-phloem ratio (SW/SC) and the percentage of tracheal area on the stem cross-section ($\%V_{out}$), whereby all the mentioned parameters, except for the last one, had higher average values in the substrate with a depth of 7 cm. The results suggest that plants can be successfully grown in both depths of the substrate, i.e. if there is a need to grow in a very shallow substrate (7 cm) as is the case with extensive roof gardens, their application can be recommended. The effect of biostimulator was statistically significant for all parameters except $\%V_{inn}$ and $\%V_{mid}$, while the effect of the interaction of pot size and biostimulator was not statistically significant only for %PE, $\%V_{mid}$ and $\%V_{out}$. Also, the application of Stim pure biostimulator showed a positive effect on most of the investigated anatomical characteristics of plants cultivated in pots with a shallow substrate depth (7 cm), while control plants showed better performance in a larger substrate volume. This suggests that the biostimulator had a more significant effect in smaller pots, while in larger pots the control plants had a better effect, which proves that a larger volume of substrate is key to a better supply of water and mineral substances, while biostimulators help plants that have a reduced space for better adaptation.

Keywords: drought stress, substrate depth, biostimulants, stem anatomy, urban compositions

Potential of existing green roofs in Novi Sad

Anastasija Vujović[1*], Lazar Pavlović[1], Ksenija Hiel[1], Jelena Čukanović[1], Milica Grubač[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

**anastasija.vujovic@polj.edu.rs*

Urban areas today are characterised by high population density, tall buildings, and a decreasing number of green spaces, leading to a decline in environmental quality, as climate change, natural disasters, and ecosystem disruptions have become more frequent. One way to improve urban living conditions is by creating green roofs, especially as modern architectural designs increasingly feature flat roofs, unlike traditional attic structures, providing ample opportunities for their implementation. Green roofs can help restore natural ecosystems in urban environments and their integration into cities presents an ideal model for planning sustainable cities. This study analyzes the existing green roofs in Novi Sad, Serbia, evaluating their real-world effectiveness and identifying key challenges (e.g., financial, design-related) that limit wider adoption. The research provides crucial evidence-based recommendations to policymakers and urban planners for optimizing green roof implementation as a tool to enhance urban sustainability in mid-sized European cities with similar climatic and socio-economic conditions. The methodology combines a critical review of green roof typologies and their documented benefits with primary data collected through semi-structured interviews with green roof managers, users, and construction professionals. Seven green roofs are examined, and the purpose of the facility on which they were built is determined. There are 2 educational facilities, 3 facilities used for residential and business purposes, and 2 facilities used only for residential purposes. In addition to the purpose of the existing facility, the type of green roof mentioned is determined, where six green roofs are intensive, and only one is extensive. Besides the defined advantages and disadvantages, the results showed the content, vegetation, users, type of maintenance, type of use, surface area, existing installations, the year of construction, and the principles used in the construction of green roofs. The research revealed that the presence of green roofs in Novi Sad is very limited, mainly due to financial costs, lack of public awareness, and insufficient promotion of this type of greening. The plant selection is mostly adapted to environmental conditions and includes resilient species such as cherry laurel *(Prunus laurocerasus L.)*, Japanese maple *(Acer palmatum Thunb.)*, rosemary *(Rosmarinus officinalis L.)*, lavender *(Lavandula angustifolia Mill.)*, forsythia *(Forsythia x intermedia Zabel.)*, and others. A major drawback is the lack of professional involvement, such as landscape architects, resulting in monotonous and less functional green roof designs. Additionally, raising awareness of the benefits of green roofs through media campaigns, workshops, and green infrastructure initiatives could encourage their further implementation and development. After the conducted analysis, certain measures are proposed about the choice of the plant material, promotion of green roofs, and ways of improving the existing ones.

Keywords: green roof, plants, urban sustainability, environmental quality

An underexplored source of bioactive compounds: A case of *Prunus* by-products

Milica Petković[1], Tatjana Jurić[1], Boris Popović[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

**milica.petkovic@polj.edu.rs*

Prunus is an important genus of the Rosaceae family, consisting of about 430 species of deciduous and evergreen shrubs and trees, distributed across most countries around the world. *Prunus* species have considerable horticultural value and are often grown for their decorative qualities and showy flowers. Their fruits represent an important part of the daily diet and have shown medicinal properties. This is a result of the presence of polyphenolic compounds, which are the main source of biological and antioxidant activities. As a result of large-scale production and commercial use, a significant amount of by-products is generated, including stalks, branches as well as leaves. However, these parts still remain underexplored and underestimated in contrast to the widely researched fruits. In our study, we analyzed aqueous extracts of branches and leaves of the selected *Prunus* species: cherry (*Prunus cerasus*), plum (*Prunus domestica*) and peach (*Prunus persica*). In our work, water extracts from the mentioned *Prunus* species were compared in terms of their contents of total phenols, phenolic acids, flavonoids, and antioxidant activity, evaluated through *in vitro* assays: 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay and ferric reducing antioxidant power (FRAP) assay**.** Among the tested *Prunus* species, the leaves of plum (*P. domestica*) contained the highest concentrations of phenols (406.2 mg gallic acid equivalents/100 g dry weight [dw]), phenolic acids (216.3 mg caffeic acid equivalents/100 g dw) and flavonoids (43.3 mg quercetin equivalents/100 g dw). In addition, this extract exhibited the strongest antioxidant activity capacity among the tested leaves extracts (DPPH: IC_{50}=0.22 mg/mL; FRAP: 1297 µg ascorbic acid equivalents/g dw). Similarly, the plum branches extract also contained a high amount of flavonoids (5.1 mg quercetin equivalents/100 g dw) and showed the strongest antioxidant capacity among the tested branches extracts (DPPH: IC_{50}=0.17 mg/mL; FRAP: 316 µg ascorbic acid equivalents/g dw). In general, leaves of all *Prunus* species contained a higher amounts of total phenols, flavonoids and phenolic acids than branches, except for the cherry (*P. cerasus*), where a higher values of phenols and phenolic acids were measured in the branches. In general, the highest antioxidant activity in all *Prunus* species, according to the DPPH method, was recorded in the branches, while extracts of leaves exhibited the strongest activity in the FRAP assay. This difference can be explained by the specific types of antioxidants present in the branches and leaves, as well as the different mechanisms of action of the applied antioxidant tests. According to the results of our study, the branches and leaves of *Prunus* species are also valuable sources of natural biomolecules with antioxidant activity. Considering that a large amount of by-products is generated during the cultivation of *Prunus*, the alternative use of these resources may therefore be significant for the food and pharmaceutical industries, with the potential contribution to the waste reduction. Our further investigation will be aimed at identifying the specific compounds that contribute to the specific biological activity.

Keywords: *Prunus*, by-products, phenolic compounds, antioxidant activity

The effect of 6-benzyladenine and gibberellin acids on the fruit quality of plum after harvest and fruit storage

Gordana Barać[1*], Nenad Magazin[1], Žarko Kevrešan[2], Jasna Mastilović[3], Biserka Milić[1], Jelena Kalajdžić[1], Maja Milović[1], Aleksandra Bajić[2]

[1]University of Novi Sad, Faculty of Agriculture, Dositej Obradović Sq. 8, Novi Sad, Serbia, [2]University of Novi Sad, Institute of Food Technology in Novi Sad, Boul. Cara Lazara 1, Novi Sad, Serbia, [3]University of Novi Sad, Biosense Institute, Dr Zorana Đinđića 1, Novi Sad, Serbia

