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Plenary Session

Transferring Smart Agriculture from the Lab to the Field

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Abstract
Research on how Smart systems can be incorporated into production agriculture is currently a topic of great interst. In order to realise the benefits from research, Smart technologies must be suscessfully transferred from the research laboratory to the field. It is important that researchers, extension professionals and others involved in the implementation of Smart systems into agriculture recognize the challanges that must be sucsessfully addressed. The paper reviews challanges to the on-farm implemention of Smart systems as well as methods that can be used to overcome these challanges. The initial cost, uncertain economic return of Smart systems, and sourcing workers with the required training to operate and interperate informartion provided by Smart systems has limited thier adoption on farms. This presentaion reviews actions that researchers and extension educators can take that can increase the transfer of Smart techjnologies and systems to production agriculture. These actions begin with a dedicated effort by researchers to include economic analysis as a fundamental requirement when researching and reporting on Precision Agriculture and Precision Livestock Farming, other Smart agriculture technologies or systems. Planning and conducting research in an on-farm setting can be more challanging than lab research, but offers the ability to demonstrate Smart systems in a real world setting to producers. Cost-share programs for early adopters can also accelerate the transfrer of reseach from the lab to the farm. Educational programs designed to train workers to operate and maintauin Smart Agriculture systems are of value if trained workers are limited.

Key words: Technology, transfer, smart, agriculture, field, implementation

Imaging-based phenotyping for early detection of plant stress

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Abstract
The aim of this lecture is to present the potential of non-invasive imaging-based phenotyping techniques for early detection and characterization of plant responses to abiotic and biotic stress. Methods such as thermal imaging, multispectral and hyperspectral imaging, X-ray computed tomography (CT), and chlorophyll fluorescence analysis are increasingly used to assess plant physiological status with high spatial and temporal resolution. Through selected examples from recent studies, including nutrient deficiency, drought, salinity, and herbicide-induced stress, we demonstrate that these techniques can reliably detect early physiological changes before visible symptoms appear. Imaging-derived traits such as leaf temperature, spectral reflectance indices, photosystem II efficiency, or morphological changes have shown strong correlations with stress intensity and plant performance. These findings confirm that integrating imaging technologies with automated analysis and advanced statistical methods significantly improves the accuracy and efficiency of plant stress detection. Such approaches hold strong potential for application in both basic physiological research and crop breeding programs.

Key words: thermal imaging, multispectral imaging, chlorophyll fluorescence imaging, x-ray CT,

Plant genetic resources collaboration in Europe for conservation and use

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Abstract
Plant genetic resources stand out as a strategic asset to address existing and emerging global and regional challenges of climate change, food security and environmental sustainability. The European region holds the responsibility and the opportunity to preserve, investigate and utilize its rich resources. In the last forty-five years the European Cooperative Programme for Plant Genetic Resources (ECPGR) has promoted regional cooperation. Its achievements include the European Search Catalogue for Plant Genetic Resources (EURISCO), the European Genebank Integrated System (AEGIS) and the Evaluation Network EVA. The recent Plant Genetic Resources Strategy for Europe identifies the recommended future path, possibly via the establishment of a European Research Infrastructure, to upscale long-term conservation and offer breeders and researchers access to high-quality germplam and services for its study and valorization.

Key words: plant genetic resources, ECPGR, AEGIS, Evaluation Network EVA

Enhancing active learning through syllabus design in animal science: the cases of the Universities of Belgrade and Osijek

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Abstract
A learner-centered syllabus in higher education better serves the students' needs, plays a significant role in their engagement, and has a positive impact on students' perceptions of a course and their motivation to engage in teaching/learning. This study aimed to examine to what extent the designs of the syllabi in the study programs in Animal Science at the Faculty of Agriculture, University of Belgrade, and at the Faculty of Agrobiotechnical Sciences, Josip Juraj Strossmayer University of Osijek, were designed to be learner-centered and to support active learning. Document analysis was used and the following results were obtained: a) the syllabi lacked the key elements of a learner-centered syllabus; b) the course objectives were not adequately defined, having been mostly too general, unspecific; (c) objectives and outcomes were usually set at a low cognitive level; (d) there was often no alignment between the syllabus elements; (e) the required learning materials were limited to the texts, having failed to mention other resources necessary to teach a course; and (f) the analysis of an affective tone proved that the syllabus text was neutral and impersonal, while a research indicated the advantages of an affectively colored syllabus (addressing the students, being pleasantly constructive, etc.). The analyzed syllabi are not designed as the learner-centered ones and therefore do not adequately support active learning at these faculties. The findings indicate a lack of academics' teaching competencies to create the learner-centered syllabi—in fact, they are not trained for this—and an insufficient focus of the quality standards applied in the accreditation of faculties with regard to the teaching/learning quality.

Key words: syllabus, active learning, a learner-centered syllabus, Animal Science, higher education

Session 1

Plant and Food Production

Application of phosphogypsum in wheat production in sandy soil

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Abstract
Phosphogypsum, a byproduct of phosphoric acid production, contains essential nutrients but also traces of heavy metals, raising concerns about its agricultural use. This study aims to evaluate the impact of phosphogypsum as a nutrient source on spring wheat growth while assessing potential heavy metal accumulation. A greenhouse pot experiment was conducted on sandy soil (pH_{KCl}=4.92), where spring wheat were treated with phosphogypsum at doses of 2 and 10 t ha^{-1}. Growth parameters, nutrient and toxic element content of plant and soil nutrient content were analyzed. Phosphogypsum increased the total biomass and wheat grain wheight by 9-10% compared to the control, although this effect was not significant. No statistically verifiable effects were observed for SPAD values or transpiration coefficients between control and phosphogypsum treatments. The nutrient content of grain and straw remained largely unchanged by phosphogypsum application. However, the Mn and S content of straw, as well as the Mn content of grain, significantly increased with higher phosphogypsum doses. Furthermore it is important to note that phosphogypsum application did not lead to increased levels of toxic elements in wheat. The phosphogypsum treatment significantly increased the ammonium-lactate (AL) soluble Ca-content, which is crucial for improving sandy soil structure as well. These results may help to determine the applicability of phosphogypsum as a safe and effective soil amendment and nutrient source for wheat production. The research work was supported by the grant 2023-1.2.4-TÉT-2023-00037.

Key words: phosphogypsum, wheat, sandy soil

Modification of two types of waste brewer's yeast to obtain protein bait for olive fruit fly monitoring and/or control

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Abstract
The brewing process involves several steps and produces considerable quantities of by-products. One of these is waste brewer's yeast (WBY), an inactive yeast rich in proteins, minerals, vitamins and enzymes. Yeasts and yeast products serve as an important food source for Tephritidae and are considered an alternative protein source. Some studies have shown that modified WBYs from different beer producers are attractive to certain tephritids, but the attractiveness to the olive fruit fly (*Batrocera oleae* Rossi) has not been tested so far. Therefore, the aim of this study was to modify WBYs from ale and lager production to obtain protein baits that can be used for monitoring and/or control of *B. oleae*. Both types of WBYs were modified by boiling and digestion with 0.4% papain and then preserved and stored at 4 ^{o}C in the laboratory. After modification, the alcohol and solids content were measured and a nutritional analysis of both modified WBYs was performed. In addition, the volatile compounds of both modified WBYs were identified by HS-SPME-GC/MS. The results show that both modified WBYs contained less than 0.2% alcohol and 27.47 - 43.4% solid content. Analysis of the nutritional values showed that modified WBY from ale had a higher protein and mineral content. It was also found to contain more volatiles. According to the results obtained, both modified WBY have the potential to be promising protein baits and should be tested for their attractiveness to *B. oleae*.

Key words: attractant, fruit flies, lure, olive, sustainable pest management

Antibacterial effect of *Capsicum chinense* pepper extract on bacteria *Erwinia amylovora* and *Escherichia coli*

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Abstract
Bacterial plant diseases are a global problem in plant production, especially on perennial crops, where the disease control is quite complicated, mainly preventive, continous and expensive. Because of the announced ban of many copper-based bactericides, there is need for alternative antibacterials, such as plant derivatives (phenoles, essential oils and glycosides) that are eco-friendly and harmless for humans/animals. Chilli pepper extract posesses analgetic, anti-inflamatory and antimicrobial properties, whereas their effect on plant pathogenic bacteria is poorly characterized. Hence, this study focuses on chilli pepper 'Carolina reaper' extract's antibacterial effect on plant pathogenic bacterium *Erwinia amylovora*, but also on a food contaminating bacterium *Escherichia coli*. The aim of this work was to determine the minimal concentrations necessary for that effect. Viability test method was used, with extracts added to liquid bacterial cultures, and the bacteria inoculated onto solid nutrient medium at time intervals and the colonies counted after incubation. The extract at concentrations of 5% and 10% reduced the viable titer of *E. amylovora* culture, thus showing bactericidal effect. The 5% concentration had a mild bacteriostatic effect on *E. coli*, whereas 10% extract moderately reduced viable titer of *E. coli*, exhibiting mild bactericidal effect. Therefore, we conclude that antibacterial effect of chilli pepper extract is dose- and time-dependent.

Key words: plant extracts, phytopathogenic bacteria, antimicrobials, chilli pepper, disease control

Optimization of nitrogen topdressing of spring barley in continental Croatia

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Abstract
In a three-year field study (2022–2024), the response of the malt variety spring barley (*Hordeum vulgare* L.) to nitrogen topdressing under continental climate conditions was investigated. The aim was to determine the optimal amount of nitrogen to maximise grain yield and protein content. The study was conducted at three locations in continental Croatia (Zagreb, Kutjevo and Osijek) using a randomised complete block design (RCBD) with four replicates. Four treatments were applied: a control without nitrogen (N0) and three nitrogen applications — 40 kg ha^{-1} (N1), 80 kg ha^{-1} (N2) and 120 kg ha^{-1} (N3). The nitrogen was applied in the form of calcium ammonium nitrate (KAN, 27% N) at the tillering stage. Higher nitrogen applications of more than 120 kg/ha were not considered as they offer no agronomic benefits and may pose environmental risks. Standardised conventional agricultural practises were applied uniformly at all trial sites. No statistically significant differences in grain yield were found. However, the highest yields were recorded for the N3 treatment in 2022 (Osijek) and 2023 (Zagreb) and for the N1 treatment in 2024 (Osijek). In contrast, grain protein content varied significantly in the second and third year ($P<0.05$). These results underline the importance of optimising nitrogen topdressing to achieve a balance between yield, grain quality and environmental sustainability.

Key words: spring barley, nitrogen topdressing, continental Croatia

Application of Sentinel-2 data in maize seed production monitoring

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Abstract
Seed production is the key element of any crop production effort. It is a high-input, well-organized endeavor with critical planning of operations such as irrigation, detasseling and harvest. Many factors affect the timing of these operations, relying on work of specialized seed-production personell. Advances in remote sensing technologies such as unmanned aerial vehicles (UAV) and satellites have changed information collection in many areas, such as biodiversity monitoring, agricultural mapping and disaster prevention / prediction. The aim of this work was to utilize the optical multispectral remote sensing data from Sentinel-2 satellite to capture seed production determinants important for operation planning and yield prediction. Data from 147 seed production fields between 2020 and 2024 were collected and combined with remote sensing indices such as NDVI, PSRI, LAI, MSI, NDMI, NDWI, GNDVI, ARI, SIPI, EVI, SAVI, MSAVI, RVI, DVI, NDRE, VARIgreen, NBR, CIgreen, OSAVI, RDVI, EVI2, NGRDI, MCARI, WDRVI. After filtering the data using the data masks, the AUC integrals were calculated for each field. Partial least squares models were used to predict grain yield in sliding window manner with 30-day window size. The results showed that best predictor of yield is AUC between 40-70 days after planting (DAP), capturing water-critical vegetation period, while for predicting grain moisture, the further AUC from 70-100 DAP showed better prediction accuracy. Cross validated R2 values ranged from 0.320 for grain yield and 0.442 for grain moisture. Implications of these results in context of operation-optimization will be discussed.

Key words: maize, seed production, monitoring, remote sensing, Sentinel-2

Transmission of *Ampelovirus trivitis* to grapevine cv. 'Plavac mali' by *Planococcus ficus* (Sign.)

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Abstract
The species *Ampelovirus trivitis*, known as *grapevine leafroll-associated virus 3* (GLRaV-3), is the most widespread virus identified in grapevine. GLRaV-3 is transmitted via grafting of infected plant material and by insect vectors. In the Croatian coastal region, one of the most common vectors is vine mealybug *Planococcus ficus* (Sign.). The aim of this study was to determine the vector-mediated transmission efficiency of GLRaV-3 from infected to virus-free vines using *Pl. ficus*. As a GLRaV-3-source plant variety Grk (GRK-003) from the grapevine virus collection was used. Mealybugs were placed in clip cages on the GLRaV-3-source plant for a five-day acquisition access period (AAP). Then, the potentially virulent mealybugs were transferred to 79 virus-free 'Plavac Mali' plants (PMC-012) and left for a five-day inoculation access period (IAP). The test plants were kept in a greenhouse for five months and afterwards the infection status was determined using real-time RT-PCR. The results of GLRaV-3 transmission with *Pl. ficus* showed successful infection in 11 out of 79 test plants, corresponding to a transmission rate of 13.92%. This study improves the understanding of virus epidemiology in the Croatian coastal region, especially in the case of cv. 'Plavac mali'. Although the transmission rate is relatively low compared to some previous studies, continuous monitoring of the sanitary status of grapevine and *Pl. ficus* populations remains crucial for the control of GLRaV-3 spread.

Key words: virus transmission, vine mealybug, *Vitis vinifera*, real-time RT-PCR

Exploring the insecticidal potential of caffeine for the control of *Halyomorpha halys*: preliminary results

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Abstract

The brown marmorated stink bug (BMSB), an invasive pest from East Asia, damages over 300 plant species and causes economic losses. In urban areas, it hibernates indoors and disrupts daily life, while chemical control poses health risks. Therefore, environmentally friendly control alternatives are needed. In this study, caffeine (CAF) was investigated as a potential biocontrol agent against BMSB. Different CAF concentrations (1%, 3%, 4%, 5%) were tested with solvents - water (H_2O), 3% acetic acid (AC), 5% ethylene (ET) and 1% chitosan (CTS). The adult BMSB were sprayed with these solutions and mortality was determined in four trials over three days at 24-hour intervals. The first trial was conducted with aqueous CAF solutions, while solvent-enhanced efficacy was investigated in subsequent trials. Among the aqueous solutions, 3% CAF + H_2O showed the highest mortality (LD_{50} = 52.5%). The combination of 1% CAF + 1% CTS + 3% AC showed comparable efficacy (LD_{50} = 57.5%) to 3% CAF + H_2O, but higher CAF concentrations (3% - 5%) in different solvent systems decreased efficacy (37.5% - 20%). These results suggest that CTS and AC enhance insecticidal activity at low CAF concentrations, while higher CAF concentrations may have antagonistic effects. Future research should optimize formulations, explore surfactants, and evaluate cost-effectiveness and environmental impacts for sustainable BMSB control.

Key words: brown marmorated stink bug, acetic acid, ethylene, chitosan, insecticidal activity

Attraction of the olive fruit fly to two types of modified waste brewer's yeast

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Abstract
The olive fruit fly (*Bactrocera oleae* Rossi) is the most economically important olive pest. To limit the economic damage and reduce the use of insecticides, sustainable methods must be developed. Current knowledge suggests that various modified waste brewer's yeasts (WBY) attract certain tephritids, but the interaction between *B. oleae* and modified WBY has not yet been investigated. Therefore, the aim of this study was to investigate whether two types of modified WBYs are attractive to *B. oleae*. The behavioral response of adult *B. oleae* to two types of modified WBYs (Ale - *Saccharomyces cerevisiae* and Lager - *S. pastorianus*) at three concentrations was tested in the laboratory and in the field and compared with two commercially available food attractants and water (control). The initial results of the field trail and the results of the laboratory study show that more *B. oleae* were caught in the traps containing all the modified WBYs tested than in the control traps. Compared to the commercial food attractants, the traps containing torula yeast caught the most flies in both trials. This is the first study on the behavioral response of *B. oleae* to modified WBYs. Our results suggest that both types of modified WBYs are attractive to *B. oleae*, but further research is needed.

Key words: attractant, protein bait, sustainable pest management, Tephritidae

Some qualitative properties, minerals and heavy metals in juice and Madzun (grape molasses) produced from Stanushina grape variety

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Abstract
In this study, we analyzed some chemical characteristics and mineral composition of juice and madzun (grape molasses) produced from Stanushina grape variety by traditional method. Madzun (grape molasses) is a natural sweetener widely consumed in the R. N. Macedonia in the past decade and mostly in Eastren Mediterranean countries. It is an important food for humans in terms of mineral content and high energy content (carbohydrates). Comparative analyses have been conducted to one sample juice (S1) and two (S2, S3) samples madzun. As a result of research: soluble dry matter 29.41% (juice) 82.98% (madzun), total sugar 28.04% (juice)-67.99% (madzun), total phenols 875 mg L^{-1} (madzun)-1212 mg L^{-1} (juice) and HDM (hydroxymethyl furfural) were detected in the range of 5.25 mg kg^{-1} (juice) to 723.05 mg kg^{-1} (madzun). In the samples, the macro minerals K, Ca and Mg are ranged from 386-640 mg kg^{-1} (S1)-111.7-375 mg kg^{-1} (S3), 111.7 mg kg^{-1} (S3)375 mg kg^{-1} (S1) and 205.5 mg kg^{-1} (S2)-297 mg kg^{-1} (S1), respectively the range of microminerals was: Fe 11.26-15.18 mg kg^{-1}, Mn 2.42-4.90 mg kg^{-1}, Zn 7.34-17.47 mg kg^{-1}, B 35.2–39.9 mg kg^{-1} and Ba were found between 0.35-0.84 mg kg^{-1}. Regarding the content of heavy metals (Pb and Ni), sample C1 and C2 are above the permissible limits for this type of food. Concentration of metals in grapes is influenced by the microregion of origin and type of soil.

Key words: grape juice, Madzun (grape molasses), chemical composition, minerals

The effects of tillage systems and nitrogen fertilization on the productivity of winter wheat

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Abstract
This paper deals with the effects of tillage systems and nitrogen fertilization on grain yield of different winter wheat cultivars in period 2020/21–2021/22 on the chernozem luvic soil type at Faculty of Agriculture Belgrade-Zemun Experimental field trial "Radmilovac". Winter wheat technology consisted from the following tillage systems: conventional, mulch tillage and no-tillage. Plots were fertilized with two nitrogen levels: rational level (60 kg ha^{-1}) and high level (120 kg ha^{-1}). For testing wheat growing technology, low input varieties (NS Pobeda and NS Zvezdana) and high input varieties (NS Ilina and NS Rajna) were carefully selected. Different tillage systems, nitrogen levels and cultivars were applied in four-crop rotation (maize - winter wheat - spring barley+red clover - red clover). Conventional technology, which includes basic tillage with low and high N levels, had better effect on productivity than both investigated conservation tillage systems (mulch tillage and no-tillage). Good results with mulch tillage suggest that it could be one of the possibilities for rationalizing winter wheat cultivation technology and soil conservation. No-tillage with no fertilization increased weediness, especially in the second year of investigation, and in this variant the lowest grain yield was achieved. Fertilization with high nitrogen levels (120 kg ha^{-1}) led to higher yields compared to the low nitrogen levels (60 kg ha^{-1}), but that was not statistically significant. Low input cultivars of winter wheat, especially NS Pobeda, positively responded to low input technology (mulch and no tillage and rational nitrogen applications) in winter wheat production, with higher yields than high-input cultivars. To obtain high and stable yield of high input cultivars, intensive tillage and N amounts higher than 60 kg ha^{-1} are required.

Key words: tillage systems, N fertilization, cultivar, grain yield

Does an apple a day keep the doctor away? Assessing apple blue mold and patulin contamination risks

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Abstract
Significant economic losses in the apple industry derive from postharvest diseases, such as blue mold caused by *Penicillium* spp. Additionally, *P. expansum* produces patulin, a mycotoxin with strictly determined legal limits: 10 µg kg^{-1} for baby food, 25 µg kg^{-1} for purees and 50 µg kg^{-1} for fruit juices. Besides health, economic impact of mycotoxin contamination is significant, since contaminated products need to be destroyed while the country's reputation and competitiveness in international trade can be affected. Such an incident occurred in February 2025, when Croatian border control detected patulin level (92.53 µg kg^{-1}) above the legal limit in apple juice from Serbia. Our study explored the diversity and patulin production of *Penicillium* spp. in Serbian apples. *Penicillium* isolates causing apple blue mold were collected from storage facilities and identified based on morphological and molecular analyses as: *P. crustosum*, *P. solitum P. chrysogenum*, and *P. expansum* as the most prevelent species (92.9%). Patulin levels in apple fruits inoculated with *P. expansum* strains were determined by HPLC, and results ranged from 0.17 to 56.44 µg g^{-1}. Molecular analysis confirmed the presence of *msas* gene involved in patulin biosynthethesis in *P. expansum* strains, suggesting it as suitable prediction tool. Public awareness campaigns, industry guidelines, and stringent monitoring activities are needed to reduce patulin-related public health risks.

Key words: Patulin, Apple, Blue mold, *Penicillium*, Food safety

Influence of agronomic and microbial biofortifications with selenium on the elemental composition of amaranth

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Abstract

Widespread selenium (Se) deficiency poses a global health risk. Agronomic and microbial biofortifications sustainably increase Se levels and optimize food's elemental profile. This study examined microbial bioagents (bacteria, mycorrhizae) and Se biofortification (mineral Se, Se-enriched compost) on amaranth's elemental composition. Treatments varied by substrate (ordinary compost or Se-enriched compost mixed with commercial substrate). The control used compost and commercial substrate (1:1). Microbial treatments were: Mo1 = *Vesicular Arbuscular Mycorrhiza*; Mo2 = *Azotobacter vinelandii, Azotobacter chroococcum, Bacillus subtilis, Bacillus megaterium, Pseudomonas spp., Trichoderma spp.* Amaranth was grown in ARALAB phytotron in polystyrene containers. Bacteria increased essential elements, notably K (4.9% with mineral Se), Fe, Cu, Mo, and Ni. Mycorrhizal inoculants reduced harmful elements: Co (0.038 mg kg^{-1}), Cr (0.234 mg kg^{-1}), As (0.046 mg kg^{-1}), and Cd (0.046 mg kg^{-1}). Mycorrhiza raised P from 0.65-0.68% to 0.81%. Mineral Se biofortification with bacteria significantly increased Se (426 µg kg^{-1}). Se-enriched compost also raised Se (14.7 µg kg^{-1}), a 2.3-fold increase compared to the control (6.5 µg kg^{-1}), though less effective. Toxic elements (Cd, Cr, As, Pb) remained low (e.g., Cd: 0.046-0.069 mg kg^{-1}). Zn decreased with bacteria (38.4 mg kg^{-1}) and mycorrhizae (38.1 mg kg^{-1}), while the control had the highest Zn (42.4 mg kg^{-1}). Mycorrhiza with Se-enriched compost reduced Mn (17.4 mg kg^{-1}) compared to other treatments (20.8-23.2 mg kg^{-1}). Mineral Se biofortification significantly raised Se concentrations, while Se-enriched compost, though less effective, still increased Se 2.3-fold. Bacterial bioagents boosted K, Fe, Cu, Mo, and Ni, while mycorrhizae increased P and lowered Co, Cr, Cd, and As.

Key words: selenium, amaranth, biofortification, microbial bioagents, compost

Potential of *Trichoderma* spp. against phytopathogenic *Fusarium* isolates originating from onion bulbs

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Abstract

Fusarium spp. represents a group of pathogenic fungi which cause significant economic losses in agriculture, also posing a risk of contaminating the bulbs with mycotoxins. Symptomatic plants were randomly collected from multiple locations across Serbia. Molecular analysis of isolates with confirmed pathogenicity based on ITS, β-tubulin and TEF gene analysis, enabled identification at species level, suggesting that the isolates belong to different *Fusarium* species *F. proliferatum, F. verticillioides, F. graminearum, F. acuminatum.* The aim of the study was to evaluate the antimicrobial effects of two bioagents: *Trichoderma viride* and *Trichoderma asperellum strain* TA21 against the *F. proliferatum, F. verticillioides, F. graminearum, F. Acuminatum*. The dual culture method was performed by placing mycelial discs from *Fusarium* spp. culture and *Trichoderma* strains on PDA medium in sterile Petri dish, maintaining a 3 cm distance. A triplicate experiment was conducted for each isolate, one isolate per *Fusarium* species. Radial growth was observed and measured for *Fusarium* spp. seven days after the incubation period at a temperature of 25±2 °C and inhibition rate was calculated compared to the control without applied bioagents. The results showed that *Trichoderma viride* was effective in reducing *Fusarium* spp. growth within a range of 70% to 85%, while *Trichoderma asperellum* exhibited an inhibitory effect ranging from 74% to 82%. The promising antifungal activity of *Trichoderma* opens up new possibilities for integrated disease management strategies, which could play a crucial role in reducing crop losses caused by *Fusarium* spp. and promoting environmentally sustainable agricultural practice.

Keywords: *Fusarium*, Biocontrol, Onion, *Trichoderma*

Acknowledgment:

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Biomass as a Part of the Circular Economy: Optimization of Wood Chip Drying for Efficient Energy Recovery

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Abstract
Fuel wood chips are currently a preferred form of biomass in terms of sustainable energy utilization. Their efficient use depends primarily on moisture content and the adjustment of material properties before combustion, particularly through drying processes. A significant issue during storage is the decline in calorific value caused by environmental conditions and microbial activity. To ensure optimal energy output, wood chips must meet specific criteria, including low moisture and ash content, as well as a minimal proportion of fine particles. Drying aims to remove both free and bound water from the biomass. However, due to the high latent heat of vaporization, this process is energy-intensive, and molecular water cannot be eliminated using conventional methods. In addition to natural drying, several technological drying systems are employed, such as rotary drum, belt, fluidized bed, air-based, or hybrid dryers—using hot air, steam-air mixtures, or superheated steam as the drying medium. Economic efficiency largely depends on the cost of heat input, with the most cost-effective solutions utilizing waste heat from industrial processes. In response to environmental and economic considerations, the development of solar-powered and hybrid solar-thermal drying systems is gaining momentum. Within the framework of the Energy Use of Biomass research project under the infrastructure initiative Centre of Excellence for the Forest-Based Sector LignoSilva, a Katres KBD 3-4 belt dryer has been installed at the BTP Stráž site. This facility is intended for experimental drying of sawdust and wood chips. The primary objective is to optimize the energy recovery process from fuel wood chips and to explore efficient storage strategies in line with circular economy principles.

Key words: biomass, wood chips, drying technologies, renewable energy, energy recovery

Effect of conteiner size and design on morphological and pomological characteristics of blueberry

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Abstract
In the spring of 2022 in high tunnel in experimental orchard of the Center of Pomology and Vegetable crops ten blueberry varieties was planted in five types of pot that varied in size and design. Aim of this study was to determine effect of container size and design on morphological and pomological characteristics of blueberry. Varieties Aurora, Bluecrop, Bluejay, Brigitta blue, Chandler, Darrow, Draper, Duke, Elliot and Liberty was planted in polypropylene planting bag 63 l, polypropylene planting bag 47.5 l, "Oxygena" pot 46 l, plug foil container 71 l, plug foil container 71 l on white foil and soil as control. Three bushes were planted for combination. Ground in container was covered with black foil except for the second plug foil container 71 l which was on white foil. Substrate for all containers and control was mix of fir bark 33%, sawdust 33%, Lithuanian peat 33 % and perlite 1 %. Hight tunnel is 30 m long, 9.8 m wide and 5.15 m high. In 2024 overall yield for varieties ranged from 1.48 kg (Aurora) to 9.07 kg (Draper) and for containers ranged from 4.07 kg ("Oxygena" pot 46 l) to 11.23 kg (plug foil container 71 l on white foil). Average fruit weight for varieties ranged from 1.61 g (Elliot) to 4.38 g (Chandler) and for containers from 2.14 g ("Oxygena" pot 46 l) to 2.79 g (plug foil container 71 l). Results show that containers have a greater impact on yield, while the variety has a greater impact on fruit weight, however it is necessary to continue with the research to reach final conclusions.

Key words: blueberry, container, yield, fruit weight

Composition and antioxidant activity of phenolic acids in soybean cultivars

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Abstract
Soybeans are rich in phenols with high antioxidant potential and on a global level have become a staple part of the human diet. Phenolic acids (PAs) and flavonoids are the most common types of phenolic compounds found in soybean grains and are mainly found in conjugated forms. Conjugate phenolics are bound to soluble oligosaccharides and peptides through ester, ether, or C-C bonds and can be released with an aqueous methanol solution after hydrolysis. The objective of this research was to determine the distribution of conjugate PAs in the seeds of ten soybean cultivars grown in 2024 at the Agricultural Institute Osijek. Syringic and sinapic acids analysed by UPLC were dominant among the six detected PAs, ranging from 378.76 µg g^{-1} DM to 568.25 µg g^{-1} DM and from 126.40 µg g^{-1} to 217.29 µg g^{-1} DM, respectively. The highest total PAs had an introduced cultivar I-5 (1131.53 µg g^{-1} DM) and the lowest line OS-2212 (727.67 µg g^{-1} DM). The mentioned cultivars also showed maximum and minimum DPPH scavenging activity (37% and 29%, respectively), which means that PAs can be used as an indicator of the antioxidant potential of soybeans. The observed variability suggests that selective breeding can be used to create genetic backgrounds for increasing phenolics and antioxidant potential of Croatian soybean cultivars.