**gordana.barac@polj.uns.ac.rs*

During the three-year research (2017, 2019, 2020), the influence of 6-benzyladenine (BA) and gibberellic acid (GA_3) on the fruit quality of the Čačanska rodna grafted onto two rootstocks, Wavit and *Prunus cerasifera* with interstock *Prunus spinosa*, was examined. Bioregulators were applied at the early stage of fruit development (fruit diameter of 12 mm) in the following concentrations: 50 mg L^{-1} BA (BA 50), 100 mg L^{-1} BA (BA 100), and 200 mg L^{-1} GA_3 (GA_3). Fruit quality parameters (weight, size, firmness, skin elasticity, color, soluble solids content, total acids) were measured after harvest, cold storage (20+1) and shelf life (20+3). The effect of bioregulators on fruit quality differed depending on the year and rootstock. A great influence of BA and GA_3 on the weight and fruit size was recorded on the *P. cerasifera/P. spinosa* rootstock, where the greatest impact on their growth was observed in the treatment with BA 100 and GA_3. A significant influence of bioregulators on fruit firmness was recorded after cold storage on *P. cerasifera/P. spinosa*, where the application of GA_3 increased fruit firmness by 19.3% and fruit skin elasticity by 35.5% compared to the control, while BA 100 treatment increased fruit firmness by 13.8% and skin elasticity by 27.8%. After harvest, a significant effect of bioregulators on fruit color was recorded only in the fruit mesocarp where, in both rootstocks, all treatments reduced the lightness (L*) and increased the intensity of the blue color (b*) compared to the control. During fruit storage, a strong influence of the bioregulators on the skin color was recorded after cold storage (20+1). On the Wavit rootstock the application of the BA 50 treatment resulted in a significant increase in the intensity of the red color (a*) by 17% and a decrease in the blue color (b*) by 25%. On the *P. cerasifera/P. spinosa* rootstock, the application of BA 100 treatment increased the lightness of the fruit skin by 10% compared to the control, while the use of GA_3 reduced the intensity of the blue color by 69%. After the shelf life (20+3), all treatments had an effect on increasing the intensity of the red color in the skin of fruits on the Wavit rootstock. The positive effect of GA_3 on increasing the content of soluble solids (SSC) in this research was recorded after the harvest in 2017 in the Wavit, as well as in 2020 on *P. cerasifera/P. spinosa*, while after the shelf life in 2019, the SSC was significantly increased on the *P. cerasifera/P. spinosa* compared to the control. The significant influence of bioregulators on the content of total acids (TA) was recorded on the *P. cerasifera/P. spinosa* rootstock (2017) after fruit harvest in the BA 100 treatment, where there was a significant increase in TA compared to the control fruits, and in the Wavit rootstock (2020) after shelf life in the BA 50 treatment, where there was a significant decrease in TA. In conclusion, treatments with bioregulators contributed to an increase in the values of measured fruit parameters and can therefore be recommended in regular practice.

Keywords: bioregulators, fruit firmness, fruit color, SSC, TA
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Using satellite data to map water availability changes in Ramsar wetland water bodies

Senka Ždero[1*], Zorica Srđević[1]

[1]University of Novi Sad, Faculty of Agriculture, Department of Water Management, Novi Sad, Serbia

**senka.zdero@polj.uns.ac.rs*

Wetlands are unique ecosystems in transitional zones between terrestrial and aquatic environments where plant and animal life have adapted to dynamic changes in water regimes. These ecosystems, typically found in floodplains, river channels, lakes, ponds, and depressions, are today adapted to the prevailing hydrological regime and altered climate patterns, allowing them to continue providing essential ecosystem services (goods and services). Scientific studies have shown that climate change poses the greatest threat to wetlands and the habitats they provide, as changes in hydrological and meteorological conditions alter their functionality. Droughts particularly endanger wetland ecosystems, and the dynamics of natural processes are shaped by intra-annual variations in climatic parameters, resulting in numerous, often irreversible changes. To mitigate these risks, the Ramsar Convention policy is implemented in Serbia, covering eleven designated Ramsar sites. One of these sites is the Special Nature Reserve "Koviljsko-Petrovaradinski Rit" (KPR), located in the northern part of Serbia, in the Vojvodina Province. Recent research indicates that many Ramsar sites in Serbia increasingly face reduced water levels during the summer months and, in some cases, complete drying. Projections suggest that this situation will only worsen, emphasizing the urgent need to monitor and protect these fragile ecosystems. The KPR, a Ramsar site, is classified as the highest protected area category, characterized by wetland habitats, floodplain meadows, muddy shores, and various aquatic and swamp vegetation. As such, it is important to study wetland ecosystems and their responses to changing climatic conditions.

This study aims to identify trends in changes in water availability over the past five years. The research began with collecting high-quality satellite imagery, which implies a good resolution of 3m or 10m and low cloud cover. The delineation of small water bodies, such as ponds, canals, and wetlands, was carried out based on the calculation of the Normalized Difference Water Index (NDWI) and the percentage of water surfaces in the study area of the KPR. The satellite images used cover the period from April 2020 to September 2024.

NDWI values successfully delineate water bodies from other land cover types, such as dry vegetation, soil, and urban areas, with values greater than 0 representing water areas. Based on this, the polygons were created, and the percentage coverage of water areas was calculated. Trends in coverage changes can be observed, particularly during the summer months. However, it is remarkable that reduced water coverage on KPR is also evident during other months, such as April, May, and September. This suggests that dry/rainless periods significantly impact water availability and coverage in wetland water bodies, limiting their ability to fulfill key functions such as supporting biodiversity, maintaining ecological minimums, providing irrigation, supporting fishing, and filtering nutrients. The findings can help reveal ecological changes in KPR and guide future research directions, especially regarding the spread of invasive species, impacts on water quality and reduced groundwater recharge, biodiversity degradation or loss, and even changes in ecosystem composition.

Keywords: wetlands, drought effects, delineation water, satellite data

Soil physical properties in pea-wheat intercropping

Ksenija Mačkić[1*], Đorđe Krstić[1], Svetlana Vujić[1], Srđan Šeremešić[1], Velimir Mladenov[1], Bojan Vojnov[1], Elena Antunić[1], Branko Ćupina[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

**ksenija.mackic@polj.uns.ac.rs*

Intercropping has the potential to improve soil physical properties for enhanced soil function. Primarily it refers to water retention, water infiltration, hydraulic conductivity, and aggregate stability. The extent to which intercropping can contribute to improving stated properties depends on the selection of crops and their mixture and environmental conditions. Under the Horizon Europe IntercropVALUES project (https://intercropvalues.eu) research team from the University of Novi Sad, the Faculty of Agriculture (UNSFA) established a two-year field experiment within the network of on-station field experiments in organic and conventional management. The experiment set-up and measurement follow the common protocol delivered by the project. The field trial was established in autumn 2023; winter and spring wheat and pea varieties as sole crops and intercrop mixtures were sown. The ongoing trial analyses soil water properties as one of the soil health parameters to determine the indicators that best respond to intercropping. The Beerkan method was used to measure soil infiltrability. The steady-state infiltration rate was calculated for selected treatments and replicate block at two sampling times (sowing and harvest). Before installing the cylinders, the soil was sampled for initial gravimetric water content and dry bulk density, and at the end of the measurement, the saturated soil was sampled to determine the saturated gravimetric water content. During the growing period, the soil water dynamics and gravimetric soil water content were monitored. Spatial and temporal distribution of surface and below-surface soil water and water availability are the result of dynamic interactions within intercrop species and the environment. Field observations indicate higher water utilization in the mixture, but without affecting the water properties of the soil. Preliminary results were obtained in an extremely dry year, and to recommend practical measures for this production system further multi-year research is necessary. From the soil water standpoint, in dry conditions, the use of intercropping is challenging in conditions of climate change in temperate regions.

Keywords: soil water dynamics, soil infiltrability, intercropping

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Usage of Multispectral Imaging for Early Detection of Hazelnut Powdery Mildew

Miljan Miljanović[1*], Aleksandar Sedlar[1], Mila Grahovac[1], Nenad Magazin[1], Marta Loc[1], Filip Vasić[1], Lazar Turšijan[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

**miljan.miljanovic@polj.edu.rs*

This research addresses significant topics in the field of contemporary agriculture. Remote detection, as one of the most important branches of precision agriculture that allows monitoring of large spatial areas and the tracking of seasonal and multi-year vegetation changes, early detection of diseases, assessing stress levels in plants, as well as the use of biostimulants, reducing the usage of standard chemical protection in crops. The goal of this research was to determine the possibility of applying vegetation indexes in hazelnut orchards, for early remote detection of powdery mildew, caused by the fungus *Phyllactinia guttata*, and to assess the effect of the biostimulant of plant immune response to the disease. For imaging, a drone with a multispectral camera was used, which can generate several different vegetation indexes: NDVI, LCI, GNDVI, NDRE. The experiment was set up in two experimental groups: biostimulant + fungicide (BF) and standard protection without biostimulant (F) and untreated control group (C). Two imaging sessions were conducted, first in June and second in September. The images were processed using the PIX4DFields software. From the images obtained in June, it can be concluded that the best results were achieved in group (F), while for all indices, the (C) group values were higher than (BF) group. For all indices captured in September, higher values were observed compared to June. In this case, the highest index values were obtained in group (F). Unlike the June images, the results of the LCI, NDRE, and NDVI indices showed higher values for the experimental group (BF) compared to the (C). The plants were also examined visually using a modified EPPO (PP 1/69(3)) method for assessing the effects of fungicides on apple powdery mildew. After inspecting the orchard in the early stages of hazelnut powdery mildew symptom development, similar results were obtained in all parts of the orchard. Over time, in later measurements, the lowest number of infected leaves was observed in the (BF) group. The highest number of leaves with powdery mildew symptoms was recorded in the (C) group. The presence of the pathogen causing hazelnut powdery mildew, *P. guttata*, was confirmed through subsequent microscopic examination of hazelnut leaves.

Analysis showed that remote detection cannot identify any significant differences in vegetative indices between the treated experimental groups. Considering that the control group had similar or higher values for some indices compared to both experimental groups in June, while in September, the lowest values were mostly observed in the control, remote multispectral imaging could not detect the early onset of hazelnut powdery mildew symptoms. The three-dimensional structure of the canopy, along with the fact that the first symptoms of hazelnut powdery mildew appear on the lower leaves, which are shielded from the sun and, consequently, from the drone camera, affected the inability to detect the symptoms early.

The results of the research did not conclusively demonstrate the beneficial effect of biostimulants application in the hazelnut plantation. Better results observed in later measurements suggest a potentially positive effect of biostimulants on the plant's immune system. The authors believe that the short observation period influenced this result and that further research should focus on testing the effects of biostimulants over a longer observation period with additional treatments.

Keywords: hazelnut, vegetation index, remote detection, biostimulator, *Phyllactinia guttata*

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Regenerative agriculture practices in Martonoš: enhancing soil health and microbial activity

Shanika Gajanayake[1]*, Borislav Banjac[1], Branko Cupina[1], Svetlana Vujić[1], Velimir Mladenov[1]

University of Novi Sad, Novi Sad, Serbia

**djshanikaniroshani@gmail.com*

Martonoš, located in the northern region of Serbia along the Tisa River , is an ecological hotspot. Intensive agriculture practices pose a considerable threat to the biodiversity of the region. This case study aims to analyze the impact of regenerative agriculture practices on soil and microbial properties, applied on a 200 ha field in Martonos as part of a TechnoServe U.S.-funded project. Two field expeditions were made to evaluate the present state of the soil and microbial properties. During the first field expedition, which was done in June 2024, prior to regenerative practices, 17 soil samples were taken for planned analyses on plots where parsley, corn, and wheat were grown. The microbial activity was determined by identifying the total number of bacteria, fungi, actinomycetes and azotobacter, using the dilution method on selective nutrient media and counting colony-forming units. Dehydrogenase activity was quantified spectrophotometrically by measuring the color intensity of triphenyl formazan (TPF) at a wavelength of 546 nm . As per observed soil and microbial properties during the first visit, regenerative agriculture practices were applied. Purple vetch, rye, field pea, and fenugreek were planted as cover crops, and compost was applied at the rate of 15 t/ha, before sowing. A flower strip was planted (30% black medic (*Medicago lupulina*), 25% bird's foot-trefoil (*Lotus corniculatus* L.*)*, 25% white clover ((*Trifolium repens* L.), 10% ribwort plantain (*Plantago lanceolata* L.), 5% crown vetch (*Securigera varia (*L.*) Lassen*), and 5% wild carrot (*Daucus carota subsp. sativus*), During the second field expedition, sixteen soil samples in total were taken for further analyses in November 2024. Soil samples analyzed in the first field expedition reported notable findings in both nutrient levels and microbial activity. Humus content was in the low range (1–3%) across most of the plots. The pH levels of the soil were within the optimal range (6.2-8.4). The available phosphorus content varied significantly across the plots, ranging from very low levels (2.52–3.70 mg P_2O_5/100 g) to high levels (29.25–34.59 mg P_2O_5/100 g), suggesting a significant disparity in soil fertility. Available potassium (K_2O) was found to be high across all tested samples. Total bacteria counts ranged from 7.59 to 8.96 log CFU g^{-1}, and DHA ranged from 68.54 to 361.23 µg TPF per 10 g, suggesting active soil microbial processes. The second field expedition was focused on evaluating the impact of regenerative agricultural practices. Microbial activity remained high, with total bacterial counts increasing to 8.13–9.49 log CFU g^{-1}. DHA was lower compared to the first expedition, with values ranging from 42.81 to 142.71 µg TPF per 10 g, possibly due to the compost requiring more time to significantly influence microbial enzymatic activity. The variation in available phosphorus levels across the plots highlights the need for site-specific nutrient management. However, the low humus content in most of the plots suggests that organic matter inputs may need to be increased to improve soil structure and fertility over time. Overall, these results highlight the complexity of soil responses to regenerative practices, where changes in microbial populations may precede observable improvements in soil characteristics, and underscore the need for continued monitoring to assess the long-term impacts of regenerative practices.

Keywords: Cover crops, sustainable agriculture, soil health, soil microbial processes

Regulation and synergistic activity of heat-shock transcription factors in tomato heat stress response

Rada Šućur[1], Velimir Mladenov[1*], Borislav Banjac[1], Teodora Feher[1], Milana Čurčić[1], Sotirios Fragkostefanakis[2]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

[2]Department of Molecular and Cell Biology of Plants, Goethe University Frankfurt, Frankfurt am Main, Germany

**velimir.mladenov@polj.edu.rs*

The heat-shock (HS) response in tomato (*Solanum lycopersicum*) is a valuable model for studying the mechanisms and regulation of transcription. This adaptive process is primarily controlled by heat-shock transcription factors (Hsfs), which play a crucial role in modulating the expression of numerous genes, thus influencing the dynamics of the transcriptome. The ability of Hsfs to confer thermotolerance mainly relies on their regulation of heat shock proteins (HSPs), which help cells cope with stress-induced protein misfolding and accumulation. In tomato, three classes of Hsf transcription factors (A, B, and C) act as key regulators of the heat stress response. Class A Hsfs are distinguished by a C-terminal activator domain, enabling them to function as transcriptional activators. Class B Hsfs contain a conserved LFGV motif in their C-terminal domain (CTD), which is thought to confer repressor activity, while Class C lacks both activator and repressor domains. The heat stress response is triggered by the activity of HsfA1a, which is expressed continuously but remains inactive under normal conditions. HsfA1a is a primary transcriptional regulator of heat stress in plants, playing a key role in forming promoter-enhancer interactions across multiple loci in response to heat. On the other hand, HsfB1 acts as a repressor for several Hsfs but also serves as a co-activator for HsfA1a, with its inhibition leading to an enhanced photosynthetic rate in leaves due to increased accumulation of Hsfs. The heat stress response (HSR) involves the detection of stress signals, activation of heat stress transcription factors (Hsfs), and the production of heat shock proteins (HSPs).

In this study using the Moneymaker tomato variety, the synergistic activity of HSFs was assessed, and the role of histone acetyltransferase in the formation of co-activator complexes was explored. This variety grows uniformly and has predictable physiological responses, which is crucial for experiments that need repeatability. The aim of this research was to addressed the mode of the repressor and co-activator function of HSFA1a, HSFB1, and HAC1 by analyzing transgenic tomato plants with ectopic or suppressed levels of mentioned transcription factors. Eight-week old tomato plants were exposed to heat stress for 1 hour at 39°C in growth chamber, and then allowed to recover for 1.5 hr at 25°C or kept for the same time at 25°C as control. The investigation involved transiently expressing these factors in tomato protoplasts and evaluating their activity using a GUS reporter system. The findings suggest that co-expressing HSFA1a, HSFB1, and HAC1 leads to a strong induction of HS-responsive genes, likely enhancing the tomato's thermotolerance.

Keywords: tomato, heat stress (HS), HS transcription factors, thermotolerance

Using soil legacy data for the assessment of regional nutrient distribution as a fundamental for soil management and fertilizer distribution

Vladimir Ćirić[1*], Pavel Benka[1], Dragana Marinković[1]

[1]Faculty of Agriculture, University of Novi Sad, Serbia

**vladimir.ciric@polj.uns.ac.rs*

Soil data sharing has a significant impact on soil management. Shared data can be utilized in various ways. The most effective use of soil big data involves environmental and biodiversity protection, land management, and regional fertilizer distributions. Unification of coordinate reference systems for 170.000 georeferenced soil samples at 0-30 cm depth across Central Serbia (55.968 km²) resulted in six regional maps displaying soil nutrients and properties: pH H_2O, pH KCl, $CaCO_3$, soil organic carbon (SOC), P_2O_5 and K_2O. Results show that 33.76% of the soils in Central Serbia are moderately acidic (5.6-6.0) to acidic (<5.5), while 39.02% are slightly acidic (6.1-6.5). The remaining soil area (27.22%) has a neutral pH (6.6-7.3). Soil lime content ranges from 0-2% in 92.36% of the area, while the other areas are moderately calcareous (2.1-5%). The SOC content varies between 6,37-11,5 g kg^{-1} across 32,08 % of the soils, while the SOC content between 11.6-23.2 g kg^{-1} occupies 53.11% of the soils. Rest areas at higher altitudes have SOC levels ranging from 23.3-58 g kg^{-1}. Available phosphorus (P_2O_5) content ranges between 0-5 mg/100g (very low) in 1,8% of the total area, 5-10 mg/100g (low) in 18,09%, 10-15 mg/100g (moderate) in 72.31%, and 15-25 mg/100g (optimal) covers 5,34% area. The remaining area has high P_2O_5 content. Potassium (K_2O) content ranges from 5-15 mg/100g (below optimum) in 19.68% of the investigated area, 15-25 mg/100g (optimal) in 67.61%, and 25-40 mg/100g (above optimal) is determined in 12.71% of soil cover. These results indicate that K_2O fertilization is not always necessary, and that P_2O_5 content is below optimum in 94.66% of the land, providing valuable foundation for national fertilizer advisors and rational regional distribution to farmers. The observed fertilization practices in Central Serbia, along with other soil properties, can offer valuable insights for implementing changes in soil management.