Key words: soybean cultivars, phenolic acids, UPLC, antioxidant activity

Damage assessment of wheat cultivars due to rice weevil infestation (*Sitophilus oryzae* L.)

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Abstract
For the strategic planning purposes of safe cereals storage and minimizing reliance on synthetic insecticide applications, it is essential to assess the susceptibility of cereals to pest infestation. One of the most common and destructive primary pests of cereals is the rice weevil (*Sitophilus oryzae* L.). A preliminary susceptibility test of four wheat cultivars (Agenor, Cultivar 1, Sofru, Apache) on *S. oryzae* infestation was assessed. The assessment included an evaluation of the F1 generation progeny and grain damage (damage and weight loss). The progeny assessment was conducted 60 days after the adult parent's were introduced into jars filled with the test wheat cultivars. According to biochemical and physical characteristics, Cultivar 1 stands out with a significantly higher protein content (13.0%) compared to Apache (11.1%), Sofru (11.8%) and Agenor (11.6%) and significantly lower starch content (68.2%) compared to Apache (72.3%). In terms of grain hardness, a significant difference was found between Sofru and Cultivar 1 (83.4% and 59.9%, respectively). The Agenor cultivar was pointed out as potentially the least suitable for *S. oryzae* development, based on the number of produced progeny (17 individuals), compared to those produced on Cultivar 1, Apache, and Sofru (70, 102, and 121, respectively). The Agenor cultivar showed the lowest total grain weight loss (0.69 g), the lowest number of damaged grains (2.3 grains), the lowest percentage of damaged grains (7.8%) as well as the least grain weight loss (1.3%), indicating the lowest susceptibility to *S. oryzae* infestation. To establish guidelines for longer-term wheat storage, further research is required on other biological and nutritional characteristics of *S. oryzae* (assessment of the development cycle duration and digestive enzyme activity in the progeny). Also, the study should be expanded on other species of stored product insects.

Key words: wheat cultivars, susceptibility, storage pests, grain damage

Use of fungal secondary metabolites in plant protection

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Abstract
Fungal secondary metabolites represent a largely unexplored but promising resource for sustainable plant protection. The aim of this paper is to examine the diversity and potential applications of these bioactive compounds, which are produced through interactions between fungi and their environments and exhibit antimicrobial, insecticidal, herbicidal, and growth-regulating effects. The review focuses on metabolites derived from endophytic, entomopathogenic, and phytopathogenic fungi, describing their modes of action, target specificity, and effectiveness against major crop pests and diseases. Recent findings highlight the relevance of these compounds in integrated pest management strategies, especially in light of increasing restrictions on synthetic pesticides. Advances in metabolomics, synthetic biology, and fermentation technologies have significantly accelerated the discovery and production of novel fungal-based biopesticides. However, challenges related to large-scale production, formulation stability, and regulatory compliance remain. Based on the reviewed data, fungal secondary metabolites offer a viable pathway toward more resilient and environmentally friendly agricultural systems.

Key words: fungal metabolites, biopesticides, pest control, integrated pest management, sustainable agriculture

Impact of storage and shelf life on berry properties of four table grape cultivars

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Abstract

During the storage of table grapes, changes in both physical attributes and chemical composition occur. Understanding the differences between varieties in this context is essential, as selecting the appropriate variety can contribute to the reduction of food loss. In the research conducted during 2024 at the Experimental field for Viticulture in Sremski Karlovci grape storage potential of table grape cultivars 'Lasta', 'Ljana', 'Muscat hamburg' and 'Nada' was examined. The grapes were stored for 21 days in a cold storage facility with normal atmosphere at temperature of 3±1 °C and with relative humidity of 90% and exposed to additional three days i.e shelf life conditions at 20±2 °C. After storage, physical characteristics and chemical composition were measured at harvest, after storage and after shelf life. After 21 days of cold storage, berry weight loss ranged from 4.0 to 9.6%, depending on the cultivar. 'Nada' exhibited the highest weight loss, while 'Lasta' had the lowest weight loss both after cold storage and subsequent shelf life. All cultivars accumulated more than 20% sugar in the grape juice. 'Nada' had the highest sugar and acid content in the grape must. During cold storage, sugar content in grape juice remained unchanged; however, an additional shelf-life period led to an increase in sugar content in 'Lasta' and 'Nada' grape berries compared to their respective harvest dates. Both cold storage and shelf life enhanced berry firmness in the 'Lasta' and 'Nada' cultivars. The 'Lasta' cultivar exhibited the lowest food loss during both cold storage and shelf life.

Key words: table grapes, cold storage, shelf life, berry firmness

The effect of citric acid addition on the properties of starch isolated from different potato varieties

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Abstract
The aim of this study was to investigate the effect of citric acid addition on the properties of native starch isolated from two potato varieties (*SL 13-25* and *Scala*) grown in Osijek-Baranja County (Croatia). The starch citrates were obtained by adding citric acid in different doses (5, 10 and 20 g per 100 g of starch dry matter). The native starch was thoroughly mixed with the citric acid solution, then the moistened starch was conditioned at room temperature for 12 hours and subsequently dried in a laboratory oven (Memmert, Germany) at 50 °C for 12 hours. The dried material was then roasted at 100 °C for 3 hours. To remove the unbound citric acid, the roasted samples were rinsed three times with ethyl alcohol. The washed precipitate was dried in an air dryer at 30 °C for 12 hours. The resulting starch citrates were ground in a laboratory mill and sieved through a sieve with a mesh size of 400 µm. The degree of substitution, the swelling capacity and solubility index, the texture of the starch gels and the gelatinization properties of the modified starches obtained were determined. The results showed that the degree of substitution increased proportionally to the citric acid concentration in all potato starch citrates, with the effect being most pronounced in the *Scala* variety. The gelatinization temperature increased with esterification, while the swelling capacity and solubility index decreased regardless of the potato variety. The hardness and adhesiveness of the starch gels increased as a result of esterification, while the breaking strength decreased, although the trend was the same for both varieties.

Key words: potato, starch, citric acid, esterification

Sustainable Flavonoid Recovery from Satsuma Mandarin Peels Using High-Pressure Homogenization

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Abstract
Satsuma mandarins (*Citrus unshiu* Marc.) peels are valuable agroindustrial byproducts rich in bioactive compounds like flavonoids, offering valuable potential for food and pharmaceutical applications. However, efficient and sustainable extraction of flavonoids from mandarin peels remains a challenge. This study investigated the recovery of flavonoids from freeze-dried mandarin peel residues using only water as the extraction medium, applying high shear mixing (HSM) at 20,000 rpm and high-pressure homogenization treatment (HPH) at 80 MPa for up to 10 passes. HPH reduced the initial mean particle size D[4,3] of 217.03 μm to 51.67 μm, enhancing flavonoid mass transfer into the aqueous phase. Optimal extraction was achieved after 5 passes, yielding a 38.78% increase in total flavonoid content compared to HSM. HPLC analysis revealed significant increase in sinensetin by 38.50%, nobiletin by 39.18%, and tangeretin by 60.74%, alongside an 11.47% rise in ferulic acid. HPH enables the mass transfer of flavonoids into the aqueous phase, without the need for organic solvents, improving flavonoid recovery through a purely physical and sustainable process, making the extracts suitable for functional food and nutraceutical applications.

Key words: agroindustrial byproducts, Micronization, Bioactive compounds, Solvent-free extraction, Functional ingredients.

How to develop a methodology for verification of the geographical origin of potato tubers

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Abstract
The geographical origin is often a very important factor in the purchasing decisions of people in economically developed countries. The European Union has a strong integrated framework for protecting geographical indications of food products. Product with declared geographical origin has higher prices but often are subject to food fraud. Therefore, developing reliable, scientifically validated methods for determining the geographical origin of agricultural and food products is of great importance. In contrast to the standardized analytical procedures used to assess the quality and safety of agricultural and food products, the procedures for determining the geographical origin are much more complex. Currently, no single analytical methodology has been developed that would universally be applicable for determining the geographical origin. Instead, various techniques have been proposed, including the analysis of stable isotope ratios—such as $^{1}H/^{2}H$, $^{12}C/^{13}C$, $^{14}N/^{15}N$, and $^{16}O/^{18}O$—as well as metal content profiling or a combination of both. These methods rely on sophisticated high-resolution analytical techniques, such as isotopic ratio high-resolution mass spectrometry (IRMS), liquid chromatography coupled with mass spectrometry for the determination of several chemical and biochemical parameters, inductively coupled plasma combined with mass spectrometry (ICP-MS) for the metal determination, etc. Due to their high sensitivity and resolution, these methods enable high reliability with the high cost of analysis and specialized analytical staff. Emerging methods such as UV-Vis, fluorescence, Raman, and near and mid-infrared spectroscopy are developing as alternatives. These approaches offer potential advantages in terms of cost-effectiveness and accessibility while maintaining reliable results.

Key words: agricultural and food products, geographical origin, IRMS, ICP-MS, LC-MS/MS

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Adaptation of viticulture to climatic challenges by using newly created grapevine cultivars

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Abstract

The common challenge addressed by this cross-border project is the vulnerability of viticulture in the regions of eastern continental Croatia and western Serbia to the impact of climate change, especially drought stress. Drought is a direct threat to grapevines, affecting their growth, development and yield. Insufficient water availability due to changing climate conditions can result in reduced grapevine productivity and reduced grape quality. The aim of the project is to propose measures adapted to the challenges brought by climate change, with a special emphasis on drought risks, through comprehensive research. The project examines insufficiently researched newly created grapevine varieties, as well as their potential for application in the cross-border area. Centres for preventing the negative impacts of climate change in viticulture will also be built on both sides of the border, necessary for systematic monitoring of climate conditions and encouraging research into resistant grapevine varieties. The construction of modern and technologically excellently equipped centres will make a strong contribution to viticulture and winemaking, as the centre will serve not only for research, but also for training students, young researchers, and winegrowers and winemakers. During summer 2024, leaf samples were collected for analysis of biochemical stress indicators to determine the zero state. The highest chlorophyll pigment content was measured in the cultivar Calardis blanc (0.813 mg g^{-1}), and the lowest chlorophyll pigment content was measured in the cultivar Muscaris (0.252 mg g^{-1} FW). The lowest proline content was measured in the cultivar Calardis blanc (0.246 mM g^{-1} FW), and the highest proline content was measured in the cultivar Sauvignon cretos (0.67 mM g^{-1} FW).

Key words: viticulture adaptation, climate change, grapes

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The Azores agricultural monitoring and warning network (RMAAA)

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Abstract
The Azorean agricultural monitoring and warning network (RMAAA) is an indispensable tool for guaranteeing the production of quality food, food safety and environmental protection on our islands, that focuses on phytosanitary problems affecting the region's main crops and extends to the Azorean nine islands. The following pests are being monitored: spotted wing drosophila (*Drosophila suzukii*), honeydew moth (*Cryptobaldes gnidiella*), codling moth (*Cydia pomonella*), chestnut tortrix moth (*Cydia splendana*), Mediterranean fruit fly (*Ceratitis capitata*), pasture army worm (*Pseudaletia unipuncta* and *Spodoptera littoralis*), banana weevil (*Cosmopolitus sordidus*), olive fruit fly (*Bactrocera oleae*) and banana thrips (*Heliothrips sp*., *Anisopilothrips sp*. and *Haplothrips sp*.). Also, the incidence of three vine diseases: mildew (*P. viticola*), botrytis (*B. cinerea*) and oidium (*U. necator*) is monitored, as well as three wood diseases, three species of citrus mealybug, olive cotton worm, whiteflies and citrus leaf miner. The field data collected are introduced on a cell phone application and automatically transferred to a computer platform, where data from the weather stations placed at the various biological observation areas (BOAs) are also recorded. Thresholds have been established for the presence and abundance of populations (pests) and incidence (diseases), which allow for the automatic emission of warnings sent by mobile phone and email to the technicians and farmers. The aim of this work is to learn about the temporal evolution of the pests but also to identify their population peaks, and together with the meteorological data collected, to validate models for predicting their field appearance. This will serve as a unique tool essential for technicians and farmers to support their decision-making regarding crops phytosanitary problems in the Azores archipelago.

Key words: warnings, agriculture, pests, diseases, platform

The first evidence of putative kokumi oligopeptides in Malvazija istarska wine: Effect of yeast species

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Abstract
The aim of this study was to investigate the effect of co-inoculation and sequential inoculation with non-*Saccharomyces* yeasts and a *S. cerevisiae* control on the levels of umami flavor and kokumi-inducing amino acids and oligopeptides in Malvazija istarska wine. The grape must was co-inoculated with *Torulaspora delbrueckii* and *S. cerevisiae* (TDSC), and sequentially inoculated with *Pichia kluyveri* (PC), *Schizosaccharomyces pombe* (SP), and *Torulaspora delbrueckii* (TD), followed by *S. cerevisiae*. *S. cerevisiae* was inoculated in monoculture as a control (SC). The analysis was conducted by ultra-high-performance liquid chromatography-mass spectrometry (UHPLC-MS/MS). Significant differences between the wines were found for many compounds. TD wine contained the lowest concentrations of most of the identified amino compounds. All non-*Saccharomyces* yeast treatments elevated the level of umami imparting L-glutamic acid. Among the putative kokumi oligopeptides, control SC wine had the highest levels of Ala-Asp, Ala-Pro, Ala-Lys, Asp-Gly-Leu, and L-glutathione, while SP wine contained the most Gly-Val. No differences between the concentrations of γ-Glu-Val-Gly, the most powerful kokumi compound, were observed. The obtained results indicate that the use of non-*Saccharomyces* yeasts has a potential for regulating the levels of amino acids and oligopeptides responsible for umami flavor and kokumi effect in wine.

Key words: non-*Saccharomyces* yeasts, umami flavor, kokumi effect, Malvazija istarska wine, oligopeptides

Acknowledgement: This study was funded by Croatian Science Foundation under the project HRZZ-IP-2020-02-4551.

Storage of blueberry fruits depending on the cultivar and harvest timing

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Abstract

The northern highbush blueberry (*Vaccinium corymbosum* L.), considered as rich source of nutrients, has shown a continuous increase in production and consumption worldwide. To extend its market availability, cold storage is becoming increasingly important. The primary challenge is maintaining fruit quality. The aim of this study was to examine the impact of selective harvest timing on the quality preservation of two blueberry varieties 'Duke' and 'Bluecrop,' after cold storage (2±1 °C and 90% relative humidity) and after 3 days of shelf life at room temperature (20±1 °C). The experiment was conducted during 2024 year and fruits were harvested in five selective harvests. For storage, fruits were collected from the first, third and fifth selective harvest. Fruit weight and firmness, soluble solid content (SSC) and total acidity (TA) were measured after harvest (0 day), cold storage (21+0 days) and shelf life (21+3 days). After cold storage, fruit weight loss ranged from 9.6 to 13.8%, depending on the cultivar and the timing of selective harvest. After shelf life, a greater fruit weight loss was recorded compared to the loss measured after cold storage, with the highest loss observed in the cultivar 'Bluecrop', during the first and third selective harvests. After shelf life, a significantly higher percentage of decayed fruits was observed in cultivar 'Bluecrop' compared to 'Duke', in all selective harvests. The highest fruit firmness was recorded immediately after harvest in both cultivars, while the lowest values were measured after storage and shelf life. SSC and TA varied depending on the cultivar, harvest timing, and storage duration. Sugar content ranged from 7.1 to 13.7%, while acid content from 0.02 to 0.34%. Based on the obtained results, it can be concluded that 'Duke' fruits from the first selective harvest have the best storage potential. Due to significant decay occurrence fruits from cultivar 'Bluecrop' from the third and final selective harvests are not recommended for cold storage and 3 days of shelf life.

Key words: berries, cold storage, shelf life, fruit weight loss, firmness

Application of phosphogypsum in wheat production in saline soil

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Abstract
The aim of the research work was to evaluate the suitability of phosphogypsum, a by-product of phosphoric acid production, in the nutrient supply of spring wheat in saline soil. Plants were grown in a completely randomized design pot experiment in an open-sided greenhouse. Phosphogypsum application rates were 2 and 10 t ha^{-1}. Untreated saline soil was used as control. Phosphogypsum treatments increased the yield by 30.91-39.96 % compared to the control. The weight of 1000 grains, shoot weight, spike weight, shoot length and spike length also were increased. The relative chlorophyll content (SPAD value) of leaves and transpiration coefficient of plants did not differ in the phosphogypsum treatments from those of the control. The measured element contents of wheat grain were not different, but the Ca, S, Sr, Ba and Cd contents of straw were significantly higher in the phosphogypsum treatments compared to the control. The AL soluble K, P and Ca content of soil also became higher in the treated soil compared to the control. The use of phosphogypsum may be limited primarily by its radioactivity and the amount of toxic heavy metals it may contain. The phosphogypsum used in our experiment was formed by processing sedimentary apatite, showed no radioactivity and its toxic element concentrations (Cd, Cr, Pb) were below 2-5 mg kg^{-1}. The results of the present experiment demonstrated the beneficial effects of phosphogypsum in spring wheat production application on saline soils. The published research results and conference participation were supported by the grant 2023-1.2.4-TÉT-2023-00037 and the Pannonia Scholarship Programme.

Key words: phosphogypsum, spring wheat, nutrient supply

Physiological importance of sunflower leaf position on stem

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Abstract
Developmental stages of plant leaves have been investigated in terms of anatomy, morphology, and physiology. However, more research is needed to describe the physiological status by the position of the leaves on the sunflower stem, from the youngest to the senescent leaf on the plant. Therefore, a study of the physiological reaction in natural senescence on eight different positioned leaves on the stem was performed on sunflower hybrid in the flowering stage. Every second leaf from the top to bottom of the stem was investigated. The results showed that during the developmental stage of leaves, the photosynthetic pigment content follows a parabolic trend, peaking at mid-height and decreasing towards both the top and base of the plant. The young and senescent leaves have a lower content than the mature leaves. It was noticed that photosynthetic pigment degradation in the oldest leaves is connected with disturbances in photosystem I (PSI). Namely, parameters that characterize electron transport to the end electron acceptors of photosystem I, electron flux reducing terminal electron acceptors at the PSI acceptor side per RC (RE_0/RC), the probability that an electron is transported from reduced plastoquinone to the electron acceptor side of PSI (δR_0), the quantum yield of electron transport from primary acceptor quinone (Q_A^-) to the PSI end electron acceptors (φR_0), electron transport from plastoquinol to final PSI acceptors ($\delta R_0/(1-\delta R_0)$), and performance index for energy conservation from exciton to the reduction of PSI terminal acceptors (PI_{total}) are depending on the maturity of the leaf. So, those parameters can be considered a better indicator of the influence of sunflower leaves senescence than parameters that described photosystem II. Further, leaf senescence causes metabolic changes in the form of degradation of soluble proteins, total phenols, flavonoids, and antioxidant activity, a decrease in enzyme activity, and an increase in lipid peroxidation. In conclusion, the most significant changes were observed in the oldest (lower) leaves on the sunflower stem, where physiological processes were disrupted. In contrast, young and mature leaves continued to perform their essential functions, which are critical for the grain-filling stage.

Key words: senescence, hybrid, photosynthesis, antioxidant activity, pigments

Inhibition of *Botryosphaeria dothidea* Mycelial Growth: Biocontrol Potential of *Trichoderma virens* and *Bacillus amyloliquefaciens*

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Abstract

Fruit production is one of the most important branches of agriculture in Serbia in which apple production plays a significant role. This highly profitable production provides raw materials that are consumed fresh, while a portion is used for processing (juices, purees, vinegar, etc.). The productivity and quality of apple fruits are frequently compromised by various plant pathogens, among which *Botryosphaeria dothidea* is a significant pathogen which causes Botryosphaeria rot ("Bot rot") on fruits. This study aimed to assess the biocontrol potential of non-pathogenic isolates of *Trichoderma virens* and *Bacillus amyloliquefaciens* against *B.dothidea*, using dual-culture assay. *B.dothidea* mycelial discs were placed on PDA plates, and antagonists were positioned 3 cm away from the fungal discs, with three repetitions for each. The plates were incubated at 25 °C for 5 days, after which the radial growth of *B.dothidea* was measured, and the percentage of inhibition was calculated. The results indicated that both *T.virens* and *B.amyloliquefaciens* effectively inhibited *B.dothidea* growth, significantly reducing fungal expansion. Based on these promising results, further research is needed to evaluate the performance of these agents under *in vivo* conditions, to better understand their mode of action and potential for practical application in integrated pest management strategies. This study provides valuable insights into the antifungal properties of biological agents from the genera *Trichoderma* and *Bacillus*, offering a potentially eco-friendly solution for managing postharvest fruit rot.

Key words: *Trichoderma virens*, *Bacillus amyloliquefaciens*, *Botryosphaeria dothidea*, biocontrol, apple

Sustainable Valorization of Spent Coffee Grounds: Enhancing Bioactive Compound Yield via Disc Mill

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Abstract
Spent coffee grounds (SCG) are a major residue of the brewing process. SCG are rich in bioactive compounds, making them a valuable resource for sustainable valorization. This study investigates the application of disc mill (DM) technology to enhance the extraction and bioaccessibility of these compounds. DM induces the micronization of plant tissues through shear forces, disrupting cell structures and improving mass transfer. In this study, SCG were treated with the addition of distilled water at a weight ratio 1:2. The extraction efficiency was assessed through ferric-reducing antioxidant power (FRAP) and 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assays for antioxidant capacity of the extracts, along with total phenolic compounds (TPC) and total flavonoid compounds (TFC) content analysis. Particle size distribution and microscopy evaluated the extent of cellular disruption. Results showed that up to three DM passes caused a significant size reduction, with d0.1 being reduced to 2.575 µm, d0.5 being reduced to 22.244 µm, and d0.9 being reduced to 96.896 µm, suggesting the occurrence of complete cell disruption. Because of this, the analyzed metric values significantly increased compared to the untread sample. However, additional passes caused a measurable decline in the same values, likely due to sample overheating. Overall, DM technology effectively enhances bioactive compound extraction in SCG, offering a promising approach for sustainable waste valorization.

Key words: Spent coffee grounds (SCG), disc mill (DM), bioactive compounds, waste valorization

Resistance of citrus blue mold, *Penicillium italicum* (Pers.) Sacc., to imazalil in Croatia

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Abstract

The phytopathogenic fungus *Penicillium italicum* causes blue mold on citrus fruits. It is considered the most economically important pathogen of Unshiu mandarins in Croatia during the post-harvest phase, causing substantial losses. Depending on the warehouse, estimated losses in 2024 ranged from 5-10 % of the total amount of mandarins in the Neretva Valley. The fungicide imazalil has been predominantly used to control *P. italicum*, applied in a drencher system or by waxing the mandarins. In this study, 5 samples of mandarin fruits were collected from mandarin orchards and from the storage facilities, all showing symptoms of *P. italicum* infection. Pure cultures of *P. italicum* were isolated from all samples, and *in vitro* test of mycelial growth at different concentrations of the fungicides imazalil was conducted to calculate the fungicide's median lethal concentration (EC50). The results confirmed resistance of all *P. italicum* isolates from the storage facilities to imazalil, while field isolates of *P. italicum* showed to be sensitive. The average EC_{50} value for storage isolates to imazalil was 0.69 mg L^{-1}, while the average EC_{50} value of the field isolates was 0.01 mg L^{-1}. This research represents the first confirmed case of resistant isolates of *P. italicum* to fungicides in Croatia. The findings of this research can contribute to a sustainable and integrated approach to mandarin fruit pathogen control in the post-harvest phase, as well as to an effective anti-resistance strategy.

Key words: *Citrus unshiu*, blue mold, fungicide resistance, integrated plant pest management

Effect of salt stress on oat seed germination

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Abstract
The aim of this study was to determine the effect of salt stress on selected germination parameters of oats. The experiment was conducted on 10 oat varieties, with seeds placed on filter paper and exposed to four different treatments: control K – water, treatment A – NaCl 50 mM, treatment B – NaCl 100 mM, and treatment C – NaCl 150 mM. The evaluated parameters included fresh and dry weight, germination energy, germination rate, root length, and shoot length. The highest average fresh weight was recorded in treatment A (4.52 g), while the lowest was observed in treatment C (3.21 g). The highest average dry weight was found in treatments A and C (0.59 g), whereas the lowest was in treatment K (0.54 g). The highest average germination energy was recorded in treatment C (63.27%), while the lowest was observed in treatment A (32.13%). The highest average germination rate was found in treatment B (79.07%), while the lowest was in treatment K (69.93%). The longest average root length was measured in treatment A (10.32 cm), while the shortest was in treatment C (6.86 cm). The longest shoot length was recorded in treatment A (7.63 cm), whereas the shortest was in treatment C (5.76 cm). Analysis of variance revealed a statistically significant effect of variety, treatment, and their interaction ($p < 0.01$) on all examined traits. The results indicate a significant impact of salt stress on oat germination and germination energy, with higher NaCl concentrations negatively affecting fresh weight, root length, and shoot length, while certain parameters, such as germination energy, exhibited variability depending on the variety and treatment.

Key words: oat, salt stress, germination

Seasonal dynamics of *Halyomorpha halys* Stål, 1855 in the experimental station „Maksimir“, Zagreb

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Abstract

In two orchards of the experimental station "Maksimir", the seasonal dynamics of the invasive brown marmorated stink bug (*Halyomorpha halys* Stål, 1855) were monitored throughout the growing season 2024 using CYMATRAP PRO (GEA s.r.l.) traps baited with a two-component aggregation pheromone (Trécé Inc.). Pest activity was monitored weekly from April to October, and the number of adults (females and males) and nymphs was recorded at each sampling interval. The first adults were caught in the traps on April 5, 2024, while the first-generation nymphs (2^{nd} to 5^{th} instars) were detected on June 26, 2024. Due to the favourable climatic conditions and the availability of energy-rich food sources, the pest probably developed to the mature adult stage and produced another generation by the end of the season. This hypothesis is supported by the highest proportion of nymphs observed in September 2024, especially in the 4^{th} and 5^{th} instar. Pest catches continued to be recorded until the end of October 2024. These results strongly suggest that *H. halys* could go through more than one generation per year in Zagreb under the temperate continental climate. The study underlines the successful acclimatization of *H. halys* in this region and highlights the need to conduct field-based research on pest biology, which is planned for the coming growing seasons.

Key words: brown marmorated stink bug, temperate continental climate, pest phenology, voltinism, City of Zagreb County

Preliminary study on the impact of sunburn on early Satsuma mandarin cultivars in the Neretva Valley

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Abstract

In Croatia, Satsuma mandarin fruits develop during the summer when drought and high temperatures limit normal physiological processes. Excessive solar radiation can lead to sunburn on the fruits, which negatively affects their quality. Sunburn on citrus fruits represents a significant problem, especially in early-ripening cultivars with thinner peels, such as *Citrus unshiu* 'Zorica rana, 'Iwasaki,' and 'Ichimaru.' The aim of this preliminary study was to determine the pomological and physicochemical changes in sunburned fruits compared to healthy ones. The research was conducted at five locations in the Neretva Valley during the 2024 growing season, and the fruits were classified into three categories based on the degree of sunburn: 1 (0-15%), 2 (15-30%), and 3 (more than 30%). The fruit analysis included quantitative and qualitative pomological traits determined according to IPGRI descriptors for citrus. The physicochemical analysis included juice content, soluble solids, total acids, phenols, maturity index, fructose, glucose, sucrose content, antioxidant activity, ascorbic acid (vitamin C), and pH value. The results indicated significant differences in fruit sensitivity to sunburn and changes in their chemical composition, depending on the cultivar and growing location. The cultivars 'Iwasaki' and 'Ichimaru' showed higher sensitivity, while 'Zorica rana' was more resistant. The most pronounced changes were recorded at the Vidrice location, where an increase in soluble solids and sugars by 4% was observed, along with a decrease in vitamin C and total acidity by up to 12%. On the other hand, fruits of the same cultivar from the Glog location showed milder deviations in the analyzed parameters. These findings highlight the need for further research and potential protective measures to mitigate the negative impact of sunburn on citrus fruit quality in the Neretva Valley.

Key words: mandarin, sunburn, Neretva Valley

Recognition of new varieties of soybean in the Republic of Croatia in the period from 2019 to 2024

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Abstract
Since Croatia's accession to the European Union, Croatian legislation has been continuously aligned with the European legal framework. The process of registering agricultural plant varieties is currently governed by the Law on Seeds, Planting Material and Registration of Agricultural Plant Varieties (OG 110/21), the Ordinance on the Entry of Varieties in the List of Varieties (OG 48/2023), and the Ordinance on the Registration of Agricultural Plant Varieties (OG 7/2024). The registration procedure includes two key tests: the Value for Cultivation and Use (VCU) and the Distinctness, Uniformity and Stability (DUS) tests. Both procedures take two years to complete. During the observed period, these procedures have shown a positive trend, with an increase in the number of tested varieties. From 2019 to 2024, a total of 149 soybean varieties were tested for VCU, while 72 varieties underwent DUS testing. In 2024, we had the largest number of recognitions in DUS (30) and VCU (37) testing. In 2019, there was the smallest number of soybean varieties (12) in VCU testing, and in 2023, the smallest number of soybean varieties (5) in DUS testing.