Keywords: soil data, maps, fertilizer distribution

Sustainable and nutritional potential of insect-based protein bars

Zsolt Matyas*[1,2], Loredana F. Leopold[1,2]

[1]Faculty of Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine, 3-5 Calea Mănăștur, 400372, Cluj-Napoca, Romania;

[2]Life Sciences Institute, University of Agricultural Sciences and Veterinary Medicine, 3-5 Calea Mănăștur, 400372, Cluj-Napoca, Romania;

**zsolt.matyas@student.usamvcluj.ro*

With the continued rise in global population, the urgency of securing sustainable and nutrient-rich food sources has intensified. Edible insects, *Acheta domesticus* (house cricket) and *Tenebrio molitor* (mealworm), offer a compelling alternative to conventional protein sources due to their high protein content, essential fatty acids, and rich mineral profile. This study investigates the development of a high-protein bar incorporating varying concentrations of insect flour (10%, 20%, and 30%), combined with oat flour and coconut oil. Standard analytical methods, including Kjeldahl, Soxhlet, and gravimetric analysis, were employed to determine protein, lipid, carbohydrate, and ash content. Analyses revealed that increasing the proportion of insect flour led to a higher protein content (up to 19.03% in cricket-based bars and 18.05% in mealworm-based bars), while also influencing lipid and carbohydrate levels. Mealworm-enriched bars exhibited the highest lipid content (22.64%), whereas carbohydrate levels decreased with increasing insect flour concentration. Sensory evaluations demonstrated a high acceptance rate among untrained panelists, with the 30% mealworm-based bar emerging as the most preferred option. These findings underscore the nutritional and environmental benefits of insect-based protein bars, positioning them as a viable and sustainable food option. Future research should explore large-scale consumer acceptance and refine formulations to further enhance sensory attributes.

Keywords: sustainable protein, edible insects, alternative nutrition, food innovation, consumer acceptance

Screening the epiphytic yeast communities for sustainable biocontrol of apple blue mold

Tatjana Dudaš[1*], Giuseppe Celano[2], Pietro Cotugno[3], Mila Grahovac[1], Vera Stojšin[1], Dragana Budakov[1], Antonio Ippolito[2], Simona Sanzani[2]

[1] University of Novi Sad, Faculty of Agriculture, Department of Plant and Environmental Protection, Novi Sad, Serbia, [2] Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari Aldo Moro, Bari, Italy, [3] Biology Department, University of Bari Aldo Moro, Bari, Italy

**tatjana.dudas@polj.edu.rs*

Modern plant disease management requires alternatives for chemical fungicides, due to public concerns about their toxicity and environmental impact, the emergence of fungicide-resistant pathogens, increasing bans on existing fungicides, and a decline in the registration of new ones. Biological control is recognized as a promising alternative or addition to fungicides and a part of integrated pest management (IPM). However, the large-scale adoption of biocontrol is challenging mainly due to the lack of effective commercially available biocontrol agents (BCAs). The same challenge applies to the biological control of apple blue mold caused by *Penicillium expansum*, a major postharvest disease that raises both economic and health concerns due to mycotoxin contamination. Therefore, identifying new BCAs for controlling apple blue mold is of great importance. Successful BCA selection requires understanding of the pathogen, the host plant, and the cultivation practices of the given crop. This approach enables the selection of BCAs that effectively control the disease and are well-adapted to the production conditions of a specific agroecosystem. The most promising BCAs are generally found in environments where plants remain healthy despite the high inoculum pressure. In our study, putative biocontrol yeast strains were collected from the surface of apple fruit using the sterile swab and streaked onto the YPD min medium. Following incubation (48 h at 25±1 °C), 80 isolates were obtained, and screened for antagonistic activity *in vitro* using a dual culture assay. The plate was divided in two halves: in the center of one half, 10 µl of conidial suspension (10^4 conidia/mL) of the pathogen was placed, while on the other half, a loopful of yeast cells was streaked as a vertical line. Control plates were inoculated with the pathogen alone. After incubation (10 days at 25±1 °C) the pathogen's colony diameter in dual culture was compared to the control. A total of 20 yeast strains demonstrating the highest inhibitory activity *in vitro* (growth inhibition >30%) were further tested *in planta*. Healthy fresh apple fruits (cv. Golden Delicious) were surface sterilized, then wounded (3 × 3 mm) in 4 equidistant places near the peduncle. Wounds were treated with 10 µL of yeast suspension (10^7 cells/mL), while positive control fruits were treated with sterile distilled water. Once dried, the same wounds were treated with 10 µL of pathogen suspension (10^4 conidia/mL), while negative control fruit were treated with sterile distilled water. After incubation (7 days at 22±1 °C) disease incidence (infected wounds, %) and severity (lesion diameter, mm) were assessed. One yeast strain showed remarkable success in suppressing blue mold development on apple fruit, achieving the result on the same level of statistical significance as the negative control. This strain was selected for future research, including detailed identification, investigation of its mode of action and patulin degradation potential, as well as the efficacy assessments in the orchard trials. Future research will focus on optimizing the formulation and scaling-up production, which are essential steps before registration and market introduction. These results emphasize the potential of epiphytic yeasts as BCAs against *P. expansum*. The development of an effective yeast-based biocontrol product could provide a sustainable alternative to synthetic fungicides.

Keywords: Biocontrol agents, yeast, apple blue mold, *Penicillium expansum*, sustainability

Effect of mastitis on hematological parameters in dairy cows

Jovan Stanojević[1*], Miodrag Radinović[1], Marko Cincović[1], Zorana Kovačević[1], Mihajlo Erdeljan[1], Tijana Kukurić[1]

[1]Department of Veterinary medicine, Faculty of agriculture, Novi Sad, Serbia

**jovan2912@email.com*

Mastitis is defined as inflammation of the udder and presents one of the most important diseases in dairy cows, leading to significant economic losses due to reduced milk yield and milk quality. Besides, mastitis affects the entire cow's organism, causing changes in metabolic and hematologic parameters in blood. The aim of this study was to investigate the effect of clinical and subclinical mastitis on the hematological parameters in dairy cows. The study included 60 Holstein Friesian cows with the same body score condition and in the same stage of lactation. All cows were divided into three groups of 20 each: clinical mastitis, subclinical mastitis, and a control group of healthy cows. The cows with a clinical form of mastitis were detected based on the presence of signs of inflammation in the udder, including swelling, pain, redness, and changes in the first jets of milk characterized by the presence of clots, color alterations, and density variations. Cows with a subclinical form of mastitis were detected using the California mastitis test (CMT). Blood was sampled from the jugular vein after morning milking, and blood samples were analyzed for white blood cells (WBC), red blood cells (RBC), hemoglobin, hematocrit, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), neutrophils, and lymphocytes. A significant increase ($p<0.05$) in WBC and neutrophils was recorded in the cows affected by the clinical form of mastitis compared to healthy cows. On the other hand, a significant decrease ($p<0.05$) in lymphocyte count was recorded in cows with subclinical mastitis compared to cows affected by clinical mastitis or healthy ones. Red blood cells, MCV, MCH and MCHC didn't show significant differences between examined groups of cows. In conclusion, mastitis significantly affects the number of white blood cells, while it does not have a significant effect on the number of red blood cells in cows.

Keywords: cows, mastitis, hematological parameters

Effects of biocontrol on alternaria apple fruit rot

Aleksandra Delić[1*], Tatjana Dudaš[1], Milica Meseldžija[1], Dobrila Kovačević[1], Teodora Mihaljfi[1] Dragana Budakov[1], Vera Stojšin[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Republic of Serbia

**aleksandra.delic@polj.edu.rs*

In intensive apple production, the use of synthetic fungicides is inevitable in order to control phytopathogenic fungi that cause postharvest decay in fruits. However, the intensive use of chemicals impairs the safety and quality of products and affects human health and the environment. Also, the frequent use of synthetic fungicides poses a risk for the development of resistant pathogen populations. Most fungicides applied during vegetation do not provide complete protection of fruits during storage, while postharvest application of fungicides is increasingly limited because of environmental, toxicological and health risks. Therefore, fruits remain unprotected and susceptible to infection during and after harvest and this is the crucial problem for which biocontrol agents can offer effective alternative. The experiment evaluating the biological efficacy of a biocontrol agent (BCA) from the genus *Pichia* was conducted in two commercial orchards in Serbia, located in Titel and Mala Remeta, on the cultivar Golden Delicious. The following treatments were tested, all applied foliarly: 1) synthetic fungicide based on the active ingredient fludioxonil (GEOXE® 50 WG, Syngenta), applied at a concentration of 0.45 kg/ha (450 g active substance per hectare) 14 days before harvest; 2) BCA (*Pichia* spp.) applied at a concentration of 10^7 cells/ml (1,000 l/ha; 0.2 l per tree) 7 days before harvest; 3) BCA (*Pichia* spp.) applied at the same concentration 2 days before harvest; 4) untreated control. Also, 40 fruits from treatments 2-4 were dipped into a suspension of the BCA spores (*Pichia* spp.) after harvest. In order to prevent cross-contamination between treatments, 100 fruits from each treatment were stored separately in normal atmosphere (NA) storages for 5 months and subsequently 14 days for shelf life. Afterwards, the occurrence of Alternaria rot was evaluated.

Based on the results obtained during the experiment, all treatments for management of Alternaria apple fruits rot control, applied during the growing season, as well as post-harvest and before storage, gave positive effects compared to the untreated control. In Titel, a lower efficacy of fludixonil was recorded (62.50%) in relation to all BCA treatments, while in Mala Remeta, the efficacy of synthetic fungicide and BCA treatments was equal (100%). The best results in Titel were achieved with BCA application seven and two days before harvest (93.75% and 93.75%, respectively), while in Mala Remeta treatments with BCA seven and two days before harvest with dipping of fruits in spore suspension (both 100%) were the most effective.

The results suggest that *Pichia* spp. could represent a promising alternative to synthetic fungicides for the management of *Alternaria* rot, although further research is needed to validate its efficacy under various storage conditions.

Keywords: Biological control, postharvest diseases, sustainable agriculture

Impact of a supercell storm on the plant material of the University park in Novi Sad, Serbia

Ljiljana Marić[1*], Lazar Pavlović[1], Emina Mladenović[1], Vanja Vuksanović[1], Olivera Kalozi[1], Veljko Senić[1], Svetlana Manić[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

**ljiljanaivan6@gmail.com*

University Park belongs to the Liman 1 urban district and is part of the campus of the University of Novi Sad. It covers an area of approximately 6 hectares and is categorized as protective greenery due to its proximity to the defensive embankment and the planned planting of vegetation for land amelioration. At the time of its establishment, the park was planted with the cultivar of the Euro-American poplar (*Populus* x *euramericana* /Dode/Guinier, clone I-214), and later, other species from the genera *Celtis* and *Tilia* were planted. The dominant Euro-American poplar, whose trees are now in the stage of biological aging, represents a potential hazard to park users due to frequent breakage. The condition and appearance of the poplars in the park were further worsened in July 2023, when the park suffered significant damage due to the impact of a supercell storm. The aim of this study is to examine the impact of the supercell storm on University Park by analyzing changes in the composition of vegetation before and after the event. To assess the impact of the storm on the plant material of University Park, this study analyzed data from research conducted in 2021, when a plan for the phased replacement of old vegetation was developed, as well as research from 2023, carried out one month after the storm, and research from 2024. These three analyzed researchs was conducted by the Faculty of Agriculture in Novi Sad. The comparative trend analysis included the number of species and the number of trees in the park, as well as their morphological characteristics, with significant differences observed between 2021 and 2024. Data analysis revealed that between 2021 and 2023, certain species were additionally planted, and individual trees were removed in accordance with the 2021 plan. However, the storm caused significant damage, leading to the removal of 34 trees of the *Populus* x *euramericana* species. The 2024 study pointed to intensive planned planting after the storm, with an increase in the number of individuals mostly from the genera *Celtis* and *Tilia*, as well as other plant species. The research shows that while the supercell storm caused significant damage, it contributed to the acceleration of the planned replacement of old trees in University Park. The gradual process of tree replacement, which began before the storm, has now been expedited, allowing for the revitalization of plant material and the introduction of new plant species, making the park biologically and aesthetically richer.

Keywords: revitalization, *Populus* x *euramericana*, supercell storm, plant material

The Impact of Industrial Farming on Biodiversity in the Republic of Serbia

Jovana Grba Ilić[1], Saša Dragin[1], Tamara Papović[1*], Željka Jurakić[1]

[1] University of Novi Sad, Faculty of Agriculture, Department of Animal Science, Novi Sad

**tamara.papovic@stocarstvo.edu.rs*

Agriculture is a cornerstone of Serbia's economy, contributing 10% of its GDP and employing 20% of the workforce (Statistical Office of Serbia, 2022). In past three decades, the sector has shifted from small-scale farming to industrialized practices characterized by monocultures, mechanization, and intensive agrochemical use. While this transition has boosted crop yields, it has also triggered ecological disruptions, including soil degradation, water pollution, and biodiversity decline. This paper examines the impacts of industrial farming on Serbia's biodiversity through a review of land-use changes, agrochemical use, habitat fragmentation, and case studies of vulnerable ecosystems. Data from government reports, academic studies, and environmental assessments indicate significant declines in native species and soil degradation. Industrial farming has converted 15% of Serbia's natural grasslands and 8% of its wetlands into arable land since 2000. In Vojvodina (North Serbia authonomous region), over 75% of farmland is dedicated to monocultures. Pesticide use is increased by 40% between 2015. and 2022., with herbicides like glyphosate dominating applications. Excessive fertilizer runoff has eutrophied water bodies, reducing fish populations in the Danube region. Soil biodiversity has declined, with earthworm density dropping by 30% in intensively farmed areas. The findings align with global patterns linking industrial agriculture to biodiversity loss. Monocultures and agrochemicals simplify ecosystems, reducing niches for native species. Decline of pollinators, particularly bees, jeopardizes food security, as 70% of crops depend on insect pollination. Habitat fragmentation further isolates populations, increasing extinction risks. Socioeconomic drivers, like subsidies for large-scale farms, exacerbate these trends. The analysis highlights the need for integrated policies that balance agricultural productivity with biodiversity conservation. Recommendations include promoting agroecological practices involve to adopt farming techniques that integrate ecological principles and reduced agrochemical use, strengthening protected areas that could provide refuge for vulnerable species and allow ecosystems to function naturally and enhancing monitoring systems, enabling more informed policy decisions and effective conservation strategies.

Keywords: Industrial farming; biodiversity; habitat fragmentation

Urban lawns in Podbara neighborhood, a district of Novi Sad: challenges and opportunities for environment improvement

Ivana Sentić[1*], Svetlana Vujić[2]
[1]University of Novi Sad, Faculty of Agriculture, Department of viticulture, horticulture and landscape architecture, Novi Sad, Serbia, [2]University of Novi Sad, Faculty of Agriculture, Department of Field and Vegetable Crops,
Novi Sad, Serbia
**ivana.sentic@polj.edu.rs*

Lawns are an essential form of urban green infrastructure. Historically, they served both practical and aesthetic purposes; from medieval castles to English, Renaissance and Baroque gardens to modern one by serving sociological functions and providing spaces for recreation and relaxation. In the light of climate change, especially in urban areas, lawns have become increasingly important for addressing ecological challenges. They contribute in regulating the water cycle, reduce air pollution, mitigate the heat island effect, promote cooler microclimates, and contribute to biodiversity by providing habitats for urban wildlife. Additionally, lawns are areas for rest and recreation.

Located in northern Serbia, the city of Novi Sad has a long history of urban greening, dating back to the Austro-Hungarian Empire. In the late 18th century, under Empress Maria Theresa, citizens were required to maintain their yards and green spaces in front of their houses to ensure a healthy living environment. After World War II, city parks were designed to reflect evolving urban needs and social changes. Combining functionality and aesthetics, lawns played a key role in this development. However, during the wave of urbanization, many green spaces were lost. In the Podbara neighborhood, a district of Novi Sad, lawns have remained as dominant green elements. This paper aims to raise awareness about the poor quality of environment in the Podbara district caused by urbanization, with special emphasis on lawns as the most prominent green space elements.