Key words: soybean, varieties, DUS, VCU testing

3D scanning as an innovative method to evaluate tire footprint in soil

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Abstract
This research presents a method for evaluating footprints in soil with the use of 3D scanner. Research was conducted in laboratory using the bench which allowed to generate the vertical pressure of the tire on the soil placed in the case. The research was conducted in static conditions, so the wheel was placed in the soil case and the tire footprint was generated in the soil without applying torque. There were no driving or braking forces, which could affect the pressure distribution in the soil. The variable factors were vertical load of wheel and inflation pressure. Using the test bench, a tire was loaded with each inflation pressure, and a tire footprint was generated in the soil. After making a footprint in the soil, the soil case was pulled off the bench. In next step, a 3D scanner was used to scan the tire footprint. As a result of the scan, a point cloud was obtained that reproduced the shape and geometry of the tire footprint in the soil. Then the mesh of triangles built from the points was created. Using special software the parameters of length, width, depth, and tire-soil contact area (as the whole footprint in three-dimensional space) were evaluated. In the case of the presented technique, this a novel approach that makes it possible to present the real shape and size of tire footprints. The tire-soil contact area is a very important parameter for determining the distribution of forces applied to the soil. In order to minimize soil compaction, it is advisable to constantly obtain information on the shape and dimensions of the tire footprint in the soil. Because 3D scanning methods are becoming more popular, the presented method has potential for further use. Moreover, it can be used to evaluate the deformation of both the tire and the soil, which will help in choosing the optimal conditions for agricultural tire use.

Key words: tire footprint, tire-soil contact area, soil deformation, 3D scanning

Effects of microbial bioagents on growth of *Fusarium* isolates originating from potato tubers

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Abstract

Potato production and storage ability are significantly impacted by the activity of phytopathogenic microorganisms, primarily bacteria and fungi. Postharvest diseases in potatoes, caused by fungal pathogens, result in considerable economic losses in both quality and quantity of the potato yield. Due to their favourable chemical composition, tubers serve as an ideal substrate for the development of pathogens that cause rot, among which fungal pathogens *Fusarium* spp. causing dry rot of tubers play significant role. The aim of this study was to evaluate the effects of the bioagents *Trichoderma virens* and *Bacillus amyloliquefaciens* under *in vitro* conditions in Petri dishes against *Fusarium sambucinum*, *F. oxysporum*, *F. solani*, and *F. caeruleum*. A dual culture assay was conducted to assess the antagonistic effects of these bioagents which exhibited inhibitory effects on the development of all fungal species. The strongest antagonism was observed with *Trichoderma virens*, with inhibition zones ranging from 72,8 % to 88,9 %. The high costs of chemical treatments, the emergence of resistance, and other associated challenges have stimulated interest in biological control, which offers a promising and environmentally friendly alternative to pesticides. While *in vitro* experiments have shown promising results in controlling *Fusarium* spp. using various bioagents, further *in vivo* research is necessary to confirm their effectiveness and determine their practical applicability in disease management.

Key words: *Fusarium* spp., biocontrol, potato, *Trichoderma virens*, *Bacillus amyloliquefaciens*

The Impact of Mechanical Stimulation by Brushing on Dill, Milk Thistle, and Basil microgreens

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Abstract
Microgreens are young plants harvested at the cotyledon or early leaf stage, retaining high nutritional value when consumed fresh. Due to their dense growth, brushing has been studied for its impact on morphology and phytochemical composition. This study hypothesized that brushing would similarly affect microgreens as it does with vegetable and herb seedlings. The effect of brushing on the bioactive compounds and antioxidant capacity of dill (*Anethum graveolens*), milk thistle (*Silybum marianum*), and basil (*Ocimum basilicum*) was investigated. The experiment involved 5 or 10 brushings per day from emergence to harvest, with untreated plants as controls. Microgreens were harvested at the cotyledon and true leaf stages for biochemical analysis. Results showed species-specific responses to brushing. In basil, 10 passes per day significantly increased phenolics (+5.34%), non-flavonoids (+7.19%), chlorophyll A (+8.55%), and carotenoids (+2.96%) compared to 5 passes per day. In dill, phenols (+4.40%), non-flavonoids (+9.41%), chlorophyll A (+1.31%), and carotenoids (+3.66%) increased significantly with 10 passes per day. In milk thistle, phenols (+12.48%), non-flavonoids (+10.09%), flavonoids (+14.43%), and antioxidant capacity (+2.65%) increased with 5 passes per day compared to 10. In contrast, chlorophyll A (+30%), chlorophyll B (+35.71%), total chlorophylls (+31.07%), and carotenoids (+18.46%) increased at 10 passes per day. Brushing significantly alters the phytochemical composition of microgreens, with effects varying by species and brushing intensity.

Key words: mechanical stimulation, antioxidant capacity, phenolic compounds, vitamin C, chlorophyll

Boron - positive effect on quality properties of cherry fruits varieties: Bing and Georgia

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Abstract

The demand for quality cherry fruits during the season on the market is increasing year by year. The use of mineral fertilizers to maintain the quality of the fruits is therefore increasing. Boron is an essential element for plants. His availability depends on the physical and chemical characteristics of the soil and the quality of irrigation water. Under natural conditions, both toxic and deficit concentrations can occur and should be managed for crop production. His deficiency causes many anatomical, physiological, and biochemical changes. The goal of this study was to examine response of sweet cherry fruits to boron foliar fertilization. Application of boron spraying was carried with a backpack sprayer, in location Jablanica, 15 days before fruit ripening of the tested cherry varieties. After ripening, samples were collected and pomological parameters were analyzed. In the Bing variety, the treated sample showed a parameter of fruit weight (FW): 8.90 g, fruit firmness (FF): 1.13 kg cm^{-2} and soluble solid content (SSC) 20.38 Brix %, while the control showed a weight: 9.20 g, firmness: 1.28 kg cm^{-2} and soluble solid content: 18.36 Brix%. The SSC showed a deviation in value comparing treatment and the control. Georgia showed that the average weight of treated fruits was 9.26 g, FF: 1.05 kg cm^{-2} and SSC: 13.57 Brix%, while the control fruit samples showed a FW: 7.70 g, FF: 1.52 kg cm^{-2} and SSC: 14.60 Brix%, with deviation in the fruit weight parameter.

Key words: cherry fruits, boron, firmness

Investigation of potassium content in agricultural land in the area of the city of Sombor

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Abstract

Potassium is not one of the constitutive elements, but it is necessary for all organisms. In the plant, it is found in an ionic state in the form of various salts, and it can also be absorbed by some proteins. Because of this status, potassium can be washed out of the plant with water. Its role is very important in the synthesis of sugar, transport of assimilatives, regulation of pH in the cell, during photosynthesis, in regulation of the water regime, affects nitrogen metabolism and activates various enzyme systems. It is on average 2.4% in the soil and 0.5 to 3% in the lithosphere. The structure and pH of the soil has the greatest influence on the availability of potassium. According to analyzes of the soils of Vojvodina, they generally contain a sufficient amount of potassium for most plant species. The Agriculture Extension Service „Sombor" analyzed the percentage representation of tested samples of agricultural land according to the categories of potassium content in the layer from 0 to 30 cm and 30-60 cm in the area of the city of Sombor, the average value of the content of readily available potassium by land type, by the way of use and land ownership. When determining potassium, an extraction method with an Al solution is performed, i.e. converting the easily soluble part of potassium into a solution, and then potassium is determined flame photometrically. The results show that about 42% of the surfaces are optimally supplied with potassium (between 15 and 25 mg 100 g^{-1} of soil). Only about 8% of the land is poor (below 10 mg 100 g^{-1}), and about 12% of the land has a high potassium content (25 to 50 mg 100 g^{-1}). A very high to harmful effect of potassium (over 50 to 100 mg 100 g^{-1} of soil) has less than % of the land. A toxic content of over 100 mg100 g^{-1} of soil is very rare and is found on less than 1% of our lands. According to analyzes of agricultural land in the area of the city of Sombor, the potassium content is mostly sufficient. 46.15% of the land is optimally supplied with potassium (between 15 and 25 mg 100 g^{-1} of soil), while only 3.85% of the land is poor in potassium. A high content of potassium (25 to 50 mg 100 g^{-1}) has 20.51 % of the surfaces, while the toxic content (above 50 mg 100 g^{-1}) is on only 1.92 % of the examined samples of agricultural land in the area of the city of Sombor.

Key words: potassium, content, soil, toxic, Sombor

Application of bioinoculants in the function of reducing the use of mineral fertilizers in maize production

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Abstract

Maize is one of the most important crops, with significant agricultural and economic importance, both globally and in Bosnia and Herzegovina. To achieve high yields and quality, it is essential to ensure optimal amounts of nitrogen (N), phosphorus (P), and potassium (K) in the soil. New technologies, such as the use of rhizobacteria like *Pseudomonas* and *Bacillus*, can reduce dependence on mineral fertilizers, especially due to phosphorus-deficient soils in Bosnia and Herzegovina. This research aims to improve maize productivity and soil fertility through the use of biological fertilizers and adequate fertilization. Experimental trials were conducted on the fields of KJP "Poljoprivredno dobro Butmir," which annually sows about 200 ha of silage maize for feeding 400-500 dairy cows. The experiment was set up in 10 fertilization variants with three repetitions. All variants showed a higher content of all elements (N, P, K, Ca and Mg) except zinc, both in the leaf and in the maize grain. This could be explained in the way that the examined fertilization variants had a positive effect on the absorption of phosphorus and calcium, and at the same time they reduced absorption of zinc, because the mentioned elements are known antagonists with zinc. Considering the importance of zinc in livestock nutrition and its observed levels in both the leaf and grain, along with the antagonistic effect of phosphorus, it is recommended to supplement maize with zinc. Based on the results of the research, it can be concluded that the application of bacterial inoculants in the production of silage corn is an effective measure for reducing the use of mineral fertilizers, increasing the yield and quality of silage corn.

Key words: maize, fertilization, PGP bacteria

Comparing physicochemical parameters of two soybean genotypes in terms of their resilience against water deficit

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Abstract
Soybean (*Glycine max* (L.) Merrill) is the most harvested seed legume and a primary source of affordable protein (36-40%) and vegetable oil (18-24%). Drought stress during vegetative and reproductive stages can reduce yield by over 50%, depending on severity and timing. This study evaluated two soybean genotypes (Yakarta and Poca) under PEG-induced water deficit (-0.2, -0.4, -0.6 MPa PEG-6000) and control conditions in hydroponics at the early vegetative stage to identify drought-tolerant genotypes and related traits. Under stress, solute leakage, malondialdehyde, and proline increased by 68%, 45% and 78%, respectively, while carotenoids, stomatal conductance, and relative water content decreased by 43%, 46% and 20% compared to control. Poca had higher solute leakage (72%), MDA (10.14 µmol g^{-1} FW), and carotenoids (4.087 mg g^{-1} FW), whereas Yakarta exhibited higher proline (5.472 µmol g^{-1} FW), relative water content (78.5%), and stomatal conductance (399.7 mmol H_2O m^{-2} s^{-1}), suggesting superior water retention, membrane stability, and CO_2 diffusion under stress. Osmoregulation and the maintenance of plant water relations are two important physiological mechanisms of soybean determining the membrane integrity and the degree of stomatal aperture under water-limited conditions.

Key words: biochemical traits, hydroponics, osmoregulation, water deprivation

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Ascorbate-glutathione cycle in winter wheat drought tolerance during the stem elongation stage

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Abstract
Climate change is causing more frequent and intense drought periods during the year, negatively affecting wheat development and grain yield and quality. Plants have evolved various tolerance mechanisms to combat these conditions, including an antioxidant defence response in which the ascorbate-glutathione (AsA-GSH) cycle plays a significant role. Since wheat genotypes differ in their tolerance to drought, this study aimed to determine the impact of different drought intensities (moderate and severe) on the activity of the AsA-GSH pathway of six winter wheat genotypes. The effect of drought on wheat was estimated at the stem elongation stage, a critical period when wheat plants have high nutrient and water demands. Insufficient water during this stage can significantly reduce the number of flowers in spikelets, ultimately impacting the final grain yield. Enzymatic (glutathione reductase, ascorbate peroxidase, monodehydroascorbate reductase, dehydroascorbate reductase) and non-enzymatic (reduced/oxidized glutathione ratio, ascorbate/dehydroascorbate ratio) components of AsA-GSH cycle were measured using spectrophotometric methods. Drought stress induced oxidative stress in all six wheat genotypes studied, while the response of the ascorbate-glutathione cycle varied depending on both the wheat genotype and the drought severity, with more pronounced effects observed under severe stress conditions.

Key words: antioxidative response, ascorbate-glutathione cycle, drought, wheat

Biological and Ecological Variability of Biflavonoids in Ginkgo (*Ginkgo biloba* L.) Leaves

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Abstract

Ginkgo (*Ginkgo biloba* L.) is a long-lived ornamental, food, and medicinal tree species known for its exceptional resilience to environmental stressors, including urban pollution, drought, and temperature extremes. Due to its ability to thrive under diverse climatic conditions, Ginkgo serves as a model plant for studying adaptation mechanisms to climate change. Its strong stress tolerance and medicinal properties may be linked to the presence of various phytochemicals, as the biosynthesis and diversity of specific metabolites are crucial for survival in stressful environments. One such group of compounds is biflavonoids, flavonoid dimers composed of two identical or non-identical flavonoid units linked in a symmetrical or asymmetrical manner. Despite their presence in several plant species, their precise role in plants remains largely unknown. In this study, we developed an HPLC-DAD method for the simultaneous identification and quantification of five major biflavonoids—amentoflavone, bilobetin, ginkgetin, isoginkgetin, and sciadopitysin—and investigated their biological and ecological variability in Ginkgo leaves. We present their seasonal accumulation patterns, tissue-specific distribution, variations across different growing locations, and changes related to tree age. We hypothesize that biflavonoids contribute to Ginkgo's adaptability, as their accumulation varies across tissues, seasons, and locations, with the highest levels observed during high temperatures, suggesting a protective role. Understanding these variations will enhance our knowledge of plant metabolic plasticity and stress adaptation, with potential applications in improving the resilience of other plant species to climate change.

Key words: ginkgo, biflavonoids, climate adaptation, metabolic plasticity, HPLC-DAD analysis

Introduction and multiplication of selected genotypes *in vitro* for the phenotyping experiment within Croatian breeding program

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Abstract
In vitro propagation plays a crucial role in ensuring a sufficient supply of plant material for subsequent experimental applications. This study aimed to compare two propagation methods, nodal segment culture and meristematic bulk tissue (MBT) culture, as well as two growing mediums: Murashige and Skoog (MS) and Chee and Pool (CP). The experiment was conducted using two grapevine genotypes derived from a breeding program, DRP-7 and GRP-33, alongside the Chardonnay cultivar. All three genotypes were successfully established in *in-vitro* culture, with no significant differences observed between the tested growing mediums. The multiplication rate was assessed and compared across two propagation cycles. Both multiplication methods exhibited similar multiplication rates, with MBT showing a slightly higher multiplication rate for GRP-33 and Chardonnay, while the nodal segment method performed better for DRP-7. The choice of growing medium had no statistically significant effect on overall multiplication success. These findings suggest that *in vitro* culture is an effective approach for rapid plant propagation, with the MBT method demonstrating a slight advantage in certain genotypes. When comparing the two propagation methods, no statistically significant differences in multiplication rate were observed. Therefore, the selection of the appropriate method should be based on specific research objectives and experimental requirements.

Key words: *in vitro* culture, grapevine, multiplication methods, breeding program

Maize phenology and climate change in Eastern Croatia – *in silico* analysis of grain yield

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Abstract
Despite climate change, high-yielding maize production can be maintained or even increased with a better knowledge of phenology and optimal choice of the length of the plant life cycle for a particular environment. The aim of this work is to determine the trends in the grain yield in maize of different maturity groups in relation to average air temperatures and the sum of total precipitation in the warm part of the year at 11 locations in Eastern Croatia during the last 45 years. Climatic data were taken from the AGRI4CAST platform, and soil data from the ISRIC database. Daily interpolated meteorological data from 1979 to 2023 were used for a total of 11 25x25 km grids where center points are positioned near Šamac (ŠA), Bošnjaci (BO), Đakovačka Breznica (ĐB), Đakovo (DJ), Vinkovci (VK), Lovas (LO), Orahovica (OR), Koška (KO), Čepin (ČE), Bijelo Brdo (BB) and Beli Manastir (BM). After appropriate calibration, yield simulations were carried out using the APSIM software system on maize genotypes of different phenologies of relative maturity of 85, 100, 108 and 115 days, *i.e.* FAO groups 250, 420, 510 and 640, respectively. The average air temperature was between 17.25 °C (ĐB) and 17.87 °C (BO), and the biggest annual increase (0.06 °C) was in ŠA and BO. The average amount of precipitation was the highest in OR (383 mm), and the lowest in LO (338 mm). All locations recorded an increase in precipitation from 3.03 mm in BM to 4.36 mm in BO. The *in silico* analysis shows that in all locations for all maturity groups there was an increase in yield with no change in agricultural practice. The greatest increase was for genotypes of FAO 420, then in VK and BB for FAO 510, and in LO for FAO 640. The grain yield results should be placed in a broader context of the specific interaction between genotype, environment and management, the characteristics of newly registered hybrids as well as market requirements.

Key words: APSIM modeling, climate change, grain yield, maize, maturity groups

The efficiency of the participation of authorized laboratories for the quality control of agricultural reproductive material in Ring tests

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Abstract

The Ring tests or the Interlaboratory comparative tests are the organization, performance and evaluation of tests on the same or similar items by two or more laboratories in accordance with predetermined conditions. The system of conducting interlaboratory comparative tests is one of the requirements of the HRN EN ISO / IEC 17025: 2017 General requirements for the competence of testing and calibration laboratories. The Seed testing laboratory as a part of Central laboratory for seed testing and biotechnological analyses, Centre for seed and seedlings, Croatian agency for agriculture and food, in accordance with legal regulations, conducts Ring tests for laboratories registered in the Register of laboratories for quality control of agricultural reproductive material. The tests are carried out three times a year and cover all methods conducted by laboratories that are necessary for the issuance of documents needed for placing a seed lot on the market. The success of tests performed in laboratories is evaluated according to the calculation of Z-score. The results obtained by such tests are an excellent indicator of the competence of laboratory and serve as a guideline for users of the laboratory service, as well as the laboratory itself. By participating in tests laboratory obtains information about its performance and the accuracy of test results. That information laboratory can further use for various purposes, from proving its technical competence to exploring opportunities to improve the efficiency of its work. Ring test evaluates the implementation of methods, compares methods and determines differences between laboratories. Based on the obtained results laboratory organizes necessary trainings for analysts, changes the performance of methods or checks the equipment used in the implementation of methods.

Key words: seed testing laboratory, seed, Ring test, efficiency, competence

The production of healthy veggie snack

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Abstract
Tempeh is traditional fermented food originating from Indonesia. It has a rich history and a unique production process that sets it apart from other plant-based protein sources. Believed to have been discovered accidentally, tempeh's production began with the fermentation of soybeans wrapped in leaves, like banana, by naturally occurring *Rhizopus spp*. mold on a leaf surface. Over time, this fermentation process evolved into a culinary practice that spread across Southeast Asia and eventually reached the global stage. Within Indonesia, tempeh has historically been consumed as an affordable staple source of protein (fried, boiled, steamed, or grilled: tempe benguk, tempe bongkrek, or tempe lamtoro). Tempeh can be made from other legumes, grains, or a combination of ingredients, offering a variety of flavours and textures. It stands out for its unique taste and texture but also for its impressive nutritional profile. In Indonesia, tempeh has been considered a "low-class protein" food commodity due to its low price, abundant supply, and accessibility for people. There is a global emergence of initiatives to rebrand tempeh as an affordable, sustainable, and healthy plant-based product, thus vegetarian and vegan-friendly. As a plant-based protein source, tempeh also provides a lot of health benefits which are results of its bioactive compounds and probiotics, contributing to its potential health benefits for gut health. Production of tempeh has at least eight traditional variations and includes different processes like washing of the beans, soaking, cooking, cooling and drying, mixing and stuffing of the tempeh mass, fermentation, cooling of the tempeh sausage, unwrapping and slicing, soaking in water and salt, frying, seasoning, packaging and storage. The production of tempeh has evolved and modern methods often involve the use of controlled environments and commercially available starter cultures to ensure consistency in quality and safety.

Key words: tempeh, industrial production, veggie snack, plant-based protein

The effect of light emitting diodes lightning on leaf area index of orange mullein transplants

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Abstract
Verbascum phlomoides L. (orange mullein) is a biennial medicinal plant traditionally used to treat respiratory ailments due to its rich content of bioactive compounds such as flavonoids, iridoids, phenylethanoid glycosides, saponins, and mucilaginous polysaccharides. A key prerequisite for the successful development of healthy and vigorous plants, and for mitigating the negative impact of environmental stressors, is the use of high-quality planting material. Various methods of seedling production under controlled conditions can yield robust transplants. This study aimed to evaluate the effect of different LED lighting conditions, white, blue, and red, on the early development of *V. phlomoides* seedlings. Seeds collected in 2023 were grown under controlled conditions in a growth chamber, and parameters including leaf area index (LAI) and specific leaf area (SLA) were measured once seedlings developed their fourth leaf pair. The results of this study indicate that LED light quality significantly affects the early growth of *Verbascum phlomoides* seedlings. The highest values of both leaf area index (LAI) and specific leaf area (SLA) were recorded under blue LED lighting, while the lowest were observed under red. These findings highlight the potential of using specific light spectra to optimize seedling production of this medicinal plant under controlled conditions.

Key words: *Verbascum phlomoides* L., growth chamber, medicinal plants, artificial light, morphological parameters

Advancements in cucumber micropropagation - the role of media, growth regulators and explants

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Abstract

Micropropagation has developed as a vital technique for the large-scale propagation and genetic improvement of cucumber (*Cucumis sativus* L.). Our current work aims to select suitable protocol for successful micropropagation of different cucumber genotypes. Therefore, more than 30 articles from the1980s until now were analyzed. Since the 1980s, advancements in tissue culture protocols have focused on optimizing media compositions and plant growth regulators to improve shoot proliferation, rooting, and overall plantlet development in different cucumber genotypes. Yet, Murashige and Skoog (MS) medium has remained as a primary choice for cucumber micropropagation, regularly supplemented with varying concentrations of cytokinins and auxins. Early studies favored BAP as the key cytokinin for shoot induction, while NAA and IBA were commonly used for root development. Over the years, various explants have been used as starting material for cucumber micropropagation, including cotyledons, hypocotyls, shoot tips, nodal segments, and leaf discs. Shoot tips and nodal segments have been widely preferred for direct organogenesis, while cotyledons and hypocotyls have been utilized for adventitious shoot regeneration and genetic transformation studies. The choice of explants significantly influences regeneration efficiency and response to plant growth regulators. Although there is significant progress, challenges such as genotype dependency, explant sensitivity, and somaclonal variation are still present. Future research should focus on adjusting hormonal interactions, genetic stability, and cost-effective alternatives for large-scale application.

Key words: *Cucumis sativus* L., genotype, cytokinins, auxins, explants

Current status of the sensitivity of the *Erysiphe necator* populations to DMI fungicides in Serbia

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Abstract

The management of grapevine powdery mildew depends mainly on the application of fungicides, especially single-site fungicides such as DMIs, which are frequently used in grapevine spraying programs in Serbia, favoring the resistance development. As results regarding their efficacy and the sensitivity of *E. necator* populations are scarce, the aim of this study was to investigate the sensitivity of different populations to difenoconazole, tebuconazole, myclobutanil, penconazole and mefentrifluconazole using standard and molecular methods. Field trials, bioassays and molecular analyses were carried out from 2019 to 2023. The efficacy of plant protection products containing the above mentioned active substances, applied at the recommended rates, was investigated in three commercial and one experimental vineyard. Samples of infected vine leaves were collected from an experimental and several commercial, extensive and baseline vineyards to perform leaf disc bioassays and molecular analyses. Recommended, two and fourfold higher rates of myclobutanil, difenoconazole and tebuconazole were tested in the leaf disc bioassays. For molecular detection of the Y136F mutation, the ARMS-SYBR Green real-time PCR technique with specific primers was used. Low efficacy was observed after the application of myclobutanil and penconazole, while medium efficacy was obtained with difenoconazole and tebuconazole and the high with mefentrifluconazole at each site. Isolates from ten populations were classified as resistant to myclobutanil and tebuconazole, while isolates from six populations were resistant to difenoconazole. Of 106 isolates tested, the Y136F mutation was found in 45 isolates. From field trials sites, only several isolates carried this mutation, while in three commercial vineyards this mutation was detected in each isolate tested. This suggests that the detection of the Y136F mutation does not indicate a cross-resistance pattern within a population, but that the coupling of at least two resistance mechanisms is probably responsible for this process.

Key words: grapevine, powdery mildew, DMI fungicides, Y136F mutation

Morphological characteristics and yield of olive varieties grown in super high density planting

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Abstract
This paper presents the results of olive (*Olea europea* L.) cultivation in dense planting raised in the experimental orchard of the Croatian Agency for Agriculture and Food in Kaštel Štafilić. The research included 5 varieties: 'Arbequina IRTA-i18®', 'Arbosana-i43®', 'Koroneiki-i38®', 'Sikitita®' and 'Tosca 07®', and three planting distance of 3.7x1.75; 3.7x1.55 and 3.7x1.35m (=1544, 1744 and 2002 trees ha^{-1}). Tree cross-sectional area (TCSA), canopy area, canopy volume, and number of shoots were analysed in this research. Number of shoots, TCSA, canopy area and canopy volume were influenced by variety, planting distance, year and interaction of variety * planting distance * year. The varieties differed significantly in the growth of the TCSA, especially cvs Koroneiki and Tosca. Cv Koroneiki achieved the highest yield in all research years and the highest cumulative yield (kg per tree, t per ha), followed by Arbequina. Cv Sikitita had the largest fruits (average fruit weight 2.26 g), while Koroneiki had the smallest (1.08 g). Heat and drought stress manifested the most in cvs Arbequina and Sikitita with a significant reduction in yield, while the mildest impact was on cv Koroneiki. The most sensitive variety to frost damage was Arbosana, followed by Sikitita, while the most resistent was Tosca. Stable yields of olive trees planted in the super high dense planting requires regular implementation ofall agro- tehnical measures with emphasis on regular irrigation.

Key words: olive, super high density planting, Arbosana, Arbequina, Sikitita, Koroneiki, Tosca

Validation of pesticide residues determination in baby food by liquid and gas chromatography tandem mass spectrometry

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Abstract
Infant formula is the only processed foodstuff which wholly satisfies the nutritional requirements of infants during the first months of life until the introduction of appropriate complementary feeding. The EU Directive EC/125/2006 and Regulation EC/2016/127 defined that the essential composition of infant formulae and follow-on formulae must satisfy the nutritional requirements of infants in good health as established by generally accepted scientific data. The aim of this study was to develop reliable and robust analytical methods for the determination of pesticide residues in baby food, validated according to SANTE/11312/2021 guidance. A method was developed to analyze residual pesticides using liquid chromatography-tandem mass spectrometry (LC–MS/MS) and gas chromatography-tandem mass spectrometry (GC–MS/MS), for the analysis over 600 individual compounds. The sample preparation was based on QuEChERS methodology, slightly modified in the clean-up step. The LOQ was set at 0.01 mg kg^{-1} for all the analytes. The most investigated pesticides showed recovery between 70 and 120% with the relative standard deviation < 20% (except flubenzimine and pyridate). Linearity of the methods was set in the range 0.005 - 0.1 mg kg^{-1}. The obtained correlation coefficient of most pesticides was >0.99 (except dinoseb, dioxacarb, probenazole, methomyl and flubendiamide). The developed method effectively analyzes diverse compounds simultaneously, contributing to baby food product safety.

Key words: pesticide residues, LC-MS/MS, GC-MS/MS, infant formula

Influence of different postharvest treatments on mandarin 'Saigon' fruit quality

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Abstract
In Croatia, the Satsuma mandarin (*Citrus unshiu* Marc.) is a very important fruit crop and one of the few that is exported to other countries in notable quantities. This study evaluated the impact of edible composite coating and high-temperature treatments on the quality of mandarin fruit during cold storage and shelf-life. The 'Saigon' mandarins were dipped in a solution of chitosan (0.79% w/v) and guar gum (0.11% w/v), infused with mandarin peel extract (30%), at room temperature (T1). In the second treatment (T2), the same composite coating was heated to 50 °C and applied for 3 minutes. For the third treatment (T3), the mandarins were dipped in hot water at 50 °C for 3 minutes. Untreated mandarins served as the control. All fruits were then stored at 5 °C and 90% RH for 34 days, followed by 7 days of shelf-life at room temperature. Mandarin quality was assessed on days 6, 13, 20, 27, and 34 (cold storage), and 38 and 41 (shelf-life). The treatments did not affect the total soluble solids (TSS), titratable acidity (TA) or the TSS and TA ratio of the mandarins. The composite coatings have reduced weight loss during shelf-life. On day 38, T1 and T2 significantly reduced the weight loss of mandarins, while on day 41, weight loss of mandarins was significantly lower in T2 compared to T3 or control. Overall, the fruit decay rate was low during both cold storage and shelf life. During cold storage, on days 13 and 20, fruit decay was recorded only in control, while on days 27 and 34 fruit decay was the highest in control treatment. The hot water (T3) and heated composite coating (T2) treatments were most effective in preventing fruit decay during shelf-life.

Key words: edible coatings, hot water, mandarin, fruit quality, postharvest

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Molecular responses of wheat genotypes to drought stress during the stem elongation stage

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Abstract
Water deficit in the critical periods of growth and development of wheat can affect overall grain yield productivity and quality. Under water-deficit conditions, plants induce the expression of genes encoding different stress-responsive genes. This research aims to determine the molecular response of six Croatian winter wheat genotypes exposed to medium and severe drought intensity at the stem elongation growth stage. The expression of drought-responsive genes encoding antioxidative enzymes (*APX*, *GR*, *MDHAR* and *DHAR*), dehydrins (*DHN5*) and genes encoding transcription factors (*WRKY* and *DREB*) responsible for the regulation of stress-responsive genes were analysed. The expression of gene *DHN5* was highly induced under severe drought stress in all genotypes, suggesting an important role of dehydrins in drought stress. Genes encoding different antioxidative enzymes were mostly upregulated under stress conditions depending on the intensity of the drought and the genotype, while transcription factors were differentially regulated. Identifying drought stress-responsive gene expression will contribute to understanding the complex molecular mechanisms contributing to wheat tolerance at the stem elongation stage.