A key indicator of urban quality of life is the amount of greenery per capita. In European cities, the standard is 15 to 25m² per resident. Between 1999 and 2009, Podbara's population increased by 20% due to extensive multi-family housing construction, resulting in a reduction of green spaces. It covers approximately 100 hectares, with only 25% consisting of greenery, mostly small tree groups, treelines, or low grass cover. A significant change in the area has been the replacement of private green yards with parking lots in new residential complexes, and the loss of former grassy areas that stood in front of houses. Currently, there are only 1.9 m² of greenery per resident. The quality of the lawns was assessed using the National Turfgrass Evaluation Program (NTEP), developed to evaluate the quality of turfgrass varieties intended for lawn establishment. NTEP evaluates aesthetic characteristics such as color, density, texture, uniformity and quality of the lawn, and the presence of pests or diseases by ranging the each parameter on a scale from 1 to 9—where 1 indicates the lowest quality or dead grass, and 9 represents the highest quality or ideal turf. The evaluation was conducted in March 2025 on a representative grassy area of 2.3 hectares in the northeastern part of Podbara, along the Danube River near the Belgrade Quay and Žeželj Bridge. The evaluated aesthetic characteristics of lawn received scores ranging from 3 to 8. The lowest score of 3 indicated poor lawn quality in some areas due to minimal maintenance efforts, while the highest score of 8 reflected the high quality of the selected species and varieties used in lawn establishment. These findings highlight the disruption of ecosystem services in Podbara, raising concerns about the future of green spaces and environmental quality, the permanent loss of floral meadows, and the growing environmental challenges the city faces.

Keywords: urban lawns, urbanization, green spaces in the city

Influence of litter type on leg muscle fiber diameter of broiler chickens

Dragoljub Marić[1*], Slobodan Stojanović[1], Dragan Žikić[2], Lidija Perić[2], Mirjana Đukić Stojčić[2], Sava Spiridonović[2]

[1]Department of Veterinary Medicine, Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia
[2]Department of Animal Sciences, Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia

**dragoljub.maric@uns.ac.rs*

The choice of litter type is known to affect broiler welfare and productivity, influencing physiological and histological parameters, including the development of skeletal muscle tissue. Despite extensive research on its impact on broiler performance, the specific effects of litter type on skeletal muscle morphology remain insufficiently explored. The aim of this study was to evaluate the impact of different litter types on the morphological characteristics of skeletal muscle tissue in broiler chickens. A total of 255 one-day-old Ross 308 broilers were assigned to three treatment groups, with five replicates per treatment and 17 birds per pen. The treatments consisted of three different litter types: wheat straw (WS), peat (P) and peat with wood shavings (PW). On day 42, ten male broilers from each treatment group were sacrificed, and samples of leg muscles (*m. semimembranosus*) were collected for further analysis. Histological examinations were performed to determine muscle fiber diameter. The analysis of muscle fiber diameter showed significant differences between groups. Broilers reared on peat exhibited significantly larger ($p < 0.05$) muscle fiber diameters (41.26 µm) compared to those raised on straw (38.60 µm). The PW group showed intermediate values (39.63 µm), with no significant difference from the other two groups. The observed differences in muscle fiber morphology suggest that litter type may influence skeletal muscle development in broilers, likely by affecting both physical activity and overall physiological status. These effects may be linked to compromised foot health in broilers raised on straw, which could alter locomotor behavior and subsequently influence muscle adaptation. These findings highlight that litter, as an important environmental factor, influences not only the welfare and health of broilers but also the morphodynamics of muscle tissue development.

Keywords: broiler, bedding material, muscle morphology

Postharvest essential oils treatment: impact on the antioxidant potential of apple fruit

Jelena Vukotić[1*], Marijana Peić Tukuljac[1], Vera Stojšin[1], Dejan Prvulović[1], Jelena Kalajdžić[1], Biserka Milić[1], Mila Grahovac[1], Brankica Pešić[2]

[1] University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, Novi Sad, Serbia

[2] Institute for Pesticides and Environmental Protection, Banatska 31b, Zemun-Belgrade, Serbia

**jelena.medic@polj.edu.rs*

Malus domestica Borkh. is a commercially and nutritionally important fruit species with global production. Rich in antioxidants, apples help reduce oxidative stress in humans and decrease the risk of degenerative diseases. To maintain fruit quality and extend shelf life, alternative postharvest treatments are needed. Compared to conventional postharvest treatments, essential oils (EOs) offer several advantages, including biodegradability, reduced risk of harmful chemical residues, and decreased potential for resistance development in pathogens. Essential oils (EOs) have emerged as a promising natural approach, with various EOs recognized as potential biocontrol agents, among which thyme and wild oregano are particularly notable for their strong antimicrobial and antioxidant properties. The aim of this study was to investigate effect of thyme and wild oregano on the content of phenols (TPC), tannins (TTC), and antioxidant capacity of the treated apples. Apple fruits cv. Golden Delicious were exposed to thyme and wild oregano EOs (manufacturer "Eterra", Serbia) at concentrations 0.08 and 0.16 µl/ml of air in closed plastic boxes. Fruits stored under identical conditions without treatment were used as a control. The effects of the treatments were determined after the incubation of 78 days in cold storage (air temperature 3 ± 1°C and relative humidity 70%) with normal atmosphere. Extracts for further biochemical analyses were prepared by homogenizing 1 g of apple flesh with a 70% methanol solution. The total phenolic and tannin content was quantified spectrophotometrically using a modified Folin–Ciocalteu method, while antioxidant activity was assessed via the ABTS assay ((2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid)). Statistically significant differences were observed among treatments. The application of thyme EO at the concentration of 0.16 µl/ml was the most effective in maintaining phenols and tannins contents, as well as antioxidant capacity of apple fruit during storage. In contrast, wild oregano EO, applied at the same concentration, resulted in a statistically significant decrease in the measured parameters relative to the control. These findings suggest that the type and concentration of EOs influence the biochemical response of apple fruits during storage. Future research should investigate the underlying mechanisms and explore the commercial viability of EO treatments in postharvest management.

Keywords: thyme oil, wild oregano, antioxidant activity, phenolic content

How do imidazolium-based ionic liquids affect the growth and canopy temperature of tomatoes?

Marina Putnik-Delić[1*], Ivana Maksimović[1], Milan Vraneš[2], Aleksandar Tot[2], Philipp Weihs[3]

[1] University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia; [2] University of Novi Sad, Faculty of Sciences, Department of Chemistry, Biochemistry and Environmental protection, Novi Sad, Serbia;
[3]Institut für Meteorologie und Klimatologie, Universität für Bodenkultur, Vienna, Austria;

**putnikdelic@polj.uns.ac.rs*

Ionic liquids (ILs) are promising alternatives to traditional organic solvents. Imidazolium-based ILs have gained popularity in both chemical and industrial applications because of their ease of synthesis and numerous modification options. Additionally, imidazolium-based ILs offer high thermal, hydrolytic, and electrochemical stability, which can complicate their removal from the environment.

This study examines the effects of two commercial imidazolium-based ILs, 1-butyl-3-methylimidazolium chloride ([Bmim][Cl]) and 1-decyl-3-methylimidazolium chloride ([Dmim][Cl]), on tomato growth and canopy temperature. Tomato seeds (Solanum lycopersicum, cv. Alparac) were planted in pots (R=17 cm, V=2L, one plant per pot) filled with universal substrate (Klasmann-Deilmann, Geeste, Germany), supplemented with nutrients (1.5 kg/m3) and high-absorbing clay granules. The pots were placed under semi-controlled conditions (cage house with a glass roof, which allowed for regulation of water availability to the plants). Regular irrigation was provided, as tomato plants require consistent watering. To ensure optimal growth, chemical fertilizers were applied following standard agricultural practices.

When the seedlings were approximately 20 cm tall, each plant was irrigated with 200 mL of a solution containing 0 (control), 10, 100, or 1000 mg/L of [Bmim][Cl] or [Dmim][Cl] (with 4 replications for each concentration). The same treatment was repeated after two weeks.

Ten days before harvest, canopy temperature inside the canopy was measured using a FLIR E50 thermal camera. Temperature readings were taken over three consecutive days at the same time each day. Tomatoes were harvested over 15 days, with the number of fruits and their fresh weight recorded to determine the total yield.

The applied ionic liquids (ILs) impacted tomato shoot biomass and yield, although no significant changes were observed in fruit number. The fresh weight of tomato shoots decreased significantly (by 50%) when exposed to the highest concentration (1000 mg/L) of [Bmim][Cl], and even more so (56%) with [Dmim][Cl], compared to the control and other treatments. The temperature of tomatoes exposed to the highest concentration of [Dmim][Cl] (1000 mg/L) was 3.2°C higher than that of the control plants. Plants treated with [Dmim][Cl] showed visible signs of wilting, which could explain the increase in temperature compared to the control, even at the lowest IL concentration (10 mg/L). Fruits exposed to higher concentrations (100 and 1000 mg/L) of [Dmim][Cl] ripened earlier compared to 10 mg/L and the control.

In summary, the applied ILs had a significant effect on tomatoes, with [Dmim][Cl] showing a stronger negative impact on plant growth, yield, and physiological response.