Key words: antioxidative enzymes, dehydrins, drought, transcription factors, wheat

Consequences of arbuscular mycorrhizal fungi and viruses interactions on grapevine primary metabolism

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Abstract
The cultivation of grapevine is often endangered by various diseases caused by viruses, consequently affecting yield and fruit quality. One of the ecologically acceptable strategies for increasing a plant's resistance to different environmental stresses is using arbuscular mycorrhizal fungi (AMF) in cultivation. This study aims to determine the consequences of AMF and viruses interactions on grapevine primary metabolism and establish the potential role of AMF in grapevine defence response against viruses. The study was conducted on Merlot grapevine infected with three viruses (GRSPaV, GLRaV-3, GPGV) and inoculated with AMF. It included 15 treatments with different combinations of grapevine, virus and AMF. Enzyme activities involved in glycolysis, pentose-phosphate pathway, starch biosynthesis and sucrose metabolism were analysed using spectrophotometric methods. The interaction of grapevine, viruses and AMF caused changes in the activity of some enzymes involved in the carbohydrate metabolism of grapevine leaves. Virus infection had a minor impact on carbohydrate metabolism, and certain combinations of viruses affected metabolic enzymes differently. Inoculation with AMF increased sucrose synthesis and decreased starch synthesis, as well as the activities of enzymes involved in glycolysis in uninfected and infected grapevine leaves. Study results contribute to a better understanding of the role of primary metabolism in the interaction of AMF, virus and grapevine.

Key words: arbuscular mycorrhizal fungi, carbohydrate metabolism, grapevine, viruses

Does the Zeo-bio preparation affect the qualitative and quantitative properties of wine and olive oil?

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Abstract
Consumers are becoming more aware of healthy eating and the impact of agricultural practices on the environment. It is planned to switch to less harmful methods of plant protection while encouraging the use of natural minerals such as zeolite to control plant diseases. The aim of the research was to determine whether the use of Zeo-bio preparation, compared to copper preparations, in the control of *Plasmopara viticola* and *Venturia oleaginea*, has an impact on the qualitative and quantitative properties of wine and olive oil. The research was conducted in 2023 and 2024 in Ravni Kotari, Zadar County, in a vineyard with the Cabernet Sauvignon variety in Suhovare and an olive grove with the Oblica variety in Škabrnja. The experimental areas were divided into four treatments, each with four replications: 1. Positive control Cu100 (2 kg ha^{-1} of copper), 2. Cu50/Zb50 (a combination of copper and Zeo-bio preparation in a 50:50 ratio; 1 kg ha^{-1} of copper and 3 kg ha^{-1} of zeolite), 3. Zb100 (full dose of Zeo-bio preparation with *Pseudomonas* sp. strain DLS65; 6 kg ha^{-1}), and 4. Negative control Cu0 (no treatment). During the two growing seasons, four treatments of grapevines and three treatments of olives were carried out. Harvesting occurred at the time of technological maturity, and samples of must, wine, and olive oil were subjected to physicochemical and sensory analyses, the results of which were statistically processed. Statistical analysis of the data determined that the treatment with Zeo-bio preparation did not negatively affect the quality of wine and olive oil. The application of the standard dose of copper (positive control Cu100) led to a reduced sugar concentration in the must and a slightly higher content of total acids compared to the other treatments.

Key words: Cabernet Sauvignon, copper, Oblica, organoleptic analysis, physicochemical analysis

Heritability estimates for grain yield in Croatian official variety trials of winter wheat and winter barley

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Abstract
In official variety testing, heritability can be served as a measure of the precision of the trials. The objective of this study was to compare the heritabilities for the grain yield, estimated on an entry-mean basis, in balanced data sets within a growing season, in three series of official Croatian variety trials of winter wheat varieties, winter barley varieties and winter barley hybrids. Estimates of heritability and its approximate standard errors were calculated from variance components in the combined analysis of variance, on data generated in a randomized complete design, conducted in three or four environments, each year from 2020 to 2024. Grain yield (t ha^{-1}) in wheat varied from 6.8±0.3 (2023) to 12.2±0.3 (2021). In barley, grain yield (t ha^{-1}) of varieties was between 6.4±0.4 (2023) and 9.9±0.5 (2021), and between 7.2±0.3 and 9.9±0.5 for barley hybrids. Heritability estimates in wheat were relatively high varying from 47.9±16.5 (2022) to 93.0±1.85 (2023). On the other hand, in barley, heritability estimates were zero in some instances due to very small genotypic variance components. However, heritability in 2023 was 84.9±6.7 and 69.2±17.1, for barley varieties and hybrids, respectively. Our results suggest that heritability estimates in wheat can be informative in official variety trials, while in barley they are not useful due to specific relations among variance components. These recent results are in accordance with the data published earlier for the period between 2001 and 2019.

Key words: barley, wheat, grain yield, heritability, variety testing

Fauna of cicadas (Hemiptera: Auchenorrhyncha) on grapevines at the Rodoč-Mostar site

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Abstract
The suborder Auchenorrhyncha is a diverse group of sap-feeding insect species and includes economically important pests of grapevines worldwide. They can cause direct damage by feeding on grapevine or indirect damage by transmitting plant pathogens. The diversity of Auchenorrhyncha species was studied during 2022 and 2023 at site Rodoč-Mostar (Bosnia and Herzegovina). Cicadas were sampled weekly from June to the end of September. Collecting was done with an entomological net and with Csalomon® SZz and Rebell® amarillo sticky traps. A study of the diversity of the suborder Auchenorrhyncha revealed the presence of 24 species belonging to seven families. The most abundant was the family Cicadellidae with 14 species, followed by Cixiide, Delphacidae and Membracidae each with two species, and Dictyopharidae, Aphroporidae, Cercopidae and Flatidae, with only one species recorded. The most abundant species during both years of research were *Empoasca vitis* (Göthe, 1875), *Edwardiana* sp. and *Arboridia* sp. The research revealed the presence of *Dictyophara europaea* L., a vector of the *Flavescence dorée* phytoplasma, and *Hyalesthes obsoletus* (Signoret), a vector of the *Bois noir* phytoplasma.

Key words: Auchenorrhyncha, cicada fauna, grapevine, Mostar

The Effect of Water Salinity on Stomatal Conductance in Early Unshiu Mandarin (*Citrus unshiu* Marc.) Cultivars in Croatia

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Abstract
The global climate is rapidly changing, impacting agricultural productivity worldwide. Increasing salinity, caused by irrigation-related secondary salinization, presents challenges for mandarin cultivation in Mediterranean regions like Croatia. This study investigated the effect of salinity on stomatal conductance (gsw) of three early unshiu mandarin cultivars ('Ichimaru', 'Iwasaki' and 'Zorica rana', all grafted to *Poncirus trifoliata* (L.) Raf.) across four locations (Vidrice, Glog, Bostanac, Modrič) during two growing seasons (2023 and 2024). Measurements were performed using the LI-600 Portable Fluorometer and Porometer in June, August, and October each year. The average total dissolved solids (TDS) and electrical conductivity (EC) levels varied significantly between locations, with the highest salinity recorded at Vidrice (5132 µS cm^{-1} in 2023) and the lowest at Bostanac (685 µS cm^{-1} in 2023). Glog and Modrič showed moderate and increasing salinity levels over time. ANOVA results indicated highly significant effects of Year, Location, and their interaction (Year × Location), suggesting that stomatal conductance varied both temporally and spatially. Although cultivar alone was not a significant factor, significant interactions with Location and Year × Location suggest that cultivar responses depend on environmental context. Notably, the 'Ichimaru' cultivar exhibited increased gsw in Modrič from 2023 to 2024, despite rising salinity, implying potential adaptive or tolerant traits. In contrast, 'Iwasaki' and 'Zorica rana' generally showed a decline in gsw across most locations over the same period. These findings highlight the importance of salinity management and selection of tolerant cultivars. 'Ichimaru' is a promising candidate for cultivation in salinity-affected areas. Further research should explore physiological mechanisms contributing to tolerance and evaluate their applicability to other citrus crops.

Key words: climate change, salinity stress, mandarin, stomatal conductance

Session 2

Animal Production and Food Quality

Low-Copper Products vs. Copper Fungicide: Implications for Oxidative Stability of Virgin Olive Oil

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Abstract
The quality of virgin olive oil (VOO) is largely determined by its oxidative stability and oxidation products, affecting shelf life, sensory properties, and nutrition. Fungicides play a key role in olive disease control, with copper-based ones being effective but raising concerns about soil accumulation and oil quality. Alternative solutions should be sought to reduce the use of copper. This study therefore investigates the effects of different copper-based products on the quality indicators of VOOs; acidity, analytical oxidation parameters, phenols and oxidative stability. The experiment was carried out in two harvests on Oblica olive trees treated with products with differed Cu content (1%, 12% and 37.5%), and with a control treatment. After harvesting, the oils were obtained by laboratory oil mill and the VOOs were chemically analyzed. In the first year, differences were limited to the peroxide value, which was either the same as in the control (12% Cu) or lower than control, but not significantly different from each other. Phenols ranged from 300 to 700 mg kg^{-1}, showing no significant differences between treatments. A tendency to decrease the peroxide value and K_{232} was observed in the VOOs originating from trees treated with low-copper product. Higher oxidative stability was found for VOOs extracted from treatment with higher Cu content. Results support sustainable disease control in olives, preserving oil quality while reducing copper use.

Key words: Virgin olive oil quality, Oxidation Products, Phenolics, Sustainable agriculture

Integrating Advanced Genomics and Phenomics in Dairy Cattle Breeding: A Modern Approach for Croatian Dairy Farming

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Abstract

In response to the emerging challenges in dairy cattle breeding, we have developed an interdisciplinary strategy that integrates cutting-edge technologies into breeding programs in Croatia. Our approach combines advances in phenomics and genomics to develop innovative methods for routine use in dairy cattle breeding. A key component of this effort is DaMoS (Dairy Multi-Omic Strategy), a cost-effective approach tailored to large-scale genotyped dairy cattle populations, such as Holstein cattle. DaMoS is built upon 1X low-pass whole-genome sequencing (lpWGS) of milk samples, a strategy that not only generates genomic SNP data, but also enables the retrieval of complete mitogenomes, milk microbiota profiling (including mastitis pathogen detection) and estimation of mtDNA copy number, a potential new phenotype associated with milk production and health. Remarkably, all this is achieved at a cost of less than 40 euros per sample, making it an accessible and practical tool for modern dairy cattle breeding. Beyond genomics, DaMoS aligns with state-of-the-art phenomics leveraging machine learning techniques and large-scale data analytics. In this presentation we introduce use of FTIR spectral data, focusing on the coagulation properties of milk and other milk components, offering a powerful framework for big data management. While our main focus is on the practical implementation of novel breeding tools in Croatian dairy farming, our concept also has an innovative underlying scientific component.

Key words: Dairy cattle breeding, Phenomics, Genomics, Machine learning

Cutting-Edge Methods for Identifying Microplastics in Agricultural Environments

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Abstract
The growing presence of microplastics in the environment and food chain raises concerns about their impact on ecosystems and health. Accurate detection in water, soil, feed, and biological tissues is essential for assessing contamination levels and risks. Modern instrumental techniques help identify microplastics, providing insights into their composition, size, and morphology. Key analytical methods include Fourier Transform Infrared Spectroscopy (FTIR), Raman Spectroscopy, and Pyrolysis-Gas Chromatography/Mass Spectrometry (Py-GC/MS). FTIR and Raman allow non-destructive polymer identification, while Py-GC/MS enables precise chemical characterization. Advanced imaging techniques like Scanning Electron Microscopy (SEM) and Flow Cytometry further enhance detection in complex samples. Despite advancements, challenges remain in standardizing methods, ensuring reproducibility, and distinguishing microplastics from other particles. Further research is needed to refine detection, improve automation, and lower costs. Reliable methods support regulations and help mitigate microplastic pollution. As part of ECO(RE)ACT—Enhancing Climate Resilience through Reducing Microplastic Pollution in Agricultural Ecosystems—FTIR spectroscopy will be key for detecting microplastics in irrigation water, soil, and feed, improving understanding of their impact on agriculture and food safety. Standardized protocols and advanced tools will enhance detection accuracy and support mitigation efforts.

Key words: microplastics, instrumental methods, FTIR, raman spectroscopy, Py-GC/MS, environmental monitoring

Effect of stocking density on footpad dermatitis and gait score

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Abstract

Increasing stocking density results in higher litter moisture and ammonia concentration, which are considered major factors in the occurrence of footpad dermatitis (FPD). Additionally, increased stocking density can affect lameness, as movement is restricted. The aim of the study was to examine the effect of stocking density on the occurrence and severity of FPD and gait score. Total of 185 broilers were assigned to two treatments, each with five replicates, in floor pens with peat as bedding material. The experiment lasted 42 days, and the broilers were divided into two groups based on stocking density. The lower-density (LD) group consisted of 17 broilers per pen (33 kg m^{-2}), while the higher-density (HD) group consisted of 20 broilers per pen (39 kg m^{-2}). Lesion assessment was performed at 4 and 6 weeks of age using the Eichner (2007) method on a scale from 0 to 3. Gait score was assessed at 4 and 6 weeks of age using the Kestin et al. (1992) method on a scale from 0 to 5. Between the 4th and 6th week of age, a significant difference was observed in the occurrence and severity of FPD. At 4 weeks of age, there was no significant difference in FPD occurrence between the LD group (0.05) and the HD group (0.08). At 6 weeks of age, broilers in the higher-density group had a higher average FPD score (0.40) compared to the lower-density group (0.25), however, the differences were not significant ($p>0.05$). Age significantly influenced the increase in gait score ($p<0.05$). A significant increase in gait score was observed in both stocking densities with increasing age. Stocking density did not have a significant effect on gait score ($p>0.05$). At 4 weeks of age, the average gait score for the LD group was 1.15, while for the HD group, it was 1.43 ($p>0.05$). At 6 weeks of age, the HD group had a slightly higher gait score than the LD group (2.75 vs. 2.40, respectively), but the differences were not significant ($p>0.05$). Based on the obtained results, it can be concluded that stocking density did not significantly affect the occurrence of FPD and gait score. On the other hand, increasing broiler age led to a significant increase of gait score.

Key words: broilers, stocking density, peat, footpad dermatitis, gait score

Effect of age on meat physical parameters in male wild boar

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Abstract
The aim of this study was to determine the effect of age on meat pH, colour (lightness, redness, yellowness, hue angle/°, chroma), thawing loss (%), cooking loss (%), and tenderness (N/cm^2) in male wild boar. All animals came from individual hunts and one hunting ground. According to estimated age animals were classified as juvenile (<1 year; n=32), yearling (1-2 years; n=27) and adults (>2 years; n=25). Samples of muscle *psoas major* were collected after evisceration, vacuum packed and stored at -20°C prior to analyses. With increasing age, a slight decrease ($p>0.05$) in pH (5.64< 5.62<5.59), L* (37.86< 37.56<36.05), and hue (21.41<21.10<20.72), was found. A slight increase ($p>0.05$) in b* (6.83<7.03<7.04), chroma (19.29<20.14<20.18), and cooking loss (17.87<18.63<19.17) with increasing age was observed. The meat of juveniles had lower ($p<0.05$) redness (a*) than adults (18.16<19.20<19.29), higher ($p<0.0001$) thawing loss than yearlings and adults (15.74>7.46>8.25) and better tenderness than adults (48.60<51.01<52.72). The results indicate that age has a minor influence on the evaluated meat quality parameters, highlighting the need for further research to comprehensively assess the other factors influencing the wild boar meat quality.

Key words: pH, L*, a*, b*, thawing loss, tenderness, *Sus scrofa*

Light conditions affecting the cultivation of Yellow Perch, *Perca flavescens*

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Abstract
The influence of light on the development, behavior and maturation of fish has been described in several scientific papers. Larval development, feeding habits, and sexual maturation are largely dependent on light intensity, and photoperiod. This article describes how light conditions affect the cultivation of yellow perch, *Perca flavescens*. Two major limitations to cost-effective breeding are undefined larval rearing conditions and early sexual maturation. Commercial size, 150g fish, will yield 55-60g of edible flesh if the gonads are not developed. Gonads can account for 15-30% of total weight, what presents serious loss of marketable meat. Several experiments were conducted at the different stages of yellow perch farming under control conditions. During early larval development, fish were kept under conditions of constant light, constant darkness, and a 12/12 photoperiod until complete resorption of the yolk sac. Resorption coefficients vary from 0.043 in constant light conditions to 0.048 in constant darkness. Covariance analysis did not show significant statistical differences in the resorption process for the three tested treatments, but the growth coefficient was noticeably lower in larvae grown in constant light. The growth of larvae in the dark and on a 12h/12h photoperiod show significantly higher correlation coefficients in contrast to the growth curves of larvae in constant light. However, the growth in complete darkness is a little faster than the growth of larvae on a 12h/12h photoperiod. Survival in the dark and 12/12 photoperiod amount to over 60%, but survival in constant light is significantly lower and amounts to 48%. Juvenile fish were kept under natural photoperiod and temperatures, and at constant elevated temperature and extended photoperiod (16 hours). At constant temperatures and constant extended photoperiod, yellow perch does not reach sexual maturity in the first year, which improves growth rate, and significantly increases dress out percentage.

Key words: photoperiod, sexual maturation, larval development, survival

Productive traits of piglets fed diets with different sources of selenium (Se)

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Abstract
The aim of this study is to determine to what extent the addition of different sources and forms of selenium (organic and inorganic, and nano selenium) in the diets of weaned piglets affects production (body weight, daily gain, feed conversion) and health indicators (mortality). The study was conducted on 200 weaned piglets of the PIC (Pig Improved Company) hybrid, of which there were 100 males and 100 females. The piglets were divided into 4 groups, 50 piglets of both sexes in each group. Each group of piglets received a standard ration of 20% crude protein, and premixes with 3 ppm kg^{-1} Se from different sources were added to the experimental groups (P1 - organic Se, Selplex; P2 - Se from biofortified feed; P3 - nano Se, Framelco, Fra Easy Selenium Dry). On the 22nd day of the study, piglets in the second experimental group (P2) that received a diet with biofortified cereals had a statistically significantly higher ($P<0.05$) average body weight compared to piglets in the control group (K) that weighed. Also, at the end of the study period, piglets in the second and third experimental groups and piglets in the control group had a statistically significantly higher ($P<0.05$) body weight compared to piglets in the first experimental group that received organic selenium in their diet. The addition of different sources of selenium to the diets of weaned piglets resulted in positive effects on the production traits of weaned piglets. The lowest number of piglets that died (2%) was determined in the group that received a diet from biofortified feeds (P2). Also, a positive effect of adding a diet with Se from biofortified feeds on the health status and survival of piglets was determined.

Key words: piglets, selenium, biofortification, production traits, health status

A review of animal nutrition over the past 60 years

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Abstract
Over the past six decades, the field of animal nutrition has changed dramatically due to constant scientific research, technological innovation and global demand for animal products. The field has evolved from traditional feeding systems that focus on meeting basic nutritional needs to cutting-edge precision feeding approaches that optimise production efficiency, animal health and environmental sustainability. The 1960s and 1970s saw the introduction of scientifically formulated feeds and the use of antibiotics as growth promoters, while the 1980s and 1990s saw a focus on precision feeding techniques, computerised meal formulation and alternative protein sources. In the 2000s and 2010s, functional nutrition became increasingly important, with a focus on digestive health, nutrigenomics and sustainably produced feeds. The current decade is characterised by the introduction of artificial intelligence in the optimisation of rations and feed mixes, the implementation of feed production strategies that resist climate change and efforts to reduce the impact of livestock farming on the environment. Innovations such as insect-based proteins, fermented feed ingredients and methane-reducing additives are shaping the future of animal nutrition. This paper provides a review of these changes and discusses their implications for sustainable livestock production and global food security today.

Key words: animal nutrition, history, 60 years

In vitro starch digestibility rate of rehydrated grain silages in maize hybrids differing in hardness

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Abstract
The aim of the present study was to investigate relationship between the *in vitro* starch digestibility rate (k_d) of rehydrated grain silages and the physical properties of the mature grain from seven commercial maize hybrids. Grain was harvested at physiological maturity, rehydrated to 32% of moisture and ensiled with a commercial inoculant during different ensiling periods (0, 21 and 95 days), with five replicates in a completely randomized design. The k_d was determined using first-order kinetics following an *in vitro* digestion procedure mimicking stomach and small intestine of pigs. Physical properties assessed included 1000 kernel weight and volume, density, test weight, kernel dimensions, hardness and breakage susceptibility. The tested hybrids differed in their physical properties (test weight, kernel dimensions, density, and hardness), digestion coefficients and k_d ($p<0.05$). The k_d increased with increasing ensiling period, with average values of 0.588, 1.013 and 1.179 1/h for 0, 21 and 95 days of ensiling period, respectively. Relationship between k_d and physical properties was more pronounced with increasing ensiling period; hybrids with higher grain hardness had higher k_d after 95 days of ensiling compared to hybrids with lower grain hardness (1.272 *vs.* 1.110 1/h, respectively). Ensiling enhanced availability of starch to digestive enzymes, and this effect was greater with longer ensiling period and increased grain hardness. Thus, the duration of ensiling and maize hybrid hardness should be taken into account when formulating animal diet.

Key words: maize, hybrid, ensiling, starch digestibility rate, hardness

The impact of *Fascioloides magna* infection on characteristics of red deer antlers

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Abstract
Trematode *Fascioloides magna* was introduced to Europe by American deer species. In Europe, this fluke has established new host-parasite associations that are still undergoing a process of mutual adaptation. Though red deer is typical host of this fluke, it can be expected that heavy infections will have consequences on deer's productivity, namely antler quality and calf vitality. We compared the trophy characteristics with the intensity of *F. magna* infection in 108 red deer originating from the hunting ground "PODUNAVLJE-PODRAVLJE". The growth curves of the dependent variables were equalized by a modified Weibull function, using the Gauss-Newton algorithm. The relationship between the analysed features was calculated using the Kendall-Tau correlation coefficient. The results showed that beam length is statistically significantly related to infection in animals aged six to eight years. The total number of migratory stages and pseudocysts in six years old deer has a statistically significant negative impact on the total length of antlers. The number of migratory stages negatively affects the antler mass of six-year-old deer, while the number of flukes negatively affected the antler mass of nine-year-old deer. The conducted research confirmed the influence of the infection on the deer's productivity. The observed association of infection with trophy value in younger deer is likely a consequence of the still present increased requirements for growth of organism.

Key words: red deer, *Fascioloides magna*, trophy value, intensity of infection

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Influence of different beef meat proportions on the sensory and physical properties of dry sausages

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Abstract

This study investigated the effect of varying proportions of beef meat (25%, 50%, 75%) on the physical characteristics and sensory attributes of dry fermented sausages. The sausages were manufactured using traditional techniques under natural microclimatic conditions, with a production period of approximately three months, including drying, cold smoking, and ripening. All treatments contained equal amounts of salt and spices, and physical parameters such as weight loss, pH value, and water activity were monitored throughout the production process. At the end of production, a sensory evaluation was conducted with 65 untrained subjects from the student population, using a 9-point hedonic scale to assess cut appearance, aroma, flavour, juiciness, texture, and overall acceptability. Differences in physical traits between treatments were minor and statistically insignificant, indicating uniform processing regardless of beef content. However, the sensory analysis revealed significant differences: sausages with 75% beef received lower ratings for aroma, hardness, and overall acceptability compared to those with a lower beef content. The best sensory scores were recorded for sausages containing 25% beef. The results suggest that a beef content higher than 50% may negatively affect product acceptability, despite minimal differences in physical parameters. This research supports further development of traditional meat products through informed formulation adjustments and highlights the importance of aligning sensory attributes with consumer expectations.

Key words: dry sausages, beef meat, sensory analysis, physical traits, traditional production

Impact of High-Protein Concentrate Granules on Nutrition and Economic Efficiency in Livestock Feeding

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Abstract
This study investigates the effects of high-protein concentrate pellets in mixed animal feed and economic outcomes, focusing on the number of cows, protein %, fat %, and ash %. Mixed animal feed samples were collected from 40 farms in Kosovo during 2023. Twenty farms did not use concentrate pellets, while twenty included them as feed supplements. Protein was measured by the Kjeldahl UDK149 method, total fat by extraction in Soxtherm-Gerhardt-SOX 414, and ash by the gravimetric method. Farms using concentrate pellets had significantly ($p=0.023$) more cows (34.30 ± 23.85) than those without pellets (20.10 ± 11.32). The percentage of protein was also significantly higher ($p=0.001$) in farms fed with pellets ($18.96 \pm 2.04\%$) compared to farms without pellets ($16.70 \pm 1.86\%$). No significant differences were found for % fat ($2.51 \pm 0.93\%$ vs. $2.42 \pm 0.76\%$, $p=0.729$) and % ash ($4.34 \pm 0.75\%$ vs. $4.40 \pm 0.87\%$, $p=0.833$), indicating stability in these parameters. The findings highlight that high-protein concentrate pellets increase feed protein levels and facilitate greater herd management. Economic analysis revealed that the daily cost of using protein-rich pellets is €1.50, €10.50 per week and €45.00 per month (per cow). Using pellets raises feeding costs but increases nutritional value, productivity, and herd health. Incorporating legumes and barley residues can boost feed protein, reducing reliance on concentrates. Stable fat and ash percentages ensure feed consistency. These findings emphasize the nutritional and economic benefits of concentrate pellets in livestock feeding, enhancing productivity and cost efficiency.

Key words: concentrate granules, livestock nutrition, protein enhancement, economic efficiency

Influence of Storage Conditions on Biogenic Amine Accumulation in Fresh Cheeses

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Abstract
Biogenic amines are organic compounds formed through microbial decarboxylation of amino acids during fermentation, ripening or spoilage in food. Their presence is an indicator of microbial activity and hygiene status but also poses potential health risks. This study aimed to determine the concentration of biogenic amines in fresh cheeses and assess how storage conditions (+4 °C, +20 °C) influence their accumulation during shelf life. A developed analytical method (HPLC-DAD) was applied to measure the levels of histamine, tryptamine, putrescine, and cadaverine, which are commonly used as indicators of food freshness and quality. Samples of fresh cheeses produced without thermal treatment were collected from open markets in the city of Zagreb during three months in 2025. The results showed that temperature had a stronger influence on the levels of biogenic amines compared to storage duration. Higher storage temperatures led to a higher accumulation of these compounds, highlighting the importance of controlled storage to minimize health risks. These findings emphasize the need for strict temperature regulation in cheese production, distribution and proper storage conditions to ensure consumer safety.

Key words: biogenic amines, fresh cheese, storage conditions, food safety, temperature

Dairy cow welfare and productivity in free-stall housing systems

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Abstract
High animal welfare standards are necessary for sustainable dairy production. Dairy cow welfare is one of the major issues in most industrialised countries not only for animal health and productivity but also for public health. Previous studies carried out on dairy cow farms in Europe have indicated there is room to improve their welfare. Housing system influences many parameters of dairy cow welfare, and free-stall housing better meets the conditions required for their welfare than tie-stall housing concerning animal comfort and behaviour. The more so, unlike tie-stall housing system, free-stall housing is associated with higher fertility and prolonged productive life of dairy cows. Thus, emphasis is on using free-stall housing system for dairy cows. However, there are only rare literature reports comparing dairy cow welfare in different free-stall housing systems. In cubicle housing systems, the lying surface including inappropriate bedding, dimensions of cubicles and positioning of cubicle fittings, is stated as one of the main risks for dairy cow welfare. In deep litter systems, the risks include dirty bedding and limited lying area. Although shifting dairy cows from tie-stall to free-stall housing system generally results in a reduced dairy production, studies have revealed that productivity up to a year after such shift is the same or even greater in case of free-stall housing, however, with no productivity differences between various free-stall housing systems. To our knowledge, no large study assessing animal welfare at dairy farms has been conducted in Croatia so far, therefore, future research should focus on comparison of dairy cow welfare in free-stall housing systems, including their productivity both worldwide and in Croatia.

Keywords: dairy cows, animal welfare, productivity, housing system

Innovative Lyophilized Probiotic from Goat Milk: A Step Towards Future Functional Foods

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Abstract

Goat milk has gained attention due to its digestibility, nutritional composition, and health benefits. *Powerbiotic*® is an organic goat milk-based supplement containing standard yogurt cultures (*Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*), probiotic strains (*Bifidobacterium animalis* ssp. *lactis* BB-12, *Lactobacillus acidophilus* LA-5), and inulin. The study aimed to develop a dehydrated version of *Powerbiotic*® using lyophilization to extend shelf life, enhance safety, and reduce transport costs. Microbiological analyses were conducted to determine the presence of enterobacteria, coagulase-positive staphylococci, yeasts, molds, and lactic acid bacteria. Samples were inoculated onto selective media and incubated under controlled conditions. The identification of bacterial strains was performed using MALDI-TOF MS. Physicochemical analyses, including fat, protein, lactose, dry matter, and pH value, were conducted on both liquid and lyophilized *Powerbiotic*® using accredited methods. The lyophilization process significantly reduced the product's weight to approximately 10% of its original form while maintaining its probiotic viability and sensory properties. The results suggest that lyophilization effectively preserves the functional characteristics of *Powerbiotic*® while improving its stability and market potential. The dehydrated format simplifies distribution enhancing competitiveness in the global market. The dehydrated format simplifies distribution enhancing the availability of products to more distant destinations. This research provides a foundation for developing new functional dairy products using lyophilization technology.