Keywords: fruit, 1-butyl-3-methylimidazolium chloride ([Bmim][Cl]), 1-decyl-3-methylimidazolium chloride ([Dmim][Cl]), *Solanum lycopersicum* L.

Tree species selection for resilient and sustainable green infrastructure in Novi Sad, Serbia

Lazar Pavlović[1*], Vanja Vuksanović[1], Jelena Čukanović[1], Mirjana Ljubojević[1], Vladimir Ćirić[1], Olivera Kalozi[1], Sara Đorđević[1]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

**lazar.pavlovic@polj.edu.rs*

Urban green spaces are a key component of green infrastructure, contributing to ecological balance, the physical and mental health of the citizens, and the aesthetic enhancement of cities. These spaces, including parks, tree alleys, and other urban greenery, provide essential ecosystem services such as temperature regulation, air pollution reduction, microclimate stabilization and biodiversity conservation. The soil surrounding trees plays a crucial role in their growth and development by supplying nutrients, water, and stability for the root system, which is vital for maintaining plant health in urban environments. This study examines the importance of urban green spaces, with a focus on green spaces along busiest roads in Novi Sad. It also analyzes the chemical properties of soils that influence plant vitality, especially in the context of salinization caused by deicing salts used during winter. Field research was conducted along four busiest roads in Novi Sad, focusing on the analysis of tree species, their health, ornamental value, and soil sampling at selected locations, with an emphasis on the impact of salt. Samples were collected at two depths and laboratory analyses included measuring the content of water-soluble salts, pH values, and electrical conductivity of the samples. Research from 2024 has shown that current concentrations of water-soluble salts in soils along roadways at the selected locations are below the threshold values at which these soils can be considered saline. Specifically, the average content of water-soluble salts in soil layers at the root depth varies from 0.02% to 0.12%, which does not exceed permissible limits. The results indicate that current conditions do not threaten the vitality of trees. However, regular monitoring is recommended, especially after the winter period, which is characterized by low temperatures and increased precipitation. Although the current results do not indicate soil salinization, it is recommended to plant highly tolerant species along roadways that have shown good adaptation to urban conditions and increased levels of water-soluble salts. Furthermore, additional vegetation, such as shrub species, is recommended to improve aesthetic and ecological characteristics of tree alleys next to roadways. Finally, integration of irrigation systems into these green spaces is essential to preserving biodiversity and improving overall urban environmental quality

Keywords: urban green spaces, roadways, soil salinization, tree vitality

Advancing sustainable and resilient European livestock farming through innovative livestock production systems

Milica Kovač[1*], Maja Radišić[1], Olivera Stojilović Trivunić[2], Mladen Radišić[3]

[1]Faculty of Agriculture, University of Novi Sad, Serbia, [2]Foodscale Hub, Novi Sad, Serbia, [3]Faculty of Technical Sciences, University of Novi Sad, Serbia

**milica.kovac@polj.edu.rs*

STEP UP is a Horizon Europe-funded project that aims to enhance the sustainability, viability, and resilience of environmentally and biodiversity-friendly European Livestock Production Systems (ELPS) by, amongst other approaches, analyzing and integrating best practice from particularly innovative livestock production systems (ILPS). ILPS serve as a transformative approach to improving traditional ELPS by embedding advanced technological, ecological, and socio-economic innovations. These systems promote circular livestock farming, optimizing resource efficiency, reducing environmental impacts, and enhancing animal welfare while maintaining economic feasibility.

A core component of ILPS implementation in STEP UP involves the identification, evaluation, and integration of 20+ regionally diverse ELPS and 10-12 ILPS through an extensive case study analysis. Utilizing a multi-actor approach (MAA), STEP UP ensures real-life contextual references and testbeds for assessing and validating ILPS within existing livestock systems. This includes collaborative engagement with farmers, policymakers, researchers, and industry stakeholders to co-develop sustainable livestock solutions tailored to diverse socio-ecological contexts. The project employs state-of-the-art methodologies such as bibliometric analysis, systematic literature reviews, and meta-analysis to derive 20+ key indicators that inform ILPS development and adoption. A major strength of STEP UP's ILPS framework lies in its ability to harmonise existing livestock production data and address gaps through targeted research and innovation. The project leverages data from public sources and previous EU-funded initiatives to construct a comprehensive repository of ILPS characteristics, impact assessments, and best practices. Hierarchical clustering techniques identify NUTS2 regions with similar livestock system attributes, enabling the selection of optimal ILPS case studies.

Implementation of learnings from ILPS within STEP UP also extends to scenario development and impact assessment, using advanced modelling techniques to forecast sustainable transition pathways for European livestock farming. The project quantifies ILPS impacts across environmental, economic, and social dimensions, providing robust evidence to support policy recommendations for a more sustainable livestock sector. Key performance indicators include reductions in greenhouse gas emissions, improvements in animal welfare, resource use efficiency, and economic viability. STEP UP's ILPS implementation is positioned as a cornerstone of the broader transition towards sustainable livestock production, aligning with EU policies such as the Green Deal, Farm to Fork, and Biodiversity Strategies. By fostering multi-actor collaboration and data-driven decision-making, STEP UP's ILPS implementation paves the way for resilient and environmentally responsible livestock farming systems across Europe and beyond.

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Keywords: Sustainable Livestock, ILPS, Indicators, Farming

Storage capabilities of novel apple (*Malus* × *domestica* Borkh.) cultivars

Goran Barać[1*], Maja Milović[1], Jelena Kalajdžić[1], Nenad Magazin[1]

[1]University of Novi Sad, Faculty of Agriculture, Dositej Obradović Sq. 8, 21000 Novi Sad, Serbia

**goran.barac@polj.edu.rs*

Respiration is a fundamental metabolic process in plants that provides the energy required for vital functions. Aerobic respiration breaks down stored organic compounds into simpler molecules such as carbon dioxide (CO_2) and water, releasing energy and consuming oxygen (O_2) in a series of enzyme-driven reactions. This process continues after harvest, accelerating fruit senescence and reducing shelf life. The climacteric phase of apple fruit ripening is defined by an exponential increase in fruit respiration and is triggered by a period of autocatalytic ethylene production. Endogenous ethylene production, along with O_2 and CO_2, plays a crucial role in fruit softening and quality maintenance during storage. This research aimed to determine production levels of ethylene, CO_2 and O_2 in novel cultivars Ivana, Iskra, Gordana and Jerina and three commercial apple cultivars Gala, Red Delicious and Golden Delicious to assess their storage capabilities and improve those characteristics through hybridization and selection. Six fruits of each cultivar were measured and placed in a sealed plastic container (3.6 L) and kept at room temperature (RT, 23±1 ^{o}C) and in cold storage (CS, 2 ^{o}C). Measurements of ethylene, CO2 and O2 levels were taken every 5 to 7 days. As expected, a higher level of ethylene production was observed in fruits kept at RT compared to CS. The highest level of ethylene production after 21 days at RT was observed in Ivana (72.78 µl/g) with an exponential increase after 10 days of storage. Red Delicious showed the lowest ethylene level under the same conditions. After 21 days of CS all cultivars exhibited significantly lower ethylene production, with the highest value of 55.07 µl/g in the Ivana cultivar. The production of CO_2 and O_2 varied among cultivars. The increase of CO_2 in each cultivar was followed by an increase in ethylene production and a decrease in O_2 production. The observed results indicate low storage capabilities of Ivana and Iskra, meaning that further improvement of these cultivars could be achieved by crossing with cultivars known for good storage capabilities, such as Gala or Red Delicious.

Keywords: Ripening, storage, ethylene, breeding

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Assessing the dynamics of urban green spaces using remote sensing techniques

Sasa Orlovic[1], Lazar Pavlovic[2], Dejan Stojanovic[1], Nikola Perendija[1], Olivera Kalozi[2], Lazar Tursijan[2], Vladimir Visacki[1*]

[1] University of Novi Sad, Institute of Lowland Forestry and Environment, Novi Sad, Serbia

[2] University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia

**vladimir.visacki@uns.ac.rs*

Urban green spaces (UGS) play a vital role in enhancing environmental quality, supporting biodiversity, offering social and health benefits, and providing essential ecosystem services such as regulating temperature, sequestering carbon, and improving air quality. However, growing urbanization and environmental pressures pose a threat to these spaces, highlighting the need for effective monitoring and management strategies. Remote sensing has become an indispensable tool for monitoring UGS, enabling efficient assessment of vegetation health, stress detection, and other environmental conditions using satellite and airborne platforms. It is a powerful tool for monitoring, detecting, and analyzing UGS, providing high-resolution spatial and temporal data for informed decision-making.