Key words: goat milk, probiotics, lyophilization, functional food, microbiological analysis

Recruitment of *Mytilus galloprovincialis* on PET strap collectors in the eastern Adriatic Sea

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Abstract
Although mussel farming of *Mitylus galloprovincialis* has a centuries-old tradition in the eastern Adriatic Sea, the potential of shellfish aquaculture in Croatia is insufficiently exploited. The availability of seed is one the water colume is one of the basic requirements for shellfish farming. The use of suitable collectors, favourable locations and immersion depths are among the basic characteristics that need to be defined for mussel farming. This experimental study was conducted in the central Adriatic Sea to determine the amount of recruitment of *M. galloprovincialis* together with other bivalves in the water column on collectors of standard mussel socks and PET straps. The Mann-Whitney U Test was used for identification of differences between two observed groups, type I error was set at 5% for all calculations, and all data were performed using Statistica 14.0.1 statistical data analysis software. The absolute values show differences, but no significant differences in recruitment were found between *M. galloprovincialis* and other colonised bivalves. Further studies on the recruitment efficiency of mussels using the different collectors would be desirable. It would be good to test other types of collectors to improve the most suitable material for colonising larger amounts of mussel spat.

Key words: recruitment, collectors, *Mytilus galloprovincialis*, mariculture, Adriatic Sea

Effectiveness of selenium biofortification in improving the chemical composition of maize

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Abstract

Selenium biofortification is an agronomic strategy aimed at increasing organic selenium (Se) levels in edible plant parts to improve nutritional value and prevent deficiencies. Field experiments in 2024 assessed the effects of selenium biofortification treatments (0, 10, 20, or 30 g ha^{-1} Se) and maize hybrids (D and F) on macroelements (P, K, Mg, Ca, Na) and microelements (Se, Fe, Mn, Zn, Cu) in maize grain and vegetative mass. In the aboveground vegetative mass, macroelement concentrations followed this order: K (16,447 mg kg^{-1}) > Ca (4,905 mg kg^{-1}) > Mg (2,667 mg kg^{-1}) > P (1,119 mg kg^{-1}) > Fe (171.5 mg kg^{-1}) > Na (102.1 mg kg^{-1}) > Mn (46.0 mg kg^{-1}) > Zn (12.7 mg kg^{-1}) > Cu (6.5 mg kg^{-1}) > Se (0.258 mg kg^{-1}). No significant differences were found between hybrids. In maize grain, the order was: K (3,646 mg kg^{-1}) > P (2,845 mg kg^{-1}) > Mg (830 mg kg^{-1}) > Na (75 mg kg^{-1}) > Ca (43 mg kg^{-1}) > Zn (18.9 mg kg^{-1}) > Fe (17.1 mg kg^{-1}) > Mn (5.1 mg kg^{-1}) > Cu (1.2 mg kg^{-1}) > Se (0.205 mg kg^{-1}). Hybrid F had significantly higher K (3.86%) and Mn (5.4 mg kg^{-1}) levels, while hybrid D had higher Se concentration (218 µg kg^{-1} : 191 µg kg^{-1}). Selenium biofortification significantly increased Se concentrations in maize grain, with 10, 20, and 30 g ha^{-1} Se treatments increasing Se by 3.3, 5.9, and 9.1 times, respectively. In vegetative mass, Se concentrations increased 3.7–6.3 times. There were no significant differences in selenium accumulation between maize hybrids, but biofortification was effective. The biofortified corn grain can be used as a selenium-enriched raw material in the formulation of feed mixtures and food products.

Key words: biofortification, maize, chemical composition

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Comparative study of chemical and antimicrobial properties of European honey bee (*Apis mellifera*) and Indonesian stingless bee (*Trigona laeviceps*) propolis

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Abstract
Due to an increasing number of pathogens resistant to multiple classes of antibiotics (MDR; multidrug resistant), it is a priority to find alternative antimicrobial compounds. Propolis has been shown to exhibit excellent antimicrobial properties. In this study, European honey bee and Indonesian stingless bee propolis was used to determine the minimum inhibitory (MIC) and minimum bactericidal concentration (MBC) against MDR pathogens, and to investigate chemical properties of raw propolis samples using FTIR-ATR spectroscopy. Despite having similar initial concentrations (2.50 to 8.50 mg mL^{-1}), honey bee propolis showed a better antimicrobial property against vancomycin-resistant *Enterococcus faecium*, methicillin resistant *Staphylococcus aureus*, carbapenem-resistant *Klebsiella pneumoniae* and *Acinetobacter baumannii* MDR strains (n=16). Honey bee propolis demonstrated activity against 95.31% of tested strains, with MIC values ranging from 0.77 ± 0.42 to 1.78 ± 0.99 mg mL^{-1} and MBC values from 0.88 ± 0.50 to 1.95 ± 1.13 mg mL^{-1}. In contrast, stingless bee propolis was effective against 56.25% of strains, with MIC values equal to MBC at 1.83 ± 0.66 mg mL^{-1}. The results of spectral analysis revealed unique spectral features of investigated raw propolis samples reflecting variations in the content of major propolis constituents (phenols, flavonoids, esters, and hydrocarbons). The most distinctive spectral differences were associated with phenolics and other balsam-related compounds.

Key words: propolis, MDR pathogens, antibacterial activity, serial microdilution, FTIR-ATR spectroscopy

GM soybeans from animal feed to meat products

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Abstract
GMO food includes products that directly contain or are produced from genetically modified organisms (GMO). Croatia has aligned its entire legislation related to GMO with EU regulations and implements a policy of GMO restriction. By enforcing a monitoring system for both animal feed and food, the safety of the food chain is ensured. As part of the national Act on Genetically Modified Organisms (Official Gazette 126/19), EU Regulation 1829/2003 is applied, which stipulates that all GMOs in food and feed must be approved for use, and products containing more than 0.9% GMOs must be labeled. The cultivation of GM soy as a commercial crop is prohibited in the EU, but import and use in animal feed is allowed under strict legal regulations. Accordingly, GM animal feed, most commonly in the form of soybean meal, seeds, and soybean oil, is subject to strict control and must be clearly labeled on the market, with all approved GM lines and their percentages listed on the declaration. At the same time, legislation does not require the labeling of animal products (meat, milk, eggs) derived from animals fed with GM feed, and such products are not required to be labeled as GMO. The same applies to processed meat products originating from animals fed with GM feed. However, if they directly contain GMOs in quantities exceeding 0.9%, labeling is mandatory.

Key words: GMO, animal feed, animal products, labeling

Pesticide residues in food, risk assessment and look into the future

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Abstract

The term "pesticide residues" refers to residues found in or on products of plant or animal origin and in animal feed resulting from the use of pesticides. To protect consumers from exposure to unacceptable levels of pesticide residues in food and animal feed, maximum residue limits (MRLs) are set in accordance with EU Regulation 396/2005 as a safety threshold. Improper use of pesticides is the most common reason for the presence of residues above the allowed levels.Risk assessment is a complex process based on scientifically established facts, as well as new knowledge and information. To determine whether there is any acute risk to consumer health from the consumption of products with pesticide residues above the MRLs, several factors are required: the determined pesticide concentration, dietary models, dietary habits of specific population groups, and toxicological parameters (such as the acute reference dose – ARfD). Food is considered safe for consumption if the estimated intake of harmful substances (pesticides) does not exceed the ARfD value. In recent times, various types of food products have been withdrawn and recalled from the market due to the use of non-approved pesticides such as ethylene oxide and chlorpyrifos. Special caution is required during the import of raw materials and food originating from third countries, due to large differences in legislation. A different, individual approach to risk assessment, which is a crucial part of food safety, aims to ensure a high level of consumer protection. Every new piece of knowledge opens up opportunities to improve the entire system "from field to table".The focus on risks to human health and the environment from combined exposure to multiple chemicals ("mixture risk assessment") has increased over the past few decades. Additionally, cumulative risk assessment for pesticides is a new tool being developed to ensure the highest level of consumer protection in the future.

Key words: pesticide residues, chronic and acute exposure, risk assessment, cumulative risk assessment

Poultry farming in sustainable management systems

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Abstract

The world's population is constantly increasing and is expected to reach 9.7 billion by 2050. With population growth, the demand for food, especially animal-based proteins (meat, eggs), is also rising. Poultry meat accounts for about 40% of total global meat production, and egg production is also growing significantly. However, the poultry industry faces major challenges, particularly in terms of sustainability. An increasing number of consumers are demanding animal products from sustainable sources and are willing to pay a higher price for them. Sustainable poultry farming involves methods that reduce negative environmental impacts, improve animal welfare, and ensure economically viable production. This approach includes environmentally friendly feeding practices, enhanced animal welfare, reduced greenhouse gas emissions, and efficient resource management. Intensive poultry farming systems generate large amounts of waste and contribute to environmental pollution, while sustainable systems reduce emissions of harmful gases and waste materials. The use of natural resources, such as grazing and agroecological methods, reduces the need for synthetic fertilizers and pesticides. In intensive farming, poultry is often kept in unnatural conditions, leading to stress, disease, and reduced quality of life. The frequent use of antibiotics in intensive production, due to the high risk of infections, contributes to the global issue of antibiotic resistance. Reduced exposure to antibiotics and stress in sustainable farming systems improves the nutritional value of poultry products. The transition to sustainable poultry farming brings long-term benefits for the environment, human health, and animal welfare while also meeting the growing demand for higher-quality products. Although it requires initial investments, it can be a more profitable and resilient production model in the long run. By implementing these methods, it is possible to ensure long-term stability in the poultry industry while preserving natural resources.

Keywords: poultry, sustainable production, meat, eggs

Reliability of dental wear for age evaluation in roe deer

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Abstract
Age determination of wild animals is important for understanding the age structure and vitality of population, and to evaluate implementation of management plans and selection criteria. In the case of the roe deer (*Capreolus capreolus*), several methods are available, and one of which is dental wear, a popular method among practitioners. The aim of this study was to verify the reliability of dental wear for age evaluation in roe deer. We analyzed 15 roe deer mandibles. Three experts independently estimated the ages according to the dental wear. Second premolar was extracted and demineralized (5% nitric acid), cut at 25 µm thick slices and stained with Harris hematoxylin. This method is considered as a gold standard (GS) for age estimation. Cementum annuli (CA) were counted under the microscope. According to CA analyzed roe deer ranged from 3 to 8 (mean 4.87) years. Expert 1 estimated ages from 2 to 8 years, with absolute difference from GS of 1.06 (max 3, min 0). Expert 2 estimated ages from 1 to 6+ (1.8; 3.5; 0), while expert 3 estimated from 2 to 9+ (1.5; 3.5; 0). Average absolute difference was 1. These results show that age estimation with dental wear can vary by 3.5 years from the real age. The reason for that can be in various external and internal factors, such as different dietary components that can lead to teeth abrasion, irregular dentition and mastication or certain pathologies. Therefore, age estimation based on dental wear is frequently highly unreliable.

Key words: roe deer, age, dental wear, cementum annuli

Predicting the incidence of ketosis in dairy cows in the Republic of Croatia

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Abstract
Ketosis is a metabolic disorder of dairy cows that most often occurs in first few weeks post calving when energetic requirements of cows are higher than is possible feed intake of energy because of high milk production. Increase in concentration of ketone bodies, beta-hydroxibutiric acid (BHA), acetoacetate and acetone in milk, urine and blood of dairy cows indicate on the incidence of ketosis followed by huge financial losses on farm. The aim of this study was to determine incidence of ketosis on croatian dairy farms by determining concentration of BHA in milk samples by IR spectrofotometry. Early detection of the presence of ketone bodies is of great importance due to the losses that are ketosis caused. Determination of ketone bodies concentration by IR spectrofotometry in raw milk samples provides analysis of huge number of milk samples in a short period of time. As milk sampling method is not invasive for animals IR spectrofotometry could be used as a rutine analytical method in prediction of the incidence of ketosis in dairy cows.

Key words: ketosis, beta-hydroxibutyric acid, milk samples, IR spectrofotometry, MilcoScan 7RM

Effect of African swine fever epidemic on genetic diversity parameters in Black Slavonian pig

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Abstract
African swine fever (ASF) is a highly contagious viral disease affecting domestic and wild pigs, leading to high mortality rates and significant economic losses. Local pig breeds, such as the Black Slavonian pig, are particularly sensitive due to increased contact with wild boar. This study aimed to assess the genetic diversity parameters of Black Slavonian pigs in Eastern Croatia following an ASF outbreak in 2023-2025 using pedigree-based analyses. Pedigree file contained 13,306 animals, with a reference population of 1,658 individuals from 2018 onward. Genetic diversity parameters, including the average inbreeding coefficient, average relatedness, and effective population size, were estimated under two different scenarios: the first scenario assumed no ASF-related culling and another excluding animals culled due to ASF. An adapted optimal contribution selection procedure was applied to minimize relatedness within the population, and mating plans were developed for both scenarios to estimate future inbreeding and relatedness. Pedigree completeness expressed as the mean number of equivalent generations was 1.57 and 1.45, respectively. The average inbreeding coefficient was 5.21% in the scenario without ASF-related culling and 4.27% in the scenario with ASF-related culling. Effective population size was 47.10 in the first scenario and 42.94 in the second, indicating a reduction in genetic diversity. Despite the slightly improved genetic diversity parameters in the ASF scenario, the reduced number of mating candidates increased the risk of inbreeding due to a higher probability of mating related individuals. While genetic diversity remained relatively stable, the results suggest that ASF-related culling influenced population structure by removing highly related animals. However, the long-term impact on genetic variability requires further investigation by incorporating molecular genetic data that would enhance the accuracy of relatedness estimation, as pedigree-based analyses may over- or underestimate genetic diversity due to shallow ancestry records.

Key words: pigs, African swine fever, genetic diversity, conservation, inbreeding

Encapsulation of *Lactobacillus bulgaricus* in composite biopolymer microparticles

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Abstract
Lactobacillus bulgaricus is a beneficial bacterium widely used in the food industry, particularly in yogurt production. However, its viability can be compromised during processing and storage and under harsh gastrointestinal conditions. This research explores the possibility of simultaneous encapsulation of *Lactobacillus bulgaricus* and calcium ions by the ionic-gelation encapsulation method. Simultaneous encapsulation in the composite biopolymer microparticles was performed under previously optimized conditions. The concentration ratio of biopolymers (sodium alginate, kappa carrageenan, and casein) was 3:2:1, and calcium chloride concentration was 2%, and the vital fraction of *Lactobacillus bulgaricus* was 9.0 ± 0.1 log CFU. Microparticles were produced and physiochemically characterized (microsphere size, encapsulation efficiency, loading capacity). Simultaneous encapsulation in composite biopolymer microparticles did not have a negative impact on the *Lactobacillus bulgaricus* properties. Also, the release date of bacterial cultures was fitted to the Korsmeyer-Peppas model and the n exponent indicated that the release mechanism was Fickian. The electrostatic interactions between bacterial cultures, biopolymers and calcium ions were confirmed by infrared spectroscopy, dynamic light scattering, and zeta potential measurements. The results showed that bacterial cultures and calcium ions could be successfully and simultaneously encapsulated and applied in the process of fermenting milk product production

Key words: encapsulation, *Lactobacillus bulgaricus*, composite microparticles, calcium ions, fermented milk products

Factors affecting variations in pregnancy associated glycoproteins in cow milk

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Abstract
The detection of pregnancy-associated glycoproteins (PAG) in milk is used as an alternative, non-invasive and fast method for detecting pregnancy in early stages of gestation. Variations in PAG levels were observed on the same days of conception. The aim of this study was to investigate various factors that could influence PAG variations in milk. The influence of milk yield, fat and proteint content in milk, somatic cell count, urea, season, breed and sex of calves was investigated. The study was conducted between 2018 and 2023 on Simmental and Holstein dairy farms in Croatia. A total of 9027 milk samples were analysed. The evaluation of factors affecting variations on PAG levels were observed in four gestation periods, namely on the 28th, 29th to 35th, 65th to 75th and 100th to 120th day after conception. PAG values were found to be higher in Simmental cows than in Holstein cows and also higher in cows with male calves than in those with female calves. The coefficient of variation of PAG values was similar in all 4 investigated periods and ranged between 38% to 52%. No statistically significant relationship was found between the observed factors at day 28. A significant relationship ($P<0.05$) with a very weak correlation between PAG values and the same factors analysed was found in all other three periods, namely for milk yield (r2=-0.26, r3=-0.10, r4=-0.15) and season (r2=-0.08, r3=-0.12, r4=-0.13). Other sporadically occurring factors in individual periods analysed were urea, somatic cell count, fat content, protein content and lactation number, all at the 5% significance level. The study showed that despite the observed variations in PAG levels, a weak correlation between some factors and PAG levels was found, so that the influence of these factors on possible false positive results should be investigated.

Key words: cow, milk, ELISA, PAG, pregnancy

Session 3

Agroecology and Regenerative Agriculture

Permanent monitoring of the agricultural land Republic of Croatia

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Abstract
The aim of this research is to continuously collect information on agricultural land and introduce timely responses to record or mitigate the changes that have occurred. More than 3 million ha of Croatian land is used for various agricultural purposes; crop production, livestock farming and fishing. Unfortunately, data on land management methods, and especially on soil quality for the majority of these areas, are unavailable. There was no system in Croatia that would collect and process this information in a quality manner. Therefore, the impact of agricultural activities on the state of the environment cannot be assessed (quantified) in a quality manner. It is also not possible to make political decisions that would achieve a balance between the mutual impact of agriculture and the environment (sustainable agricultural development policy). This is necessary both for environmental preservation and for the development of agriculture for future generations. Monitoring stations have been established at 30 of the total 90 locations planned at the Croatian level. A station is a place for permanent monitoring of the condition of agricultural land, which, with its geomorphological position, pedosystematic unit and method of use, represents the agro-ecological area, or rather, the agricultural subregion in which it is located. In the first year, the stations of the subregions P2, P4, G1 and J2 were established. The permanent soil monitoring station consists of: a square-shaped area on whose diagonals points for taking individual soil samples are placed, a pedological profile from which samples were taken in a disturbed and undisturbed state and data on the endomorphological characteristics of the soil were collected, and piezometers were installed by drilling at 2 and 5 m. The classification of soil types was carried out according to the Soil Classification of Yugoslavia (Škorić, A. et al, 1973, 1985), it is a genetic classification and serves as the basis for the production-ecological evaluation of the soil, it is based on the properties of the soil, which are morphologically visible or easily measurable. The classification according to the "Soil System of Croatia" (Husnjak, 2014) also includes descriptions of the origin and characteristics and properties of individual types of soil and their lower units, while the classification of soil according to the World Reference Basis (WRB) is based on visible and measurable soil properties defined by terms (diagnostic horizons, soil properties and materials) and serves as a common language in international communication. The most common soil in the 2023 survey is Haplic Gleysols (9/30)/determination according to Škorić, Gleyic Fluvisols (5/30)/determination according to Husnjak and Fluvisol (6/30), determination according to WRB 4th edition, 2022.

Keywords: agricultural land monitoring, Škorić classification, Husnjak classification, WRB

Sowing date and supplemental irrigation for sustainable production of chickpea under the changing climatic conditions in Hungary

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Abstract
Food need fulfillment for the increasing population has put continuous pressure on the agricultural sector. Climatic changes in recent decades resulted in measurable yield loss and quality fluctuations of the produced yields. The beneficial, very well-known cereal-legume crop rotation is widely applied in Hungary. However, some valued legumes, like chickpea, are not utilized yet. Moreover, whether supplemental irrigation is needed under the drought episodes is to be evaluated. An experiment was conducted at the experimental farm of the Faculty of Agricultural and Food Sciences and Environmental Management of the University of Debrecen in 2024 in a randomized complete block design with four replicates. Three chickpea varieties (Amorgos, Elmo and Orion) were sown conventionally in Spring (May) and late, after wheat cultivation (early July), and were either irrigated supplementally or left under rainfed conditions. Results showed that seed protein concentration increased significantly in all varieties under supplemental irrigation conditions, whereas fat concentration was not measurably affected in most treatments. Protein concentration did not differ in the seeds of both Amorgos and Elmo when these varieties were sown late, whereas it significantly decreased in Orion. Interestingly, fat concentration significantly increased in the seeds produced from all varieties sown late when supplemental irrigation was provided, whereas the differences were not measurable in both Elmo and Orion varieties under rainfed conditions. It could be concluded that incorporating chickpea in a cereal-legume crop rotation in Hungary seems promising, especially if controlled irrigation is implemented, and suitable varieties are chosen.

Key words: crop rotation, fat concentration, legumes, protein concentration.

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Cu concentrations in former vineyards soils under olive groves and natural vegetation

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Abstract

The aim of the study was to determine and compare copper (Cu) concentrations in former vineyard soils under olive groves and natural vegetation and to assess soil pollution in the studied area. The study was conducted in the Primošten municipality in Dalmatia, Croatia, on Terra rossa soil. A total of 20 topsoil samples were taken from former vineyard soils, out of which 10 were from soils under natural vegetation (NV) and 10 from olive groves (OG). The total Cu concentrations were determined by using the portable X-ray fluorescence method. The Cu concentrations in OG ranged from 106.1 to 303.4 mg kg^{-1}, while in the NV they varied from 36.1 to 83.9 mg kg^{-1}. Significantly higher Cu concentrations were determined in OG compared to NV (mean values 199.3 and 51.8 mg kg^{-1}, respectively). According to the Ordinance on the protection of agricultural land from pollution (OG 71/19) the Cu concentrations in NV were below maximum permissible concentrations (MPC, 120 mg kg^{-1}). However, Cu concentrations in 9 of 10 soil samples from OG exceeded MPC. The enrichment factor (EF) in NV (0.96-2.39) pointed to minimal to moderate enrichment with Cu. However, soils of OG were moderately to significantly enrich with Cu (EF 2.22-11.4). Pollution of former vineyard soils under olive groves with Cu can be attributed to the long-term anthropogenic enrichment via the use of Cu-based fungicides.

Key words: Dalmatia, enrichment factor, pollution, Terra rossa

Production potential of perennial energy crops in different agro-ecological conditions of the Republic of Croatia

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Abstract
Biomass is the most widely used renewable energy source and can be used as a primary fuel or converted into a secondary fuel. It is expected that one of the main sources of agricultural biomass in the future will be biomass derived from the cultivation of energy crops. Energy crops are characterized by a long lifespan, high yields, possibility of cultivation on poor quality soils, low agotechnical investments and the possibility of conversion into various forms of biofuel. The aim of our work is to present the data on the production potential (yield - t DM/ha and yield components - height and/or number of shoots) of selected perennial energy crops (*Miscanthus x giganteus*, *Panicum virgatum* and *Sida hermaphrodita*) under different harvesting season and agroecological conditions in the Republic of Croatia. The plantations were established in 2011 and 2016 at three different locations. The average yields in the fall harvest after the third cultivation period were: 9.52 t/ha DM - *Sida hermaphrodita*; 19.08 t/ha DM - *Panicum virgatum* and 23.68 t/ha DM - *Miscanthus x giganteus*. In the spring harvest season, the average yields were: 6.53 t/ha DM - *Sida hermaphrodita*; 13.27 t/ha DM - *Panicum virgatum* and 12.43 t/ha DM - *Miscanthus x giganteus*. The highest yields of biomass dry matter per unit area among the observed energy crops were recorded for the species *Miscanthus x giganteus*.

Key words: energy crops, biomass, renewable energy, production potential

Conservation Tillage Strategies for Reducing Soil Erosion and Enhancing Soil Health in Sloped Stagnosols Under Maize Cultivation

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Abstract
Soil degradation in sloped agricultural landscapes, particularly in Stagnosols prone to compaction and erosion, presents a significant challenge to sustainable crop production. This study evaluates the impact of three tillage systems—conventional plowing, chisel plowing, and subsoiling—on soil erosion, sediment transport, and soil physical properties under maize cultivation in Croatia. Nine experimental plots (100 m × 8 m) were established with runoff and sediment collection systems, allowing detailed erosion monitoring throughout the 2024 growing season. Results show that subsoiling significantly reduced sediment concentration (by 77.7%) and total soil loss (by 95.9%) compared to plowing, while chisel plowing achieved a moderate reduction (49.1% and 73.4%, respectively). Nutrient losses followed a similar trend, with subsoiling retaining significantly more soil carbon, nitrogen, phosphorus, and potassium. Conservation tillage also improved soil structure, with subsoiling reducing bulk density (1.40 g cm^{-3} vs. 1.55 g cm^{-3} in plowing) and penetration resistance by 67.5% at 10–30 cm depth. Water holding capacity was highest under subsoiling (45.3%), contributing to improved soil moisture retention. Although maize biomass yields did not differ significantly across treatments ($p > 0.05$), subsoiling recorded the highest yield (25.06 t ha^{-1}). These findings confirm that deep tillage interventions, particularly subsoiling, enhance soil stability, mitigate erosion risks, and support long-term soil health in sloped agricultural systems.

Key words: Soil erosion, conservation tillage, sustainable agriculture, sediment transport, environmental impact

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Comparing Soil Conservation Strategies in Mediterranean Terraced Orchards

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Abstract
Soil erosion poses significant challenges to sustainable agriculture in the Mediterranean region, especially in areas characterized by poor-quality soils and intense rainfall events. Soils play a critical role in ensuring global food security and mitigating climate change by serving as a medium for crop production and acting as a significant carbon sink. However, degradation processes such as erosion threaten these vital functions, particularly in vulnerable regions like the Mediterranean. This study examines the effects of five land management treatments—tillage, mulch application, grass cover, herbicide application, and fire-burned soil—on runoff and soil erosion within olive orchards on terraced, low-quality soils in Mediterranean Croatia. Each treatment was replicated across five plots, and runoff and sediment loss were monitored using fenced circular plots and collected in canisters during twelve effective rainstorms. The results revealed that sediment concentrations were not significantly influenced by either the treatment type, date of rainstorm, or their interaction. However, both runoff and sediment loss were significantly affected by the individual effects of treatment and date, as well as their interaction. Grass cover consistently showed the lowest sediment loss and runoff values, highlighting its potential as a soil conservation strategy. Tillage plots, characterized by soil disturbance, exhibited higher runoff and sediment loss than mulched or grass-covered plots, suggesting their limited suitability for erosion-prone areas. Fire-burned soil exhibited the highest sediment loss and runoff values, emphasizing the vulnerability of these areas to intense erosion following disturbance. These findings underscore the importance of implementing effective soil management practices to mitigate erosion in Mediterranean agroecosystems. Grass cover, in particular, emerges as a promising approach for enhancing soil stability and reducing runoff in olive orchards. Further research should focus on long-term monitoring and the integration of additional conservation practices to ensure sustainable land use in these sensitive environments.

Key words: Mediterranean agriculture, Olive orchards, Land management practices, Soil conservation, Climate change mitigation

Acknowledgment: This work was supported by the Croatian Science Foundation through the project “Forming climate smart soils: Mitigation of soil erosion and degradation processes in Croatian agricultural systems” (IP-2022-10-5692) (FORMclimaSOIL).

Impacts of olive pomace application on *Vicia faba* L.: cytological and morpho-physiological disruptions

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Abstract
In Mediterranean basin, olive oil production, while economically significant, generates substantial amounts of agricultural by-products, such as olive pomace, posing serious environmental challenges due to its high organic load and phytotoxic compounds. This study investigated the impact of olive pomace treatment on hydroponically grown broad bean plants. Exposure to increasing olive pomace concentrations resulted in a dose-dependent reduction in shoot and root biomass, with an 80% decrease at 20% concentration, alongside diminished photosynthetic pigment and carotenoid levels, indicating impaired photosynthesis. Elevated malondialdehyde levels confirmed oxidative stress, while changes in soluble sugar and free amino acid profiles suggested metabolic stress responses. Cytological analysis demonstrated a significant reduction in the mitotic index and the induction of chromosomal aberrations (adhesion, fragmentation, delayed/damaged chromosomes, c-mitoses, and micronuclei) at concentrations exceeding 10%, highlighting severe genotoxicity. The study emphasizes the critical need for effective treatment strategies to mitigate the phytotoxic potential of olive pomace before its release into the environment or agricultural use. Properly treated olive pomace holds potential as a valuable soil amendment, requiring careful monitoring to prevent adverse effects on soil health. Further research is essential to optimize treatment methods and ensure sustainable management of olive-processing residues.

Key words: Broad bean, free amino acids, genotoxicity, olive pomace, phenolic compounds

Variable approaches to modify biochar as soil amendment improved soil properties and plant biomass

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Abstract
Biochar can be produced from various organic materials and variably modified to derive specific benefits as soil amendment. It positively affects soil physical (bulk density, water retention, aggregation) and chemico-biological properties (content of soil organic matter, carbon and other nutrients, microbial abundance, activity and diversity). Different feedstocks and conditions for pyrolysis determine biochar properties, varied biochar types are further modified by blending with other types of materials. These materials mostly enhance its ability to interact with and enter soil processes of nutrient retention, transformation and utilization by either soil organisms or plants. In several pot experiments, applications of biochar, obtained from varied feedstock, by different pyrolytic methods, treated by co-composting with manure, incubation with mineral fertilizer, or inoculation with microbial consortia, were tested in soil. The impact of final amendments on the soil properties and plant biomass was tested. The beneficial effect of variably modified biochar on the soil traits and plant yield was proven: (i) sewage sludge + sawdust biochar showed high content of organic carbon (with reduced recalcitrance) and promoted microbial activity as well as nutrient cycling, (ii) soil amended with biochar co-composted with manure increased total carbon, C:N, sulfur, respiration and dry barley biomass yield, compared to unamend manure (iii) activated biochar with mineral fertilizer increased enzymes activities in soil, microbial respiration and N, P, K concentrations in soil pore water (iv.) bioaugmented biochar stimulated microbiome abundance and enzyme activities, it increased intake of heavy metals into plant. These particular results corroborated the beneficial effect of variably modified biochar on the soil traits and plant yield.

Keywords: manure, co-composting, torrefaction, mineral fertilizer, bioaugmentation

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Application of neural network in the prediction of soil carbon content

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Abstract
This paper aims to develop and assess neural network models for predicting soil carbon content using soil properties, climate variables, and remote sensing data. The goal is to improve the efficiency, accuracy, and scalability of soil carbon predictions to support sustainable land management and climate change mitigation. Neural networks have gained attention for modeling complex, nonlinear relationships among diverse soil and environmental factors that traditional models often miss. Soil carbon is a vital indicator of soil health, agricultural productivity, and ecosystem functioning, playing a major role in the global carbon cycle. Accurate soil carbon monitoring is essential for informed policymaking, conservation, and environmental sustainability. Traditional methods like laboratory analysis and field sampling are slow, costly, and limited in coverage, making large-scale assessments difficult. Neural networks, especially deep learning models, show strong potential by analyzing large, varied datasets, including soil properties, climate data, topography, land use, and remote sensing imagery. They detect complex patterns and make reliable predictions even with limited ground-truth data. Unlike traditional regression models, neural networks flexibly model nonlinear interactions without strict assumptions, enabling more accurate predictions across diverse landscapes. Advances in computing power, data storage, and environmental datasets have further boosted neural network applications in environmental sciences. Compared to conventional methods, they often achieve higher predictive accuracy, better spatial resolution, and greater generalizability. Applying these models generates detailed, high-resolution maps of soil carbon stocks, supporting carbon sequestration initiatives, agricultural improvements, and ecosystem service monitoring. Accurate predictions also aid in assessing land degradation, promoting biodiversity, and strengthening climate resilience. In summary, neural networks offer a powerful, adaptable, and innovative approach to soil carbon prediction. Their ability to manage complex datasets and deliver high performance positions them as a leading tool in soil science. As research advances, integrating neural networks with geospatial analysis and broader machine learning methods will further improve soil carbon monitoring and management across scales, contributing significantly to sustainable environmental and agricultural systems.

Key words: neural networks, soil, carbon, climate change.

Efficacy of acetamiprid combined at a lower dose with plant biostimulants in controlling Colorado potato beetle

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Abstract
Colorado potato beetle (*Leptinotarsa decemlineata* (Say, 1824)) is the most important pest of potatoes, well known for its ability to develop insecticide resistance. This work tested the efficacy of the insecticide acetamiprid combined in a lower dose with three different plant biostimulants (AlgoVital Plus, Amino Vital, Folifertil T). During a month, potato plants were treated every seven days with biostimulants. In the final treatment, acetamiprid was applied to biostimulant variants at half the recommended dose. As positive controls acetamiprid in full and half recommended doses, both without biostimulants, were used. The efficacy of the treatments was then tested on Colorado potato beetle larvae in laboratory, by adding treated potato leaves to larvae in a Petri dish. Mortality was assessed 72 hours after the last treatment. Out of the three combinations, half dosage of acetamiprid combined with AminoVital provided the most efficacy (83%) against Colorado potato beetle larvae, while other combinations achieved lower results (66-67%). Full dose of acetamiprid had 91% and the half dose without biostimulants had 70% efficacy. This work showed that by combining insecticides with plant biostimulants it is possible to use significantly lower doses of insecticides than recommended but still achieve satisfactory results. This can help delay the development of resistance to insecticides and also reduce the negative impact insecticide usage has on the environment and beneficial organisms.

Key words: efficacy, insecticide, *Leptinotarsa decemlineata*, plant biostimulants, resistance

Impact of Foliar Application of Protein Hydrolysates on Olive Seedling Growth and Development

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Abstract
Protein hydrolysates (PH), obtained by enzymatic degradation of plant proteins from agro-industrial plant waste, are biostimulants that can be used in sustainable olive cultivation. Therefore, this study investigated the effects of foliar application of protein hydrolysates on the morphological parameters of seedlings of two economically important olive cultivars, Buža and Leccino. One-year-old olive seedlings were treated with three types of protein hydrolysates derived from pumpkin seed cake: H1 (Alcalase® Pure), H2 (Alcalase® Pure + Flavourzyme®), and H3 (Alcalase® Pure + ProtanaTM Prime), over two months. A total of four treatments were applied at 15-day intervals. The following parameters were measured: seedling height, number of leaves, and number of nodes. Each cultivar was analyzed separately using repeated measures ANOVA.The results showed a significantly higher number of leaves in the Leccino cultivar compared to the control after treatment with protein hydrolysate H3 during the third and fourth sampling periods. Furthermore, growth parameters and the number of nodes in the Leccino cultivar depended solely on the sampling time, with no effect of the applied treatments. In the Buža cultivar, all examined morphological parameters differed significantly depending on the sampling time, while the application of different treatments did not result in statistically significant differences compared to the control.This study indicates the potential of foliar application of protein hydrolysates as an environmentally friendly alternative to conventional fertilization practices in olive cultivation. However, further long-term research is needed, including analysis of mineral concentration and primary and secondary metabolites in leaves, to more comprehensively assess their effect on growth, development, and the physiological response of olive plants to protein hydrolysate application.

Key words: Pumpkin seed cake, enzymatic degradation, biostimulants, Buža, Leccino

Potential effects of endophytic fungus *Trichoderma atroviride* on microplastic-induced toxicity in earthworm *Eisenia andrei*

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Abstract
Microplastics are increasingly produced due to their versatile applications. Given their widespread presence in the environment and their diverse chemical properties, the assessment of their potential harmfulness to soil ecosystems is crucial. Soil is a complex ecosystem inhabited by various organisms, including fungi, whose interactions are essential for its functioning. Some fungi, such as *Trichoderma atroviride,* are particularly valued in agriculture for their beneficial properties. As these fungi have potential for sustainable agriculture, it is important to explore their role in improving the quality of contaminated soils. Therefore, the aim of this study was to examine the interactions between this fungus and the earthworm *Eisenia andrei* and to explore its influence on the toxic effects of microplastics on earthworms. To this end, the effects of microplastics (car tire abrasion and starch blend) on biomarker responses in earthworms was monitored, and the obtained results were compared to the effects observed when the fungus was also introduced into the soil. The measurement of several enzyme activities showed that the fungus caused significant changes in activity, both alone and in combination with microplastics. These results suggest that the presence of fungi in the soil influences the overall impact of pollutants on earthworms. In particular, the endophytic fungus *T. atroviride* was found to influence the toxicity of the investigated microplastic particles on the earthworm *E. andrei*.

Keywords: earthworms, fungi, microplastic, toxicity, biomarkers

Chickpea response under different PGPRs treatment

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Abstract
This study was conducted to assess the effects of inoculating soil with indigenous plant growth-promoting rhizobacteria (PGPR), which were isolated from the northern region and applied to the soil in the western part of Bosnia and Herzegovina. The treatments consisted of uninoculated control and two treatments with PGPR strains, designated as 8O and B33, arranged in a randomized block design with three replications. In the present study the impact on nutrient absorption, growth, and yield of chickpea plants under field conditions were analyzed. The highest dry weight of the aboveground biomass, at 10.33%, was achieved with the application of the isolated PGPR strain designated as 8O, which also resulted in a biomass yield of 33.21 grams per plant and a total grain yield of 1.04 t ha^{-1}. However, neither of the inoculants outperformed the uninoculated control in all measured parameters. Although there were no significant differences, the nitrogen concentrations in the leaves and grains, as well as potassium and phosphorus levels, were found to be higher in the uninoculated control. Comparisons among the treatments indicated that the presence of inoculant strains led to a notable enhancement in both grain yield and plant biomass. In conclusion, the application of both inoculation treatments investigated, particularly those involving rhizobium strains, may promote the growth and yield of chickpeas compared to uninoculated plants. Inoculation represents a cost-effective and environmentally friendly method to improve chickpea yields.

Key words: Chickpea, Plant Growth Promotion, Yield Enhancement, Sustainable Agriculture

Effects of Mushrooms on Mosquitoes Species: Implications for Biocontrol

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Abstract
Mosquitoes are among the most critical vectors of infectious diseases, posing a significant threat to global public health. For decades, chemical insecticides have been the primary method for controlling mosquito populations. However, their extensive use has led to severe ecological and health concerns, including the disruption of natural biological balances, the decline of beneficial insects such as pollinators and entomophagous species, environmental contamination with toxic residues hazardous to human health, and the emergence of widespread insecticide resistance.As an alternative, the Sterile Insect Technique (SIT) has emerged as an eco-friendly control strategy, relying on the mass release of sterile males to reduce mosquito populations. However, irradiation used for sterilization often weakens male fitness, compromising longevity, flight performance, and mating competitiveness, ultimately limiting SIT effectiveness. Recent research suggests that fungal polysaccharides from basidiomycete mushrooms possess bioactive properties such as antioxidant, immunostimulatory, and metabolic-enhancing effects that could help mitigate these fitness drawbacks.This study explores whether dietary supplementation with fungal polysaccharides from different fungal strains (*Ganoderma resinaceum*, *Lentinula edodes*, *Trametes hirsuta*, and *Trametes versicolor*) can enhance the survival, development, and stress resistance of non-irradiated *Culex pipiens* mosquitoes. Larvae will be exposed to varying concentrations of culture filtrates during their development until adult emergence, with key parameters such as mortality, metamorphosis rate, adult longevity, and flight performance being analyzed. By identifying whether and which fungal strains influence key biological parameters, this study aims to provide insights into novel dietary interventions that could eventually improve the biological quality of sterile males for SIT programs.

Key words: mushroom polysaccharides, mosquitoes, Sterile Insect Technique (SIT)

Current progress of autonomous systems in fruit and vine-growing

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Abstract
Automation and robotization of agrotechnical operations in agriculture enables the improvement of production by increasing the quality and quantity of products with the possibility of reducing costs. Autonomous machines operate independently and are not - neither wired nor wirelessly - connected to a control system. In order to be fully autonomous, a robot must have the following capabilities: (I) the ability to control its movements while performing a task, (II) the ability to perceive the environment in order to avoid obstacles, (III) the ability to precisely determine its position in order to carry out path planning and navigation. Thanks to the progress of technology, the share of human labour in viticulture and fruit growing has been significantly reduced, therefore autonomous systems represent the answer to the global labor shortage. The paper gives an overview—on the basis of scientific literature, as well as the websites of manufacturers of commercial autonomous machines and articles on specialized internet portals—of the most important commercial autonomous systems used in fruit growing and viticulture, with an outline of several experimental autonomous systems and of related legal regulations regarding unmanned aerial vehicle control and aerial pesticide application. Based on the analysis of the current state of robotization of production processes, it can be concluded that further technological development will bring an even greater degree of automation and autonomy of machines in viticulture and fruit production.

Key words: fruit growing, viticulture, autonomous machines, unmanned aerial vehicles

Recycling fly ash for sustainable soil management: Impacts on crop yield and soil nutrient dinamics

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Abstract
Fly ash is a fine-powdered, nutrient-rich, and alkaline co-product with significant potential for reuse in agroecosystems as a soil amendment in acidic and nutrient-poor soils. In this study, we conducted a meta-analysis encompassing 36 out of 1,325 screened studies from the most relevant scientific databases. Using a random-effects model and non-aggregated datasets, our main objective was to quantify the effects of fly ash application on soil nutrient levels and crops yield across various agroecological conditions. The results revealed a significant positive impact of fly ash application on plant yield, with an average increase of 56% (*Hedges' g* = 2.87, $p < 0.001$). Additionally, fly ash significantly increased concentration of soil Ca by 3.7-fold (*Hedges' g* = 8.65, $p < 0.001$), K by 22% (*Hedges' g* = 4.24, $p < 0.001$), and Mg by 11% (*Hedges' g* = 3.23, $p < 0.001$), but it had no significant effect on soil N (*Hedges' g* = -2.26, $p = 0.382$), C (*Hedges' g* = 0.784, $p = 0.623$) or P (*Hedges' g* = 0.921, $p = 0.536$) levels. Furthermore, a multi-moderator approach, which examined the combined effects of multiple moderators (e.g., soil type, climate conditions, crop species), revealed numerous significant interactions, highlighting the complex interplay between fly ash amendment and observed parameters. Future research should explore the broader ecological and agronomic implications of fly ash application, providing insights into its long-term sustainability and environmental safety.

Key words: Meta-analysis, fly ash, plant yield, phytonutrients, soil amendment

Olive pomace composting and its applicability for agriculture use

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Abstract
Olive pomace (OP), a byproduct of olive oil production, contains phytotoxic compounds that can negatively affect plant growth and soil quality. Composting is a promising approach to reduce these harmful effects and enhance its potential as a soil amendment. This study investigates the phytotoxic effects of raw OP filtrate on radish (*Raphanus sativus* L.) and barley (*Hordeum vulgare* L.) seed germination, as well as the impact of composted OP on radish growth. OP filtrate was tested at varying concentrations (0%, 1%, 3%, 5%, 10%, 20%, and 100%), Composting was conducted using three bioreactors with different treatments: B1 (OP + barley straw), B2 (OP + urea), and B3 (OP + sheep manure). OP concentrations revealing a significant reduction in seed germination. Germination rates declined from 90% in the control to 20% at 5% OP, with complete inhibition occurring at concentrations of 10% and above, likely due to the presence of phenolic compounds, organic acids, and high salinity. Among bioreactors, B2 produced compost with improved nutrient availability (C/N ratio of 19), while B3 exhibited elevated salinity levels (EC 9632 μS cm^{-1}), which adversely affected plant growth. In growth test, barley dry biomass decreased significantly under B2 and B3 treatments compared to the control, with reductions of 28.65% and 22.52%, respectively, while no significant difference was observed for B1. For radish, all compost treatments (B1, B2, and B3) resulted in significantly lower biomass compared to the control, with B2 and B3 exhibiting toxic effects (relative growth <80%) for both crops. Notably, radish demonstrated greater sensitivity to OP compost toxicity than barley. These findings underscore the importance of optimizing composting processes to reduce phytotoxicity and enhance the agricultural use of OP. Future research should focus on refining composting methods to improve soil health and support sustainable agricultural practices.

Key words: agricultural potential, compost stabilization, olive pomace filtrate, photosynthetic pigments, physicochemical properties

Conservation Agriculture and Regenerative Agriculture – Principles Beyond Sustainability

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Abstract
Sustainability in agricultural production is usually represented as a single overarching principle and the path that needs to be followed. Sustainable agriculture (SA) includes different practices in achieving goals with long-term positive effects on the human and environmental sphere, especially in response to Climate change (CC). Conservation agriculture (CA) is focused on three basic pillars: minimal soil tillage disturbance, effective crop rotation and continuous soil surface covering. These activities should ensure a functioning soil ecosystem, including its organic and inorganic components (e.g., biodiversity, carbon storage, nutrient use). While the concept of CA is quite clear in defining its basic premises, the definition of the concept of Regenerative agriculture (RA) is still a subject of scientific debate. The concept of RA, compared to CA, is a more holistic farming system that tries to restore soil health, ensure nutrient cycling, and promote quality soil functioning as an overall process. Inclusively the main CA pillars, RA includes additional two pillars: maintaining living soil roots and reintroducing livestock. As one of the most important preconditions for both, CA and RA, mandatory is the avoidance of conventional tillage which includes plowing. Sometimes, CA is defined and treated as a quality "fresh start" to the full adoption of RA after overcoming the basic practical principles of CA. The concepts of CA and RA are very similar to SA concept, but the main differences lie in their ability to apply fine-tuned different site-specific measures primarily focused on the soil. Both CA and RA are very powerful platforms with functional applications of their constitutive principles from the global to the local level. Nowadays, with the burden of the effects of CC, these platforms are more than welcome, especially as the response to prevailing many negative implications that persist and continuously arise in the agricultural sector.

Key words: Sustainable agriculture, Conservation agriculture, Regenerative agriculture, Climate change

Climate change and soil water deficit in the cultivation of selected agricultural crops in Osijek-Baranja and Istria Counties

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Abstract

The main objective of this work is i) to show the trend of climate change in Osijek-Baranja and Istria Counties by comparing basic meteorological data (precipitation and air temperature) between three climatic periods: 1961-1980 (first period), 1981-2000 (second period) and 2001-2020 (third period) and ii) to determine the effects of climate change on soil water deficit for alfalfa, tomato and grapevine, as the most representative agricultural crops for both Counties. In Osijek-Baranja County, a trend increase in annual precipitation and air temperature was observed in the third period compared to the second period (+52.2 mm and +0.7 °C), i.e. compared to the first period (+32.3 mm and + 1.3 °C). In the vegetation period (April-September), the third period was wetter and warmer compared to the first and second periods. Soil water deficit in vegetation in average and dry years was in the following order: grapevine < alfalfa < tomato and was greatest in the second period. In Istria County, in the third period there was a trend towards an increase in annual precipitation and an increase in air temperature by 100.3 mm and 1.2 °C compared to the second period, and a decrease in precipitation by 31.1 mm and an increase in air temperature by 1.6 °C compared to the first period. In terms of vegetation, the third period was wetter and warmer than the second period, but also drier and warmer than the first period. The water deficit of vegetation in average and dry years moved in the order: grapevine < alfalfa < tomato, and the largest water deficit was recorded in the third period. The greatest difference in water deficit during the growing season was in an average year between the first and second period and in a dry year between the third and first period. In order to compensate for water losses in the soil and achieve a satisfactory yield for these crops, irrigation systems must be planned and built, but also appropriate agrotechnical measures must be implemented (selection of varieties and cultivars adapted to dry conditions, covering the soil with foil, adapting the method and timing of sowing/planting the crops).

Key words: climate, soil water deficit, alfalfa, tomatoes, grapevine, Croatia

Microwave-Assisted Extraction of Polyphenols from the Skin of Two Indigenous Croatian Red Grapevine Varieties

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Abstract

The skins and seeds of red grapes are rich in bioactive compounds that offer various health benefits. This study aimed to utilize microwave-assisted extraction as a "green" method for the extraction of polyphenols from the skins of two indigenous Croatian red grape varieties: Volovina and Kadarka. Grapes were collected from the experimental vineyard of the Faculty of Agrobiotechnical Sciences in Osijek, located in Mandićevac. The skins of the grape berries were separated from the pulp and subjected to microwave radiation in two solvent mixtures (ethanol : water, 50 : 50 or 70 : 30 *v/v*) for 25 minutes. The resulting extracts were subsequently analyzed for their polyphenol and total anthocyanin content. The results showed that Kadarka contained high amounts of polyphenols and anthocyanins (2101 mg GAE and 382 mg Mlv-3-glc in 100 g of fresh skins), while the same were expectedly lower in Volovina (1071 mg GAE and 75 mg Mlv-3-glc in 100 g of fresh skins, respectively). In both varieties, ethanol : water (50 : 50 *v/v*) was a better solvent for polyphenol extraction, while the mixture 70 : 30 (*v/v*) was more effective for extracting anthocyanins.These results highlight the potential of indigenous Croatian red grapevine varieties as valuable sources of bioactive polyphenols which can be extracted in an environmentally friendly manner. This is also a starting point for exploring health benefits associated with grapes and wines from these two varieties.

Key words: red grapes, indigenous Croatian varieties, polyphenols, microwave-assisted extraction

Carbon Sequestration Potential of Virginia Mallow (*Sida hermaphrodita* L.)

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Abstract

As the global climate crisis intensifies, identifying sustainable and scalable carbon sequestration solutions is imperative. Virginian mallow (*Sida hermaphrodita* L.) is a resilient and fast-growing perennial grass that offers a promising opportunity for climate change mitigation. The climate change mitigation potential of *Sida hermaphrodita* is reflected in its high biomass yield, deep rooting, enhancement of soil organic carbon stocks and renewable energy production. The species efficiently sequesters carbon in its lignocellulosic structure while significantly increasing SOC content, outperforming conventional crops in long-term carbon storage. Furthermore, its use in bioenergy production offers a double advantage: it reduces dependence on fossil fuels while ensuring a negative carbon balance. Due to its adaptability, low input requirements, and multifunctional environmental benefits, *Sida hermaphrodita* proves to be a valuable species for carbon farming and climate-smart agriculture. Although a literature review exists on the origin and botany, agroclimatic requirements, cultivation methods, weed, pest, disease and nutrient management, harvesting methods, and potential for renewable energy production, an overview of the carbon sequestration potential of *Sida hermaphrodita* is lacking. Therefore, the aim of this study is to provide a literature review on the biological carbon sequestration potential of *Sida hermaphrodita*. The study revealed that *Sida hermaphrodita* has a great potential for sequestering atmospheric carbon in its biomass, paving the way for its role in global climate change mitigation strategies.

Keywords: climate change mitigation, Virginia mallow, biomass carbon content, biomass yield, harvest times

Evaluating Olive Mill Wastewater for Antibacterial Activity Against *Pseudomonas savastanoi* pv. *savastanoi*

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Abstract
The need for sustainable plant protection measures has prompted the exploration of alternative candidates for new-generation pesticides, with plant-based wastes emerging as promising resources. Olive mill wastewater (OMWW), a byproduct of olive oil extraction, has garnered attention as a potential antimicrobial agent. OMWW is particularly noteworthy for its high phenolic content, which has demonstrated antibacterial properties, aligning with the principles of circular economy. Despite efforts to manage olive diseases, such as the bacterial olive knot disease caused by *Pseudomonas savastanoi* pv. *savastanoi*, this disease remains notoriously difficult to control. In this context, OMWWs, with their phenolic compounds, offer a potential solution for controlling olive knot disease. This study evaluated the antibacterial potential of OMWWs generated from five distinct olive varieties against *P. savastanoi* pv. *savastanoi in vitro* using disc diffusion and broth microdilution assays. Treatments included raw OMWW filtrates, both with and without pH adjustment. The minimum inhibitory concentrations (MICs) were determined visually after microdilution. While pure OMWW filtrates did not exhibit significant antibacterial activity, some inhibitory effects on bacterial growth were observed in the microdilution assay. Notably, OMWWs with adjusted pH, particularly those from the cv. Istarska bjelica variety with higher phenolic concentrations (0.757 mg GAE mL^{-1}), showed lower MIC values (0.189 mg GAE mL^{-1}). These findings suggest that OMWWs, particularly those with high phenolic content, hold potential as plant-derived agents for controlling olive knot disease and warrant further investigation.

Key words: cv. Istarska bjelica, plant waste, plant–based bactericides, phenols, sustainable agriculture

Impact of biodegradable plastics on soil propeties and plant growth

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Abstract
Biodegradable plastics offer a potential strategy for preventing soil contamination by plastic and microplastics. Although their production costs remain high, their usage is expected to increase in the future. Therefore, understanding their impact on both production and non-production soil properties is essential. In recent years, our research group has focused on poly-3-hydroxybutyrate (P3HB), a naturally occurring polymer that serves as a carbon and energy storage compound in many bacteria. Our studies have investigated its biodegradation and its effects on soil health and plant growth. Specifically, we examined scenarios in which P3HB contaminates soil at elevated levels, simulating conditions comparable to mulch application or plastic littering. The findings revealed that P3HB negatively affects plant growth by causing nutrient imbalances and altering soil microbial community composition. The addition of plant growth-promoting bacteria (PGPB) and compost did not mitigate these effects, however, digestate application partially supported plant growth. Furthermore, increased microbial activity induced by P3HB biodegradation led to enhanced enzyme production, triggering a positive priming effect. Additionally, high concentrations of P3HB significantly reduced carbon use efficiency, likely due to nutrient imbalances, oxygen depletion, and shifts in the microbial community. Despite these negative effects, P3HB may still offer some benefits, as it serves as an easily degradable substrate that can temporarily replace soil organic matter and stimulate microbial activity in degraded soils. Therefore, the insights gained from this research could help optimize the use of P3HB in agriculture or soil remediation to maximize its potential benefits.

Key words: Poly-3-hydroxybutyrate, microplastics, microbial community, nutrient imbalance, carbon use efficiency, biodegradation, plant health

Acknowledgment: This research was supported by the Ministry of Agriculture of the Czech Republic, institutional support MZE-RO1225.

Long-term effects of pesticide use and microplastic contamination on soil quality in Vojvodina (Serbia)

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Abstract
Knowledge regarding the fate and behavior of pesticides and other pollutants, such as microplastics in soils is still limited. Thus, large-scale monitoring programs for pesticide residues and microplastics in soil are essential to achieve sustainable production while minimizing health and environmental risks. In this study, the results of pesticide residue monitoring in the agricultural soil carried out in 2013 and 2023, were compared. Sampling was conducted in the Vojvodina Province, the main agricultural region in the northern part of Serbia. Soil samples were collected in 2013 and 2023, with probes at 128 localities (0-30 cm) during the growing season. The extraction of pesticides was performed using the modified QuEChERS method EN15662, followed by LC-MS/MS, GC-MS, and GC-MS/MS analysis, due to the different nature of pesticides. In 2023, microplastics in soil were analysed as well. Samples were purified by a series of filtrations, the Fenton reaction removed organics, and the final analysis was performed on an anodisc filter using a Bruker micro FTIR microscope. The results indicate the presence of various polymers (PE, PP, PS, rubber, PU, etc.) in agricultural soil. Finally, 82 particles m.p./g were found in agricultural soil, 92 particles m.p./g in the rehabilitated landfill, and 195 m.p./g in the active landfill. The most frequently found in soil samples were pesticides from the group of triazoles, thiocarbamates, dinitroanilines, sulfonylurea, triazines, chloroaceamides, and organophosphates. The obtained results showed that more samples with multi-residue pesticide detection were found in 2023, while the average amount of residues determined in 2023 decreased compared to 2013. Pesticides such as chlorpyrifos, cicloate, and cyproconazole, which were found in 2013, were not present in the samples collected ten years later, possibly as a result of their banning. The results emphasize the need for strategies to reduce the accumulation of pesticides on agricultural soils and underscore the importance of continuous pesticide monitoring and sustainable land management.

Key words: soil, pesticide residues, monitoring, sustainability, microplastics.

Acknowledgement: This research was supported by the Ministry of science, technological development and innovation of the Republic of Serbia, No. 451-03-136/2025-03/200117 and 451-03-137/2025-03/200117; the European Union's Horizon Europe Project GREENLand - Twinning Microplastic-free Environment under grant agreement number 101079267; Interreg IPA Cross-border project IMPACT ENVI HR-RS 182.

Modeling the vulnerability of soils in Croatia to a possible increase in cadmium mobility

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Abstract
Cadmium is a toxic heavy metal whose concentration and mobility in soils significantly affects its accumulation in agricultural and food products. On average, the total concentration of Cd in the soils of eastern Croatia is 0.34 mg kg^{-1}, which is significantly less than the maximal allowed concentration (MAC) and represents a very significant potential for the production of quality food with a low Cd content. However, increased soil acidity, low contents of humus and clay can mean very high mobility of Cd, perhaps >50% of the total content, which makes certain the accumulation of (too) high concentrations of Cd in edible parts of plants, above all the roots and leaves of vegetables, grains of legumes, small grains, etc. Since the presence of Cd in the soil is largely a consequence of the use of phosphate fertilizers, excessive accumulation of Cd in edible parts of plants is many times more certain on phosphorus-poor soils, especially if the P-fertilizers contain high concentrations of Cd. Therefore, this paper presents the soil vulnerability to possible increase in Cd mobility. Soil Cd-vulnerability was modeled based on agrochemical properties (pH_{KCl}, pH_{H2O}, humus content, hydrolytic acidity and available P content) of 109,126 samples from more than 440,000 ha, along with model-estimated clay and cation exchange capacity (CEC) soil contents. Very high Cd-vulnerability was determined at 79,000 ha (17.92%), high vulnerability at 111,894 ha (25.39%), moderate at 41,511 ha (9.42%), and low and very low at 39,365 (8.93%) and 168,968 ha (38.34%). The most significant reasons for very high soil Cd-vulnerability are soil acidity (37.42%) and low P availability (45.73%), while in the high vulnerability category the most significant factors are humus content (58,23%) and CEC (53,37%). We can conclude that in Croatia, as much as 43.31% of soils are vulnerable to possible increase in Cd mobility, and it is crucial to apply only fertilizers with low Cd content to the soil to preserve soil health and food quality.

Key words: soil pH, humus content, CEC, Cd mobility, P fertilizer

Analytical and Prognostic Model of Needs and Possibilities for Improving Soil Fertility in the Republic of Croatia

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Abstract
The aim of the paper is to present the intensity of the degraded properties of the analyzed soils in Croatia and required materials and time for improving the soil properties. With this aim, the analytical-prognostic model was created using 109,126 samples of topsoil layer, representing the total area of 440,738.9 ha of agricultural land (in the period 2019-2023). The analysed soils were significantly degraded, the humus content <2% was on 182,522 ha (41.41%). For the target of >2% humus the deficit was 2.98×10^6 t of humus (equal to net sequestration of 1.73×10^6 t of C). The model predicts that targeted 2% humus would require 70.4-105.5×10^6 t of manure, annually 4.6×10^6 t during 15.2-22.8 years, in average. A highly acidic exchangeable soil reaction (pH_{KCl}<4.5) was determined on 79,375 ha (18.01%) and it was determined that liming was necessary on 134,926 ha (30.61%). To neutralize excess acidity, a 1.2-1.5×10^6 t of limestone would be required, i.e. annually 245,000-307,000 t of limestone or 216,600-271,400 t of industrial limestone. Since 182,630 ha (41.44%) are very poorly or poorly supplied with available P, to raise P availability to the treshold of good availability, a minimum of 44,400 t P_2O_5 or 7.4×10^6 t of manure would be required. The characteristics of degraded soil for at least one property (humus content, acidity or low P availability) were on a 317,411 ha (72.02%). A 149,091 ha (33.83%) showed degradated 2 or all 3 analysed properties: too acid and poor in humus were 42,264 ha (9.59%), poor in humus and P were 36,468 ha (8.27%), too acid and poor in P were 32,747 ha (7.43%), and all 3 properties were degraded on 37,612 ha (8.53%). The analysed soils in Croatia are significantly degraded, and it is necessary to systematically implement measures to improve soil fertility.