A variety of satellites with different spatial, spectral, and temporal resolutions enable comprehensive monitoring of UGS. High-resolution satellites such as WorldView-4 (up to 31 cm/px), Maxar Technologies (30 cm/px, up to 16 multispectral bands + 1 panchromatic + 8 SWIR, Short-Wave Infrared), Pleiades (50 cm/px), and PlanetScope (SuperDove, 3 m/px) allow fine-scale vegetation analysis, even in urban green areas as environmental monitoring. The satellites used in this study feature a daily revisitation time, enabling high temporal resolution monitoring of urban vegetation dynamics and associated environmental changes. Multispectral camera captures visible (Red, Green, Blue), near-infrared (NIR), and shortwave infrared (SWIR) bands, while the hyperspectral camera recorded over 250 continuous bands (400-2500 nm), providing high spectral resolution for vegetation and land cover analysis.

Advanced vegetation indices improve the detection of plant stressors, disease outbreaks, and pests infestations in urban green areas. The Red-Edge Chlorophyll Index (RECI) is particularly effective for assessing chlorophyll content and early stress detection. The Modified Chlorophyll Absorption Ratio Index (MCARI) and Transformed Chlorophyll Absorption Ratio Index (TCARI) enhance sensitivity to chlorophyll variations, helping to identify disease onset. Additionally, hyperspectral sensors, such as PRISMA and HySpex, enable early detection of plant stress based on subtle spectral changes.

This study aims to characterize the seasonal dynamics and assess the short-term health status of vegetation in selected urban parks in Novi Sad, Serbia—specifically Futog Park, Liman Park, the New Park on the Boulevard of Europe, and Danube Park—during the year 2024, using remote sensing techniques. The objective is to establish a baseline understanding of vegetation patterns and detect potential stress signals in response to climatic and environmental fluctuations over the course of a single year. The results indicate significant seasonal fluctuations in vegetation health, closely correlated with precipitation variability and temperature anomalies recorded during 2024. Extended dry periods in late spring and mid-summer were associated with marked declines in vegetation indices, particularly in Futog Park and Liman Park, where extensive turfgrass lawns and stands of deciduous trees showed signs of water stress and canopy thinning. In contrast, Danube Park exhibited more stable vegetation conditions, likely due to its denser tree canopy and favorable microclimatic conditions that mitigate evapotranspiration. The New Park on the Boulevard of Europe—

characterized by open, sun-exposed areas with limited shade and no irrigation infrastructure—demonstrated the highest susceptibility to drought-induced stress. This spatial variability underscores the influence of microclimate, canopy structure, and irrigation practices on vegetation resilience within urban environments.
These insights provide a foundational dataset for local authorities to prioritize irrigation planning, enhance drought resilience, and optimize park maintenance. While limited to a one-year observation period, the results establish a baseline for future long-term monitoring and serve as a decision-support tool for sustainable urban greening efforts in the region.

Keywords: remote sensing, urban greenery, multispectral images, vegetation indices, tree stress

The preliminary results of the first survey about fish welfare status on selected rainbow trout farms in Bosnia and Herzegovina

Miroslav Urošević[1*], Jasna Grabic[1], Nebojsa Savic[2], Beata Abramowicz[3], Mariusz Szmyt[4]

[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia, [2]University of Banja Luka, Faculty of Agriculture, Banja Luka, Bosnia and Herzegovina (Republic of Srpska), [3]University of Life Sciences in Lublin, Faculty of veterinary medicine, Department and Clinic of Animal Internal Diseases, Lublin, Poland, [4]University of Warmia and Mazury in Olsztyn, Faculty of Animal Bioengineering, Dep. of Ichthyology and Aquaculture, Olsztyn, Poland

**miroslav.urosevic@stocarstvo.edu.rs*

The welfare status of the fish has direct implications for their production and the sustainability of the industry as a whole. Fish kept under good welfare conditions are less stressed and less susceptible to diseases, and therefore they require less medication and treatment, show better growth rates and food conversion, and ultimately provide a better-quality product. There are not many literature sources on aquaculture in Bosnia and Herzegovina. Based on the actual official data from the Agency for Statistics of Bosnia and Herzegovina, the total production of rainbow trout fish farms in 2023 was 3.766,6 tons, based on the facilities of the surface 110.997,0 m2. To the best of the author's knowledge, there was no research survey on fish welfare status in rainbow trout farms in Bosnia and Herzegovina. It was a reason to arrange screening investigations to check which knowledge and implementation of principles of the function-based approach to fish welfare are present. Our research assessed 7 rainbow trout fish farms in the following municipalities: Trebinje, Šipovo (2 farms), Kneževo, Jezero, and Ribnik (2 farms). The fish farms included in the study had production ranging from 4 tons of fish per year to more than 500 tons, with a total production of more than 1.700 tons. The study included a survey with fish farm production managers and the use of a questionnaire based on "The MyFishCheck" (Tschirren et al., 2021) with more than 20 questions of important parameters i.e. personnel training/ education, daily check, predator protection, plant cleanliness, mortality documentation, biomass documentation, feeding interval and rate etc. Additionally, it made measurements of six water quality parameters on-site using portable instruments in a total of 22 ponds of the aforementioned 7 fish farms. The preliminary results of the sampling of water at the abovementioned fish farms and measured basic water quality parameters (air temperature; water temperature; concentration of dissolved oxygen – DO; % of DO saturation; conductivity; pH) were within the recommended limit and mandatory values in the Directive 2006/44/EC. It is important to notice that in all visited fish farms there has been a decrease in water supply for normal maintenance of fish production in the previous ten years, which is the direct consequence of climate change. Based on the results of the research, it can be concluded that in most fish farms with small production (up to 100 tons per year), knowledge of the basic principles of fish welfare protection is at a relatively low level and that there is considerable space for improvement of the current situation. This primarily relates to continuous education about welfare-related issues, including knowledge of the specific requirements of fish, considerate handling, detecting abnormalities in fish behaviour and fish health and how they react if problems show up.

Keywords: Aquaculture, salmonid fish, aquatic animal welfare

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Environmental surveillance for microbial hazards: lessons from AMR monitoring in Albania

Erinda Lika[1*], Edmond Nurellari[2], Romina Koto[3], Eugen Skura[3]

[1] Veterinary Medicine Faculty, Agricultural University of Tirana

[2] College of Health and Science, University of Lincoln, Brayford Pool, Lincoln, UK

[3] Faculty of Agriculture and Environment, Agricultural University of Tirana

**elika@ubt.edu.al*

Albania, like the majority of Southeastern European countries, is facing increasing problems due to untreated sewage, agricultural runoff, and transboundary water systems all of which are potential reservoirs for resistant pathogens. Environmental surveillance plays a vital role in public health by enabling the early detection of microbial hazards such as pathogenic bacteria, viruses, and antimicrobial-resistant (AMR) organisms in water, soil, and other environmental sources. In recent years, this approach has gained increased attention as part of a global effort to combat the spread of antimicrobial resistance—a growing threat to human and animal health worldwide. By analyzing the sewage for pathogens and Antimicrobial Resistance (AMR) genes, communities can detect early threats early, managing risks more effectively and increase health resilience. It is an excellent tool for public health surveillance since it offers early warning system through viruses and bacteria outbreaks detection (COVID-19, polioviruses, noroviruses), before the clinical cases increase.

According to the World Health Organization (WHO), AMR is responsible for an estimated 1.27 million deaths each year, with tens of millions more affected by resistant infections worldwide. A growing body of evidence indicates that environmental pathways—particularly through untreated wastewater, agricultural runoff, and healthcare effluents—play a significant role in the spread of antimicrobial-resistant bacteria and genes. Environmental compartments, particularly surface waters and wastewater treatment plants (WWTPs), act as both reservoirs and conduits for AMR transmission.

In Albania, the burden of AMR is increasingly evident. A 2023 report by the WHO Regional Office for Europe highlighted that Albania experiences some of the highest resistance rates in the Balkans for common pathogens such as *Escherichia coli* and *Klebsiella pneumoniae*, particularly against critically important antimicrobials like third-generation cephalosporins and fluoroquinolones. While most surveillance efforts have focused on clinical settings, environmental surveillance remains limited, despite increasing concerns over inadequate wastewater treatment infrastructure and antibiotic use in agriculture. For example, only about 25% of urban wastewater in Albania undergoes secondary treatment before discharge into rivers or coastal waters. As a result, rivers and coastal zones—especially in urban centers like Tirana, Durrës, Shkodër—have been found to carry elevated levels of fecal contamination and antibiotic-resistant organisms.

This paper explores the lessons learned from AMR monitoring efforts in Albania, and how they can inform the development of a more comprehensive environmental surveillance system for microbial hazards. By strengthening cross-sectoral surveillance, Albania can improve early detection of emerging threats, protect water quality, and contribute to global efforts in AMR containment.

Keywords: antimicrobial-resistant, environmental, risk management, surveillance

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