Key words: humus content, soil acidity, available P, manure, liming

Effect of bat guano on yield and quality of kohlrabi and detection of non-tuberculous mycobacteria

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Abstract
Kohlrabi (*Brassica oleracea* var. *gongylodes*) pot experiment (6 kg of soil pot^{-1} in three variants V1–V3, four replications) was conducted as follows: V1 (unfertilized control), V2 (bat guano from summer colony of *Myotis myotis*) and V3 (commercial growing substrate containing declared bat guano). The N dose was standardized for V2 and V3 at 1.5 g N pot^{-1}. *Mycobacterium avium* was found by culture and qPCR in V2 and V3 substrates. The goal of this research was to assess the effect of bat guano and commercial growing substrate with bat guano on the detection of non-tuberculous mycobacteria and their internalization into kohlrabi tissues, the yield of kohlrabi bulbs and their quality parameters.Yield (g $bulb^{-1}$ FM) at harvest was significantly different among all V1–V2–V3 variants: 56 g–241 g–42 g and in total chlorophyll content: 0.463 (a)–0.414 (b)–0.474 (a) g kg^{-1} DM; significant differences were not found in dry matter content (8.26–8.54–8.18% DM), anthocyanins (0.006–0.002–0.003 g kg^{-1} DM), flavonoids (15.50–15.18–22.13 mg kg^{-1} DM), polyphenols (7.60–8.36–7.54 g kg^{-1} DM), antioxidant capacity (20.6–22.8–17.1 mmol Fe^{2+} kg^{-1} DM), nitrates (219.1–247.7–267.8 mg kg^{-1} DM), and total carbohydrates (159.19–132.86–138.19 mg kg^{-1} DM). Bat guano (V2) substantially increased yield by 330–474% compared to both other variants. The monitored quality parameters of kohlrabi bulbs did not show significant differences among all three variants (except of total chlorophyll content). *Mycobacterium avium* was found in low doses by qPCR in roots, bulbs and leaves in V2–V3, which could represent potential health risk. Supported by Czech Science Foundation Project (21-12719S, 25-17469S).

Key words: kohlrabi, yield, quality, Greater mouse-eared bat guano, mycobacteria

Mitigation of adverse effects of Cd in Swiss chard and soil microbiome by *Bacillus mycoides*

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Abstract
The aim of this experiment was to analyze: i) the influence of Cd (cadmium) on Swiss chard, ii) the potential of *Bacillus mycoides* (strain RB11, exhibiting particularly high tolerance to Cd), to alleviate the toxic effects of Cd, iii) the effects of this inoculation on three groups of the most abundant soil microorganisms (bacteria, *Bacillus* sp, Actynomycetes and fungi).
Before sowing, the seeds of Swiss chard were immersed for 24 h in Cd solutions of the following concentrations: 0 (control), 1, 3 and 6 mmol Cd L^{-1}. Seeds were then sown in a substrate and watered with respective Cd solutions. At the 4-leaves stage suspension of *B. mycoides*, or water (control) were added.
Treatment by Cd, but also by *B. mycoides*, affected Swiss chard sprouting, biomass production, photosynthesis, biochemical indicators of stress and concentrations of essential nutrients in plant tissues. Sprouting and in particular root growth were impaired by 6 mmol Cd L^{-1} which also impaired germination. The subsequent treatment by *B. mycoides* RB11, which was previously shown to be strongly tolerant to Cd, significantly enhanced growth of both shoots and roots. Cadmium increased Shoot/Root ratio, exerting a more harmful influence on the roots than on the shoots. In addition, Cd increased variable chlorophyll fluorescence and *B. mycoides* reduced this increase. Cd and *B. mycoides* affected different indicators of abiotic stress. All treatments seem to have increased number of fungi. Number of Actynomycetes strongly declined due to the treatment of soil by 6 mmol Cd L^{-1}. Even though the concentration of Cd in the tissues of Swiss chard was bellow the limit of detection, the concentrations of essential elements were altered in both roots and shoots. The application of *B. mycoides* RB11 is a promising way to reduce the stress caused by Cd on Swiss chard growth and soil microbiome.

Key words: *Beta vulgaris* subsp. *vulgaris*, cadmium, *Bacillus mycoides*, abiotic stress, mineral composition

Use of 3D scanning method to determine the soil deformation in field conditions

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Abstract
The aim of research was to determine the differences in changes in the footprint parameters as a result of changes in operational parameters of the tires. Research was conducted in field conditions – on the arable ground (sandy loam soil). There were tested two agricultural tires with the same dimensions and different internal structure (bias-ply and radial). During the experiment three levels of inflation pressure (0.08; 0.16; 0.24 MPa) and three values of vertical load (7.8, 11.8; 15.7 kN) were used. The tires generated footprints which were then scanned using 3D scanning method. Based on the scans the dimensions of the footprint were determined. In addition to the linear dimensions (footprint length, width and depth), the area of the footprint was determined. Based on obtained results it can be conclude that the highest differences between both tires concerned the depth of the footprints and the contact area of the tires and soil. The footprint depth and contact area of the radial tire increased due to increase of vertical load (at constant inflation pressure). As with the bias-ply tire's footprint length and width, its footprint depth and contact area, increased as a result of increasing the vertical load. The exception was a tire pressure range of 0.16 MPa – in this case the first increase in vertical load resulted in an increase in the depth of the footprint and the area of contact between the tire and the soil, while subsequent increases resulted in a decrease in these parameters.

Key words: agricultural tires, compaction, inflation pressure, 3D scanning

Agricultural soil diffuse pollution risk in three locations in Serbia

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Abstract
In order to give insight in the agricultural soils pollution risk, the study evaluates sources and concentrations of the contaminants and assessed the ecological risk of potentially toxic elements (PTEs) in 3 sensitive locations, close to the lakes/protected areas of Palić-Ludoš, Bajina Bašta and Gruža, in Serbia. The research was conducted on 15 crop-animal farms; samples of soil, manure, underground/irrigation water were collected and physical/chemical properties, PTEs and organic pollutants were analyzed. Interpretation of results according to legal regulations and proposed limits (Maximum allowable concentrations-MAC, Maximum limit value-MLV, Corrective maximum limit values-CMLV), and the pollution risk assessment (Pollution index-PI, Enrichment factor-EI, and Ecological risk index-Ei), were done. The study reveals that some of the increased concentrations of PTEs in soil are caused by natural factors, but the others are related to the agricultural activities. Out of 275 soil samples, 9 had Cr and Ni, and 2 samples As concentrations over MAC for agricultural soils. Pollution risk assessment (PI, EI, and Ei) also showed slightly-moderate increase, mostly in Cr, Ni, Zn, Cd, Cu and As, depending on location and land use. On soils with PTEs concentrations higher than the limit values, continuous monitoring of soil and plants are needed, according to the national regulations. Also, it is recommended to analyze irrigation water and manure, as they can be source of pollution.

Keywords: PTEs, pollution indicators, pesticide residues, nitrates, phosphorus

Study of the effect of sowing density and fertilization on oat (*Avena sativa* L.) production

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Abstract
Oat (*Avena sativa* L.) is primarily important as fodder but has been increasingly used in human nutrition in recent years, especially when grown organically, due to the dietary qualities of its grains. It can be used for producing gluten-free bread or as a substitute for rice and milk in various food products. Due to its high content of plant fibers and beta-glucans, oat grains are beneficial for people with diabetes or obesity. This paper presents some research results from 2017 at the Agricultural Research and Development Station in Turda, Romania, regarding the influence of fertilization and sowing density on the productivity of 25 spring oat varieties originating from Romania, Germany, the Czech Republic, and the USA. The grain yields obtained for these genotypes ranged from 5,785 kg ha^{-1} (Romulus variety) to 6,897 kg ha^{-1} (Mureșana variety) under N100P50 fertilization and from 5,208 kg ha^{-1} (Romulus) to 6,617 kg/ha (Lv. 4363-86 genotype) under N50P50 fertilization. The production difference between the two fertilization levels for each genotype ranged from 24 kg (Lv. 4362-86) to 1,023 kg (T.44-81M).Regarding sowing density, higher yields were obtained at a density of 500 seeds m^{-2} (12.5 cm row spacing), with values ranging from 5,552 kg ha^{-1} (Romulus) to 6,747 kg ha^{-1} (Lv. 4363-86). At a lower density of 250 seeds m^{-2} (25 cm row spacing), the yields of the 25 spring oat genotypes ranged between 5,242 kg ha^{-1} (Romulus) and 6,608 kg ha^{-1} (Mureșana). The differences within the same variety at the two densities ranged from 115 kg ha^{-1} (Lv. 4324-86) to 335 kg ha^{-1} (for the Rumak and Integrale varieties).

Key words: *Avena sativa*, sowing density, fertilization, yield

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Research on the Influence of Soil Tillage System on Quantitative and Qualitative Yield of Fall Wheat

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Abstract
Wheat is one of the most cultivated cereals in Romania, ranking 4th in Europe in terms of area and production in 2023. Due to the high market demand for this cereal, the pressures on the environment are increasing, with consequences such as soil erosion and decreasing soil fertility. In an effort to reduce the negative effect of intensive tillage on the soil characteristics, but also to maintain satisfactory yields, an experiment was set up at ARDS Turda on a Chernozem soil type, with four different tillage systems for wheat cultivation, namely: classic system with plowing (CS, control), conservation tillage with chisel (CC), conservation tillage with disk (DS) and direct seeding without soil tillage (NT). The aim of the research was to determine the influence of the soil tillage system on the yield and some quality indices of wheat crop, in the specific conditions of Transylvanian Plain, where ARDS Turda is located. The experiment was carried out in the period 2023-2024, a growing season with a very high average temperature for Turda area, of 11. 30 ^{0}C and rainfall amount of 580 mm. The determinations were carried out during the growing season and at harvest: plant height, grain quality (determined by spectrophotometric method), yield for each variant. The highest yield was 6649 ha^{-1} for the classic system (CS), and the lowest was 6458 ha^{-1} for the direct seeding system (NT). However, yields in the variants with conservation tillage ranged from 97 to 99.5% compared to the control. In addition, the quality determinations recorded gluten values between 21 and 17.5% and protein values between 12 and 10.5% and the variant with the lowest values was direct seeding (NT) in both cases. In the other variants, the values were similar. The analysis of the results shows that conservation tillage systems represent a solution for sustainable wheat production, with good quality and quantity yields, and with effects of preservation of soil functions and minimizing the impact of intensive agriculture on the environment.

Key words: wheat crop, conservation tillage system, yield

Acknowledgement: This research has been funded by the Ministry of Agriculture and Rural Development, ADER Project no. 123/2023: Conservation of soil resources by using regenerative agriculture technological components for economic and sustainable harvest of straw cereals in the Transylvanian Plateau

Determination of the content of selected POPs in soil and well water samples at industrial sites in Tuzla

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Abstract

Persistent organic pollutants (POPs) represent a serious ecological problem due to their toxicity, bioaccumulation and long-term persistence in the environment. This research included examination of the contamination of selected POPs (PCBs and OCPs) in soil and water samples collected from industrial sites in Tuzla, in February 2024. The concentration of these contaminants were determinated in 13 soil and 5 water samples from 5 locations. The preparation of soil samples for the determination of POPs content was carried out in accordance with BAS ISO 10382:2004 method. The quantitative contents of organic contaminants in the extracted water and soil samples were analyzed by GC-MS instrument. Based on the results of the content of organic contaminants PCB and OCP in 13 soil samples, it can be seen that in all samples the values are very low and below the minimum permissible concentration (MPC). The exception is soil sample No. 4 (depth 0-20 cm) with a total PCB concentration of 0,167 mg kg^{-1}, which is significantly higher then the values in other soil samples, but lower then the minimum permissible concentration. In all analyzed well water samples, no contamination was detected because the PCB and OCP concentration values were below the minimum permissible concentration. This research is important for the development of pollution reduction strategies as well as the harmonization with international regulations.

Key words: soil, pollution, POPs, MPC, strategy

Seaweed industry and its use in agriculture

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Abstract
Due to climate change, environmental protection and the transition to the green economy, seaweed has been the focus of many studies, because of its adaptability, short development period and plenty of resources. It can be used in various sectors, from food and feed production to medicine and wastewater treatment, but also as biofertilizer, biofuel, energy etc. This research aims to examine and optimize the application of seaweed as a source of organic matter in sustainable agriculture. The macroalgae used in the seaweed industry are generally collected from the seas and oceans (68%) while a smaller part comes from aquaculture, which is cultivated (32%). While its growing requirements are not high (there is no need for irrigation, nor nutrient or pesticide application) its benefits are many, as it is a good source of fiber, rich in antioxidants, vitamins and minerals. In 2022 Asia held 97% of the world's seaweed production (China with 57%), while European production (mostly concentrated in the Northern countries), participated in only 0.8%. Speaking of agriculture, one of the most studied algae is brown algae *Ascophyllum nodosum*, used e.g. for biostimulants, and others used in Europe, as agricultural supplies, are mainly from the genus Laminaria and Fucus (brown algae) or Ulvaceae family (green algae). Studies are underway to determine the possibilities of using by-products from the seaweed industry as organic matter in agriculture that can affect soil properties when applied.

Key words: By-product, Macroalgae, Organic matter, Soil properties

Acknowledgement: The present work was financially supported by the project "Value creation and ecosystem services of European Seaweed industry by reducing and handling potentially toxic elements from breeding to soil", co-financed by European Union's Horizon 2020 research and innovation program (ERA-NET BlueBio cofund), and The Research Council of Norway (RCN), Croatian Science Foundation (HRZZ), Innovation Fund Denmark (IFD), Marine Institute (MI), Ireland, Ministry of Rural Affairs (MEM), Estonia. The work of the PhD student Iva Nikolin was fully supported by the "Young researchers' career development project–training of doctoral students" through grant NPOO-DOK-2023-10, financed by the Croatian Science Foundation.

Perennial vegetation cover of Chernozem soils supports abundance of soil microbiome

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Abstract
In addition to the favorable state of soil aggregation and nutrient status, the high organic carbon content of the soil is one of the main reasons for the fertility of soils in Chernozem. The most important factor for the preservation and replenishment of soil carbon stocks is the soil microbial community, which transforms and stabilizes the organic matter entering the soil. Therefore, knowledge of the state of the soil microbiome is crucial for understanding changes in soil organic carbon stocks.In our study, we analysed Chernozem soils at 6 sampling sites with different surface coverages and uniform in terms of their natural geographic characteristics. At 3 sites with conventional arable farming with soil rotation, we can only count on replenishment from residuals of annual crops and weeds, while at the other three locations, with different surface cover (orchard with cover grass; a 5-year-old fallow and a pasture) the residuals of a permanent, dense, perennial plant cover and a dense root system feeds the soil organic matter stock and the microbiome.Composite samples, consisting of 3 to3 subsamples per site, were collected in the field at a depth of 0-40 cm at 10 cm intervals. Bulk density, pH, EC, inorganic carbonates, readily accessible N, P, K, Ca and Mg content, and soil organic C content were measured in the laboratory. Characterization of the soil microbiome was expressed based on the amount of PLFA markers separately for fungi, AM fungi, G+ bacteria, G- bacteria, generalist bacteria, actinomycetes, anaerobes and eukaryote groups. The relationship between microbial characteristics and abiotic soil properties was analysed using Pearson correlation, while the differences between the two groups according to vegetation type were tested using the Mann-Whitney U-test for independent samples. The abiotic factors examined, with the exception ofbulk density, showed no significant correlation with the microbial characteristics of the soils, and the two groups according to land cover did not differ significantly. However, among the microbial characteristics, AM fungi, eukaryotes, anaerobes, generalists and G-bacteria, and the ratio of fungi to bacteria were significantly higher in the plots covered with perennial vegetation than in the plowed sampling sites, regardless of sampling depth. Our results support that the abundance of the soil microbial community is mainly promoted by the presence of a dense root system of perennial plants and vegetation.

Keywords: soil microbiome, PLFA, chernozem, vegetation

Impact of bioash types and dosages on physicochemical changes in contaminated rhizosphere

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Abstract
Soil metal contamination is a growing global concern, posing significant risks to environmental quality, and food safety. This study investigated the effects of four different hardwood-derived bioash types (two fly ashes – FA and two bottom ashes – BA, sourced from biomass plant facility in Slavonia and Gorski Kotar region, Croatia) on physicochemical changes in metal-contaminated soil. A controlled pot experiment was conducted using three application rates (FA at 0.5%, 1.0%, and 1.5%; BA at 2.5%, 5.0%, and 10%) mixed into metal-contaminated soil from a former mining and metallurgical site in Žerjav, Slovenia. Additionally, uncontaminated peat soil from Darda, Croatia, was used as a benchmark. In such prepared soil-bioash mixtures, a test crop lettuce (*Lactuca sativa*, L.) was grown for 125 days under a completely randomized block design with three replicates. Immediately after the harvest, rhizosphere soil samples were analysed for pH_{KCl}, electrical conductivity (EC), and DTPA-extractable Zn, Cd, Cu, and Pb concentrations. The results showed that bioash treatments influenced all observed parameters except of bioavailable Cu and Pb concentrations. Soil pH significantly increased from 7.16 (contaminated control) to 8.39 (treatment with 1.5% FA from Gorski Kotar), while in the same relations EC rose from 0.16 dS m^{-1} to 0.67 dS m^{-1}. Additionally, Zn concentration decreased by nearly 50%, from 283 mg kg^{-1} (contaminated control) to 143 mg kg^{-1} (at treatment with 10% BA from Gorski Kotar). In the same relations, Cd concentration dropped by approximately 20%, from 12.8 mg kg^{-1} (contaminated control) to 10.3 mg kg^{-1} (BA10%). These findings indicate that bioash type and dosage significantly influence master pedovariables such as pH and EC, consequently affecting bioavailability of toxic metals. The study highlights the potential of bioash application for mitigating metal exposure in contaminated pedospheres.

Key words: Metal contamination, Zn, Cd, Pb, Cu, Fly bioash, Bottom bioash, pH, EC

Impact of leguminous cover crops on soil nitrogen content in crop rotation systems

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Abstract
The input- and yield-focused agriculture of recent decades has put significant pressure on the environment, particularly on soil health. In crop production, the use of N fertilizers is the largest contributor to environmental pollution. Using leguminous cover crops in crop rotation systems can reduce the need for N fertilizer. Our research was set up in 2019 at the UD IAREF Research Institute of Nyíregyháza, Hungary, on humic-sandy soils. In the experiment, we investigated the effect of legume cover crops (lupin (*Lupinus albus*) and common vetch (*Vicia sativa*)) applied in a crop rotation system on soil nitrite + nitrate nitrogen content for 4 years. In the rotation system, cover crops were applied as a secondary crop, triticale, oats and maize were sown as main crops. The effect of the cover crop treatments was compared with that of fertilization (80 kg ha^{-1} N) and with a control treatment. The treatments were applied in a randomised block design and soil was sampled at two depths (0-25 cm and 25-50 cm) in spring and autumn of each season. A different trend was observed for autumn and spring sampling, with a significant cover crop effect in the spring period. At the end of the 4-year experiment, when lupin was used as a cover crop, the nitrite+nitrate N content in the top 0-25 cm layer of the soil in spring before maize cultivation was 3.28% higher than in the fertilized treatment and 4.36% higher than in the control treatment. In the 25-50 cm depth, these values were 61.77% higher than in the fertilized treatment and 66.38% higher than in the control treatment. In the case of the common vetch cover crop, significantly higher nitrite+nitrate N contents were measured in the upper 0-25 cm layer of the soil, with values 36.99% higher compared to the fertilized treatment and 38.43% higher compared to the control treatment. In the deeper layer of the soil, these values were 44.52% and 48.64% higher than in the fertilized and control treatments. Based on our results, the application of leguminous cover crops before spring-sown crops is a perspective solution to reduce and, in some cases, replace N fertilizer application.

Key words: cover crop, crop rotation, N fertilizer, legumes, soil

Seasonal Changes in Phenolic and Mineral Concentrations in Olive Leaves of the Rošinjola Cultivar

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Abstract
The olive tree (*Olea europaea* L.), one of the most important fruit species in the Mediterranean region, is not only valued for its fruit and olive oil but also represents a significant source of phytochemicals found in various by-products associated with its cultivation. Among these, the olive leaf stands out in particular—as it reliably reflects the tree's nutritional status and is rich in diverse secondary metabolites with strong antioxidant activity. Thanks to these properties, the olive leaf is increasingly used in various sectors, ranging from animal feed and natural food preservatives to diverse dietary supplements.The dynamics of changes in the concentration of major phenolic compounds in the olive leaf are, among other factors, related to the timing of leaf sampling. The aim of this study was to determine the effect of different sampling times—during harvest (UZ-I), winter dormancy (UZ-II), and spring pruning (UZ-III)—on the concentration of phenolic compounds and minerals in the leaves of the Rošinjola olive cultivar, a traditional variety widely cultivated in the Istrian region and Kvarner islands. The experiment was set up according to a completely randomized design, with three replications with one tree representing one replication.The results showed a significant effect of sampling time on the concentrations of hydroxytyrosol, catechin, caffeic acid, verbascoside, oleuropein, and total phenols, with the highest values recorded during UZ-III, i.e. spring pruning. Conversely, zinc (Zn) concentrations were lowest at harvest, while higher levels were recorded in UZ-II and UZ-III. On the other hand, boron concentrations were highest in UZ-I and lowest during winter dormancy (UZ-II).Further research will focus on the additional valorization of Rošinjola olive leaves through the analysis of various primary metabolites, with the aim of achieving a better understanding of phenolic compound metabolism.

Key words: Harvest, winter dormancy, pruning, oleuropein, zinc.

Pollution and Ecological Risk Assessment of Heavy Metals Accumulation in Zagreb's Peri-Urban Soils

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Abstract
Urban activities influence pollutant loads in soil over considerable distances, impacting on the life-supporting functions of soils. This research aimed to evaluate the pollution levels and ecological risks associated with aggregated heavy metals in peri-urban soils near Zagreb. Soil sampling was conducted in Šašinovec during the winters of 2021 and 2023, with eight composite soil samples (0-30 cm) collected from five distinct land uses: apple orchard, grassland, cropland, forest, and abandoned agricultural land. In 80 soil samples (8 per land use, 40 per sampling), the Cr, Ni, Cu, Zn, As, and Pb concentrations were detected and quantified using portable X-ray fluorescence. In addition, soil pH in potassium chloride solution was determined. The risk assessment was based on the calculation of the contamination factors (CF), the pollution load index (PLI), and the ecological risk index (ERI). The findings reveal that forest soil was acid (pH = 3.66), whereas soils associated with other land uses predominantly demonstrated a neutral to alkaline reaction (pH = 7.06–7.44). The two-way ANOVA and Tukey post hoc test results indicated that the accumulation of Cu, Pb, and Zn was not temporally affected in any of the observed land uses. However, significant temporal changes were recorded for Cr in grassland, Ni in abandoned agricultural land, and As and Ni in orchard soil. Although the results revealed that the peri-urban soils were only contaminated by Cr (102.5–204.9 mg kg^{-1}) and Ni (30.8–135.4 mg kg^{-1}), exceeding national thresholds, a more detailed pollution risk assessment indicated pollution across all land uses (PLI >1), with all examined metals contributing equally. The PLI values ranged from 1.13 to 2.04 in 2021 and from 1.02 to 2.09 in 2023, from forest to abandoned agricultural land. The determined contamination factors (CF = 4.0-4.5) suggested considerable contamination of orchard soil by As and Ni in both studied years. However, the ecological risk assessment, which considers the toxic response factors of Cr, Cu, Zn, As, and Pb, showed a low environmental risk (ERI<150). Lower ERI values were observed in forest soil (27.0 in 2021 and 24.4 in 2023), while higher values were found in orchard soil in both studied years (ERI = 58.0 – 61.6). The findings partially highlight the imperative of timely decision-making in peri-urban land-use planning to safeguard soil integrity amidst urban development.

Key words: pollution load index, ecological risk index, chromium, nickel, lead

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Effects of different soil types and land uses on microbial activity and barley photosynthetic performance

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Abstract
Soil type and land use have significant effects on microbial activity and plant physiological responses. This study aimed to investigate the effects of five different soils (L1–L5) with varying land use patterns (field, forest, grassland) on barley seedlings grown in pots under a controlled environment in a growth chamber for 14 days. Soil physical and chemical properties and microbial activities were measured and correlated with chlorophyll fluorescence of the barley seedlings to determine the effect of soil types and land use on the seedlings' photosynthetic performance. Results indicated variations in soil biological activity and barley photosynthetic efficiency with respect to land use. Forest and grassland soil had higher organic matter content (34-46% more total carbon, 26-58% more total nitrogen, and 22-38% more organic matter than the arable field soils), as well as a better microbial activity than the field soils with dehydrogenase activity being 27% higher and hydrolytic activity 24-45% higher than that of the field soils. Barley performance index (PI_{TOT}) was positively correlated with soil dehydrogenase activity and organic matter content, indicating that better nutrient availability and soil structure improve microbial activity and plant performance. On the other hand, high sodium and lower organic matter content negatively influenced microbial activity and plant performance indices of barley seedlings. It can be concluded that soil organic matter and high microbial activity were the most beneficial to plant performance indices, while low organic content and microbial activity can reduce plant growth and yield.

Keywords: chlorophyll *a* fluorescence, soil dehydrogenase activity, fluorescein diacetate hydrolytic activity, soil structure

Winter Factory of Phenolic Compounds - Istrian Olive Trees

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Abstract
Winter dormancy is considered the reference period for leaf sampling in order to assess the nutritional status of olive trees (*Olea europaea* L.). It is well known that different cultivars can vary in the concentrations of secondary metabolites and minerals, even when grown under the same agroecological conditions. The Istrian region of Croatia is recognized as a prominent olive-growing area, whose distinctiveness is based, among other things, on a wide range of autochthonous cultivars that contribute to the specific characteristics of Istrian olive oil. The aim of this study was to determine the influence of cultivar on the concentrations of phenolic compounds and minerals in olive leaves during winter dormancy. The study included four traditional Istrian cultivars: Istarska bjelica, Rošinjola, Karbonaca, and Buža puntoža. The experiment was set up according to a completely randomized design, with three replications, involving a total of 12 olive trees.The results showed a significant effect of cultivar on the concentrations of certain secondary metabolites and minerals during winter dormancy. Buža puntoža exhibited significantly higher concentrations of total phenols, luteolin-7-*O*-glucoside, and the secoiridoid oleuropein compared to the other cultivars, while the highest rutin concentration and the lowest calcium concentration were recorded in Istarska bjelica. Apigenin-7-*O*-glucoside levels were higher in Buža puntoža and Rošinjola compared to Karbonaca. Rošinjola and Karbonaca showed higher concentrations of luteolin and manganese compared to the other cultivars.Future research will focus on further characterization of olive leaves from different Istrian cultivars under various cultivation systems.

Key words: Istarska bjelica, Rošinjola, Karbonaca, Buža puntoža, olive leaf.

The impact of PGP fungi *Aspergillus clavatus* and *Mortierella elongata* on the lettuce yield and its bioactive compounds

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Abstract
This study examines the effects of plant growth-promoting fungi (PGPF), *Aspergillus clavatus* and *Mortierella elongata* on lettuce yield components (height, diameter, and mass) and the accumulation of bioactive compounds, including phenols, flavonoids, photosynthetic pigments, ascorbic acid, and antioxidant capacity. Morphological traits (height, diameter, and mass) and dry matter content showed limited response to treatment. The lowest height was measured in the control plants while the lowest diameter and mass were recorded for all treatments inoculated with *M. elongata*. Total phenols, flavonoids, and non-flavonoids significantly increased in all treated samples, with *A. clavatus* strain (K14-3) showing the highest values. *A. clavatus* increased total phenols by 49.44%–88.05% and *M. elongata* by 43.68%–79.35% compared to the control. Two *A. clavatus* strains were found to enhance photosynthetic activity, with K14-3 increasing total chlorophyll by 19.51%, chlorophyll a by 22.22%, chlorophyll b by 25%, and carotenoids by 28.57%. *M. elongata* significantly boosted ascorbic acid content (14.87%–51.35%), with strain K14-2 showing the highest value. Only plants treated with *A. clavatus* K14-3 had lower vitamin C than the control. Antioxidant capacity (ABTS and FRAP) was lowest in the control plants. One *M. elongata* strain (K14-2) showed higher antioxidant capacity but statistical significance was confirmed only for FRAP-based values. Two fungal strains from this research have a great potential to be further explored for application as biofertilizers. These findings underscore the role of PGPF in sustainable agriculture, enhancing crop quality while emphasizing the importance of strain selection and reducing chemical input reliance.

Key words: PGP fungi, phenolic compounds, flavonoids, photosynthetic activity

Design and estimated ecotoxicity of imidazolium-based ionic liquids as plant protection agents

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Abstract
The derivatives of imidazoles are an effective pesticide, but only a few were approved by the European Commission due to their negative impact on organisms. Imidazolium-based ionic liquids (Ib ILs) have become more popular in chemistry and industrial processes, due to their simple synthesis, numerous modification possibilities, thermal stability, good water solubility, and low vapor pressure leading to insignificant environmental impact on air. The biggest drawback of ILs is their negative effects on the environment. In the design of novel ILs, to reduce the toxicity of ILs fine-tuning in the IL molecular structures should be performed, such as variation of different alkyl lengths and type of substituent on imidazolium. Application of rational synthesis based on a chemoinformatic approach saves both the time and economic costs of large-scale experimental synthesis and biological tests. In this study, we have estimated ecotoxicological parameters, such as biodegradation, carcinogenicity, fish toxicity, rat acute toxicity, honey bee, and *Tetrahymena pyriformis* toxicity, for a series of imidazolium salts designed for potential synthesis. We evaluated the impact of different alkyl lengths and types of substituents in Ib ILs using admetSAR software. The most promising environmentally friendly imidazolium-based Ib ILs are zwitter-ionic structures with sulfonate.

Key words: imidazoles, pesticides, ecotoxicity, admetSAR, zwitter-ionic structures

Agrochemical Soil Analysis and Assessment of Nutrient Supply in Croatia 2023 – Challenges and Opportunities for the Future

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Abstract
Soil fertility testing represents one of the most important legally mandated activities aimed at protecting agricultural land. The goal is to provide access to data necessary for assessing soil conditions and implementing sustainable agricultural land management policies. The results of soil fertility testing conducted in 2023 on 39,286 soil samples revealed that 67.09% of the samples (26,359 out of 39,286) exhibited acidic substitution reactions, with 19.64% being highly acidic soils (pH<4.5), 28.88% acidic soils, and 18.56% slightly acidic soils. Neutral soils accounted for 14.76%, while the remaining 18.14% of samples had alkaline reactions. Liming is necessary for 26.25% of the samples (Hy>4 cmol kg^{-1}). Humus is a crucial indicator of soil elasticity and fertility, with 80.03% of soils containing less than 3% humus, with an average content of 2.49%. Of these, 34.43% of soils belong to the lowest classes A, B, and C, with less than 2% humus. The availability of easily accessible phosphorus in the soil is insufficient in 54.70% of the analyzed samples, with 26.07% being very poorly supplied soils of class A, and 28.69% poorly supplied soils of class B. Well-supplied soils (class C) make up 19.91%, while 24.85% of soils fall into the rich and very rich categories (classes D and E). Most soils (51.36%) are well supplied with potassium (class C), while 29.15% of soils have poor supply, and 19.49% of soils are rich in potassium. The results of chemical soil analyses, as in previous years, indicate insufficient humus content as the greatest threat to soil fertility, especially when combined with acidic reactions and low phosphorus availability. Given that 21.75% of soils have low humus content and are simultaneously poor in phosphorus, and that 22.95% of soils with the same characteristics exhibit high acidity, of which 15.79% of soils fall into the lowest fertility category due to the combination of low humus content, high acidity, and low phosphorus availability, important agronomic measures for preserving soil fertility include organic fertilization, organic matter management, optimization of phosphorus fertilization, and liming of acidic soils..

Keywords: soil agrochemical properties, interpretation of results, supply classes, humus content, soil pH

The effect of agrivoltaic systems on phenological phases and photosynthetic pigment content of apple cultivars

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Abstract
Due to growing world population, needs for energy and food production are constantly rising. Algrivoltaic systems have great potential and are subject of many researches in the last few decades especially in recent years, because they combine energy and food production on particular location. The aim of the research in the next three years is to evaluate physiological and ecophysiological responses of different apple cultivars grown under agrivoltaic systems as well as their impact on total yield and fruit morphology. Three types of agrivoltaic systems will be implemented above apple orchard - solid, semi-transparent and dynamic solar panels at Tenja experimental station, Faculty of Agrobiotechnical Sciences Osijek. In the first phase of project, the phenological phases of several apple cultivars will be determined according to BBCH scale. Photosynthetic pigments (chlorophyll a and b, carotenoids) content in leaves will be analyzed. Soil and air moisture and air temperature will be measured under every setup and control. Since the light penetration through canopy and light absorbance by leaves are the major factors affecting photosynthesis and metabolism, the photosintetic active radiation (PAR) will be determined at different heights of tree crown under every setup. The planned three-year research should show differences in the impact of agrivoltaic systems on physiological and morphological indicators in apples.

Key words: chlorophyll, green energy, growth stages, solar panels, photosynthesis

Assessing and Forecasting Water Salinization in the Polder Areas of the Neretva River Delta

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Abstract
Rising global sea levels, intensifying since the late 20th century, have increased the risk of seawater intrusion (SWI) into coastal aquifers and surface waters. The Mediterranean coastline, including the Adriatic sea, is particularly vulnerable due to natural and anthropogenic factors such as watercourse regulation and excessive groundwater abstraction. SWI degrades water quality, leading to soil salinization, threatening agricultural productivity and ecosystem stability. Effective monitoring of vulnerable river deltas requires continuous environmental observation, particularly of soil and water quality. While periodic (weekly or monthly) sampling is sufficient for some parameters, high-frequency sensor data enable a deeper understanding of hydrochemical processes and support advanced statistical modeling. This study evaluates the ARIMA model's performance in short-term forecasting of electrical conductivity (EC_w) in groundwater and surface water within the polder Luke in Neretva River Delta. Based on 365 daily EC_w measurements from 2021/2022, 80% of the data was used for training and 20% for validation, with a maximum of 5 lags considered, and AIC applied for optimal model selection. The best models were ARIMA(1,1,1) for groundwater (MSE: 0.010 dS m^{-1}, RMSE: 0.011 dS m^{-1}) and ARIMA(2,1,2) for surface water (MAE: 0.483 dS m^{-1}, RMSE: 0.616 dS m^{-1}) for a 7-day forecast. Results demonstrate ARIMA's applicability for short-term EC_w prediction in managed deltaic environments, supporting improved salinity management strategies thus protecting soil resources.

Key words: water salinity, seawater intrusion, sensors, time series, ARIMA

Acknowledgment: The work presented in this paper was supported by the projects "Advanced agroecosystem monitoring system at risk of salinization and contamination" (K.K.05.1.1.02.0011) financed by the European union from the European Regional Development Fund.

Metals in atmospheric bulk deposition in Zagreb, Croatia

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Abstract
Atmospheric bulk deposition or total deposited matter (TDM) refers to the total mass of pollutants transferred from the atmosphere to surfaces (soil, vegetation, water, buildings and other) in a given area within a given period of time (Regulation on the levels of pollutants in the air, OG 77/2020). It is a mechanism for the removal of pollutants, emitted by anthropogenic and natural sources, from the atmosphere but at the same time it serves as a way for pollutants to enter terrestrial and aquatic ecosystems. The aim of this paper was to compare the levels of TDM and its metal content at two urban sites (background and traffic) based on measurements taken 10 years apart (2014 and 2024). Using the Bergerhoff method, twelve monthly samples of TDM were collected at each sampling site in 2014 and 2024. After determining TDM gravimetrically, the samples were analysed for metals (Ni, As, Cd, Pb, and Tl) by inductively coupled plasma mass spectrometry (ICP-MS). A statistically significant difference regarding spatial distribution was found for Ni and As in 2014 with higher deposition fluxes at the urban background station (4.18 µg $m^{-2}d^{-1}$ and 0.73 µg $m^{-2}d^{-1}$, respectively), and for As and Tl in 2024 with higher deposition fluxes also found at the urban background station (0.46 µg $m^{-2}d^{-1}$ and 0.019 µg $m^{-2}d^{-1}$, respectively). Higher average mean values for deposition fluxes of TDM and metals were obtained in 2014 compared to 2024 at both sampling stations. A statistically significant difference regarding temporal distribution was found for Ni, As, Cd and Pb at the urban background station, and for all analyzed metals at the urban traffic station. Deposition fluxes of metals and TDM were below the limit values set by the Croatian air protection legislation.

Key words: air monitoring, Bergerhoff method, ICP-MS, urban sites

Acknowledgement: measurements of TDM and metals in TDM were carried out within local air quality monitoring network and were funded by the City of Zagreb. The results of this research were obtained using the facilities and equipment funded within the ERDF project KK.01.1.1.02.0007 and EnvironPollutHealth – European Union – Next Generation EU (Class: 643-02/23-01/00016) project.

Using soil color to estimate the content of organic matter in soils at three locations in Maksimir (Zagreb, Croatia)

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Abstract
Given the importance of soil organic matter (SOM), the reduction of its content due to land use changes (e.g. conversion of natural to agricultural soils) has a strong negative impact, not only on soil itself, but also on wider environment. Accordingly, SOM content is often analyzed in the laboratory. Because such analyses are costly or time-consuming, various models are sometimes used to predict SOM content using other, easily obtained and SOM-correlated, soil properties. In this study, soil color was used as the predictor of SOM content.Three soil types (humofluvisol, pseudogley and eutric cambisol) at three locations with different land uses i.e. vegetation covers (meadow, forest and ploughland, respectively) were investigated. At each site, five topsoil samples were taken within ≈100 m diameter area. In each sample, soil color was characterized under uniform ambient light, in dry and wet state, noting the three Munsell system parameters: hue, value and chroma. Across all locations, moist soil hue was 10YR (100% yellow red) and dry soil hue was 2.5Y (25% yellow). All moist samples featured lower color values than the dry samples. Tyurin method, used to analyze SOM content in the laboratory, showed a wide range of humus contents (1.6-9.4%) with significant differences between the moderately to highly humic meadow/forest soils and the poorly humic ploughland soil. Dry soil color and SOM content were significantly correlated (with chroma-SOM r=-0.94 and value/chroma-SOM r=0.87, p=0.000 for both). Subsequent regression analysis yielded coefficients of determination and prediction errors as follows: chroma-SOM R^2=0.88, RMSE=1.08%, MAE=0.83%; value/chroma-SOM R^2=0.76, RMSE=1.34%, MAE=1.10%. Therefore, in this study, soil color could be used to efficiently estimate the content of SOM, but only in dry soils.

Key words: Munsell color, humus, Tyurin method, prediction, modelling

Harnessing plant-associated bacteria from stressed environments to enhance crop resilience to drought and salinity

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Abstract
Drought, exacerbated by climate change, presents a significant threat to global agriculture, resulting in substantial economic losses for farmers. Plant-associated bacterial (PAB) inoculants have emerged as a promising sustainable solution to address these challenges. This study examines the potential of five PAB strains—*Bacillus* sp. G3, *Bacillus* sp. G12, *Acinetobacter* sp. G13, *Plantibacter flavus* 251, and *Plantibacter flavus* 259—isolated from hydrocarbon-contaminated soils and severe drought-exposed fields in Canada. These strains were assessed for their potential in promoting root initiation and elongation through a mung bean assay. The results revealed that M259 produced the highest concentration of indole-3-acetic acid (IAA) at 480.05 µg mL^{-1} within 24 hours, while M251 demonstrated the greatest drought tolerance, through its optical density (OD) of 0.389 at 600 nm. Strains G3 and G12 exhibited notable salinity tolerance, thriving at a 16% salt concentration, whereas G13 was unique in its ability to solubilize phosphorus. All strains effectively promote root elongation, with M259 having the most pronounced effect. These findings suggest that PAB from extreme environments harbor beneficial traits that improve plant resilience under drought and salinity stress. Their application as bioinoculants could enhance agricultural productivity in climate-affected regions, offering a sustainable strategy for mitigating the impact of environmental stressors on crops.

Key words: PGPR, Bio inoculation, Drought Stress, Rhizosphere microbiome.

The Influence of Organic Matter on the Water-Air Relationships of Heavy Clay Soils

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Abstract
Differential soil porosity significantly impacts the soil's water-air regime. The aim of this study was to determine the influence of organic matter on the differential porosity (large pores >10 µm, medium pores 10–0.2 µm, and small pores <0.2 µm) of soils containing over 45% clay particles. The research was conducted using 260 existing data points on soil texture, organic matter content, and differential porosity, collected during the development of the Hydropedological Map of the Republic of Croatia.The results indicate that increasing organic matter content enhances soil air capacity (pores >10 µm) and the amount of plant-available or physiologically active water (medium pores 10–0.2 µm), while reducing the volume of plant-unavailable water (pores <0.2 µm). Organic matter content below 5% does not significantly affect differential porosity. An organic matter content between 5–10% significantly increases soil air capacity and the amount of plant-available water but does not substantially reduce plant-unavailable water. Only when organic matter content exceeds 10% does its influence on reducing plant-unavailable water become significant.Depending on the organic matter content, the increase in soil air capacity can reach up to 37.3%, the increase in plant-available water up to 11.2%, while the reduction in plant-unavailable water can amount to 18.7%. The findings suggest that organic matter has a greater effect on soil air capacity and a relatively weaker influence on water capacity.

Key words: soil, organic matter, pores, texture

Developing advanced study program for Master in Agroecology – CASEE project results

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Abstract
As part of the CASEE project "Advancing agroecology in higher education of CASEE Countries", a thorough review of current study programs in the field of agroecology and a proposal for a new and advanced master's curriculum were developed in cooperation with five universities - University of Zagreb Faculty of Agriculture, Czech University of Life Science Prague, Hungarian University of Agriculture and Life Science, University of Novi Sad Faculty of Agriculture and Slovak University of Agriculture in Nitra. The project aimed to explore different approaches to education in agroecology and the prevailing concepts in each country and to develop a study program that would fill the gaps, improve knowledge and incorporate all the ecological and social principles on which the design and management of sustainable agriculture and food systems are based. At the CASEE workshop, three one-year Master's degree programs were developed – „Agroecology and Sustainable Agriculture", „Agroecology and Resilient Food Systems" and "Agroecology and Sustainable Farming Systems", which focus on the agroecological transition of the agri-food system and equip students with advanced knowledge, competencies and practical skills to study, design and implement farming systems that are environmentally friendly, socially just and economically viable. Various visions conclude that agroecology programs in higher education are beneficial and valuable and make an important contribution to environmental goals. This applies for both students and society, as green skills and careers are at the center of the EU's interest and focus.

Key words: agroecology, higher education, CASEE countries, resilient agri-food system

Production of mycelium-based biocomposites using the reishi mushroom mycelium, corn stover and waste textile

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Abstract
Mycelium-based biocomposites (MBB) represent an innovative and environmentally friendly type of material that utilizes fungal mycelium to bind substrate particles into a solid structure. These materials offer significant potential in sectors such as architecture, packaging, and furniture manufacturing due to their use of agricultural and forestry waste. Until now, MBB production has been produced from mycelium and lignocellulosic biomass, without the addition of inert components such as synthetic textiles. In this study, synthetic waste textile was added to a mixture composed of corn stover, sawdust, and the *Ganoderma lucidum* mycelium, to enhance the physical properties of MBB. Textile strips measuring 5 × 2 cm were used, with different volumetric ratios of textile to substrate: 10%, 20%, 40%, and 60%. Corn stover was selected as an available resource to promote circular bioeconomy principles in primary agricultural production. The biocomposite produced in this study has two major benefits: it enables the recycling of synthetic waste textiles, representing a significant environmental pollutant, whilst enhancing the structural properties of the biocomposite due to the skeletal effect of the textile fibers.

Key words: biocomposite, mycelium, bio-based materials, waste textile, circular bioeconomy

Preparative isolation of six compounds from Dalmatian pyrethrum extract: potential for new plant-derived insecticides

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Abstract
Dalmatian pyrethrum (*Tanacetum cinerariifolium* (Trevir.) Sch. Bip.), a perennial flowering plant is well-known as the natural source of pyrethrins, a mixture of six active compounds, pyrethrin I and II, cinerin I and II, and jasmolin I and II. Pyrethrins are natural insecticides and due to their effectiveness and relatively low toxicity to mammals and birds, they are often used in agricultural and household pest control. This study aimed to isolate and purify each of the six individual compounds from the pyrethrin extract using the ÄKTA Avant 25 system with a C18 preparative column. Gradient elution was performed with a mobile phase consisting of 0.1% phosphoric acid and methanol, utilizing both UV/VIS and conductivity detectors. In order to obtain sufficient amounts of each pyrethrin compound from complex sources, such as plant extracts, the collected fractions of each pyrethrin compound were concentrated using a nitrogen stream to achieve a final concentration ranging from a minimum of 20 mg ml^{-1} to a maximum of 45 mg ml^{-1} with a total volume of 10 ml for each fraction in methanol. Scaling up the preparative isolation and purification of plant-based insecticides from low concentrations in milligrams per milliliter (mg ml^{-1}) to higher concentrations is certainly possible. High performance liquid chromatography with UV/VIS detection was employed to quantify each fraction of the individual compound, using a C18 analytical column and gradient elution with a mobile phase like that used for preparative isolation. After concentrating the solutions to the target concentration, the resulting samples were additionally tested using Raman spectroscopy. The successful isolation and purification of the six active compounds from Dalmatian pyrethrum not only improves our understanding of pyrethrins but also opens possibilities for the development of new plant-based insecticide formulations. The production of new formulations has the potential to maximize insecticidal efficacy and provide sustainable alternatives to synthetic insecticides as more environmentally friendly products.

Key words: pyrethrins, isolation, plant-derived insecticide, preparative liquid chromatography

Insecticidal effects of the coumarin-1,2,4-triazoles against *Drosophila melanogaster* and *Orius leavigatus*

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Abstract
Drosophila melanogaster, the common fruit fly, is considered a pest since it damages fruits and serves as a carrier for various plant diseases. On the contrary, *Orius leavigatus* is a beneficial true bug that biologically controls harmful arthropods in agricultural production. In the present study, we performed an adulticidal bioassay against *D. melanogaster* and *O. leavigatus* by a series of coumarin-1,2,4-triazole hybrids. Mortality of *D. melanogaster* was observed after two, four, and eight days, while for *O. leavigatus* after 24, 48, and 72 h of exposure. The percentage of adult mortality was corrected using Abbott's formula. Four days after exposure, the standard insecticide, Laser, achieved 100% mortality of *D. melanogaster*, while the statistically significant similar results (Fisher test, $p > 0.05$) to Laser showed a derivative of 4-methylcoumarin-1,2,4-triazole with a 3-bromophenyl group (KM12) (86.36%). Eight days after exposure, compound KM12 achieved 100% mortality. The same compound showed moderately insecticidal activity against *O. leavigatus* (24 h, 65.93%; 48 h 69.17%; 72 h 75.00%). Compound KM17, 7-hydroxycoumarin derivate of 1,2,4-triazole with the 4--bromophenyl group, showed non-significant differences in mortality from Laser after eight days (92.64%), which exhibited lower mortality against beneficial insect, *O. leavigatus* (72 h 61.90%).
Compounds KM12 and KM17 are promising candidates for the further design of environmentally safe insecticides.

Key words: coumarin-1,2,4-triazoles, insecticide, *Drosophila melanogaster*, *Orius leavigatus*, plant protection

Monitoring the thermal and hydric regime of soils in the Transylvanian Plateau and recommendations for cereals technology

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Abstract
This study investigates the thermal and hydric regime of soils in the Transylvanian Depression to identify trends in pedoclimatic parameters and propose adaptive agrotechnical measures for cereal cultivation in response to climate change. Romania, particularly the Transylvanian Plateau (Someșan Plateau and Transylvanian Plain), faces significant climate adaptation challenges due to low afforestation and the absence of windbreaks. From 2008 to 2023, climatic elements were monitored using 20 HOBO microstations (10 in the Someșan Plateau and 10 in the Transylvanian Plain), recording soil temperatures at depths of 10, 30, and 50 cm, air temperatures at 1 m height, soil moisture at 10 cm depth, and precipitation. In the Someșan Plateau, the soil thermal regime is mesic with average annual temperatures at 50 cm depth ranging from 8 °C to 15 °C. Seasonal temperature variations exceed 6 °C at 50 cm depth, with differences between 10.3 °C and 15.6 °C. Annual soil moisture values range from 0.153 to 0.344 m^3m^{-3}, while air temperatures average between 9.21 °C and 11.03 °C, and precipitation ranges from 476.3 to 879.4 mm per year. In the Transylvanian Plain, the soil thermal regime is also mesic, and the hydric regime is ustic. The multiannual soil temperature averages 11.40 °C at 10 cm depth and 10.24 °C at 50 cm depth, while the average yearly air temperature is 11.17 °C. Soil moisture averages 0.227 m^3m^{-3}, with annual precipitation at 466.52 mm. Tillage techniques for soil conservation are recommended to promote plant residue retention and vegetation cover, particularly in summer and autumn.

Key words: Transylvanian Plateau, thermal and hydric regime, climatic indicators, cereals technology.

Acknowledgement: This research was funded by Ministry of Agriculture and Rural Development, Project ADER no. 123/2023: Conservation of soil resources through the use of technological components of regenerative agriculture in order to obtain economic and sustainable harvests of straw cereals in the Transylvanian Plateau.

Effect of the native biostimulant *Trichoderma koningiopsis* agg. on lettuce yield in the field

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Abstract

The *Trichoderma* genus is economically important owing to their versatile agricultural utilisation as the major biocontrol agent in biopesticide industry. Recently, has become even more important for its fertilizing potential commonly shown on the crop growth and yield quality. *Trichoderma* can improve overall plant health by creating a favourable rhizosphere environment and so, are the best candidates for use in green technology as plant growth enhancers and stimulants of natural plant defence mechanisms. Due to the shortened life span of the commercial *Trichoderma*-product during transportation, storage, and application, a possible weakened bio-control effect may occur after application. Also, the negative impact of imported *Trichoderma* spp. on the biodiversity of native *Trichoderma* and other soil organisms is receiving more attention in research studies. Hence, application of an autochthonous *Trichoderma* strain is possibly more appropriate. Our recent study has shown good biofungicidal potential of a Croatian strain, *T. koningiopsis* agg. STP8, against *Sclerotinia sclerotiorum* in association with lettuce plants and also, increased growth of seedlings. Obtained results led to the setting up of the field trials with the aim to evaluate growth promoting effect of STP8 on field grown lettuce when applied at different phenophases. The STP8 achieved significant growth increase in head diameter (77%), leaf length (87%) and width (82%), and fresh weight gain (72%) when was applied at the: 1) sowing of seeds and planting of seedlings and 2) planting of seedlings and before head formation. These findings suggest that STP8 could be used as prospective agent for plant growth promotion and protection.

Key words: bio-fertilizer, green technology, leafy vegetables

Magnesium deficiency effect on tomato cultivars and rootstocks

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Abstract
The aim of this study was to investigate the reaction of tomato cultivars and rootstocks on magnesium (Mg) deficiency during the seedling phase. The experiment was established with 14 scions-cultivars and 10 rootstocks. Two levels of Mg (standard - 1 mM and deficient- 0.1 mM) were used and plants were grown in half-strength Hoagland's nutrient solution using a floating system. One month after sowing seedlings, in the stage of 5-6 leaves were harvested and vegetative traits were measured, and samples were prepared for Mg determination.
Higher biomass production and lower root length on average were found for the cultivars and rootstocks grown under Mg deficient conditions, which was not expected, although some genotypes had opposite results. Under cultivation with optimal Mg supply, both cultivars and rootstocks leaves and stems had higher Mg concentrations, while it was not found same for roots. Regarding Mg content or total plant Mg uptake, maximum 3-fold differences were found for cultivars between both Mg supplies, while for rootstocks, 2-fold differences were measured. Rootstocks, on average, accumulated more Mg under optimal supply than cultivars, and in deficient conditions, both types of genotypes had similar Mg content per plant. Our study showed that there is high variability in Mg uptake traits in commercially used tomato cultivars and rootstocks available on EU market. The most tolerant and sensitive tomato cultivars and rootstocks on Mg deficiency will be chosen for a future experiment where they will be grafted to each other to find the effect of grafting on Mg uptake.

Key words: biomass production, grafting, Mg uptake, seedlings

Antifungal activity of biopolymer microparticles loaded with silver nanoparticles

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Abstract
Due to the growing issue of resistance among fungal pathogens to conventional antifungal treatments, researchers are actively seeking new alternatives and strategies. A recent approach to combat phytopathogenic fungi involves encapsulating various compounds within biopolymer microparticles, allowing for timed release and sustained effectiveness. This study aims to investigate the impact of biopolymer microparticles infused with silver nanoparticles on the growth and development of the selected phytopathogenic fungi: Botrytis cinerea, Fusarium solani, and Aspergillus niger. Silver nanoparticles are known for their significant pharmacological and agricultural benefits and are being evaluated as potential antifungal agents in the agricultural sector. The encapsulation of silver nanoparticles was performed using the ionic gelation method, and the antifungal efficacy of the optimal formulations of biopolymer microparticles loaded with silver nanoparticles was assessed against *Botrytis cinerea*, *Fusarium solani*, and *Aspergillus niger*. The findings confirm that biopolymer microparticles containing silver nanoparticles exhibit fungistatic and potentially fungicidal properties against these fungi. Specifically, the mycelial growth inhibition rates were 82% for *B. cinerea*, 93% for *F. solani*, and 96% for *A. niger*, all of which are statistically significant compared to the control group. This research demonstrates that biopolymer microparticles loaded with silver nanoparticles can effectively manage phytopathogenic fungi, thereby reducing the reliance on high quantities of chemical fungicides.

Keywords: silver nanoparticles, encapsulation, biopolymer microparticles, antifungal activity, protection

Impact of Phenolic Acids on Carabid Beetles as Soil Pest Predators: Biodiversity and Ecosystem Function in Agroecosystems

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Abstract
The use of phenolic acids is being explored for weed control due to their promising potential. However, their potential effects on natural enemies such as carabid beetles must be evaluated. As key predators in agroecosystems, carabid beetles regulate pest populations and contribute to soil biodiversity, making them crucial bioindicators for assessing agrochemical impacts. This study examines the contact toxicity and bioaccumulation of phenolic acids in carabids, which are reliable bioindicators of soil ecosystem health. Phenolic acids were tested at concentrations ranging from 200 mg L^{-1} to 3200 mg L^{-1}, depending on the compound. Semi-field and laboratory experiments assessed the direct and indirect effects of six phenolic acids: ferulic, vanillic, p-coumaric, chlorogenic, protocatechuic, and p-hydroxybenzoic acids. Carabids were collected from experimental plots in Zagreb and Stupovača using pitfall traps and exposed to phenolic acid treatments under both in vitro and in situ conditions. The results indicated no direct mortality within 72 hours post-exposure to any phenolic acid; however, behavioral changes were observed. Feeding activity decreased by up to 40% in treated individuals, and 30% exhibited regurgitation when treated with vanillic and p-coumaric acids. In situ experiments revealed reduced survival rates after seven days, suggesting that prolonged exposure to soil-bound phenolic acids increases mortality risks in beetle populations. Bioaccumulation of phenolic acids in beetle tissues was confirmed, with chlorogenic acid showing the highest levels: 0.914 mg 100 mg^{-1} *in situ* and 0.688 mg 100 mg^{-1} *in vitro*, while the lowest bioaccumulation was observed for p-hydroxybenzoic acid: 0.024 mg 100 mg^{-1} *in vitro* and 0.053 mg 100 mg^{-1} *in situ*. These findings highlight the potential of phenolic acids as valuable tools in integrated pest management strategies, offering a sustainable approach to crop protection. By modulating predator-prey interactions, phenolic compounds could enhance biological control efficacy, reduce reliance on synthetic pesticides, and contribute to the overall health and resilience of agroecosystems.

Key words: agroecosystem, bioaccumulation, biodiversity, carabid beetles, phenolic acids

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Physicochemical properties, antimicrobial potential, and impact on chard of novel nicotine-derived ionic liquids

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Abstract
Nicotine is a naturally occurring alkaloid in various plant species, commonly recognized for its pesticide properties due to its interaction with acetylcholine receptors in animal nervous systems. The tertiary nitrogen in nicotine's structure is highly reactive, making it prone to alkylation. Extending the alkyl side chain has been associated with increased antimicrobial potency and toxicity. Additionally, ionic liquids (ILs), salts that remain liquid below 100 °C, are known for their notable biological activity. To explore the combined influence of nicotine, alkyl chain modification, and the ionic liquid form, we synthesized four nicotine-derived ILs with different alkyl chain lengths: N-octylnicotinium bromide, N-decylnicotinium bromide, N-dodecylnicotinium bromide, and N-tetradecylnicotinium bromide.A comprehensive physicochemical analysis was conducted, including density, viscosity, and sound velocity measurements in aqueous solutions across a concentration range of 0.02 to 0.12 mol·kg^{-1} and temperatures from 293.15 to 313.15 K, providing insight into solute-solvent and solute-solute interactions. The antimicrobial activity of these ILs was evaluated against multiple strains of gram-positive and gram-negative bacteria, as well as yeasts and molds, with results compared to pure nicotine. All synthesized ILs exhibited more significant antimicrobial effects than nicotine across all tested microorganisms. Additionally, the impact of N-dodecylnicotinium bromide on *Beta vulgaris* was assessed compared to nicotine, revealing no observable phytotoxic effects on the tested plants.

Key words: nicotine, ionic liquids, antimicrobial activity, physico-chemical properties

The importance of arbuscular mycorrhizal fungi from the *Glomeromycota* phylum for sustainable agriculture

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Abstract
Arbuscular mycorrhizal fungi form symbiotic relationships with more than 72% of vascular plants. These fungi from the *Glomeromycota* phylum play an important role in sustainable agriculture through their symbiotic relationship with plant roots. These fungi form special structures within the roots, such as arbuscules and vesicles, which enable the plants to absorb nutrients, especially phosphorus (P), nitrogen (N), potassium (K) and trace elements, more efficiently. This reduces the need for chemical fertilizers, which contributes to environmentally friendly agriculture and lowers production costs. In addition, arbuscular mycorrhizal fungi increase the resistance of plants to various stress factors such as drought, salinity and pathogen infestation. They also help to improve soil structure, increase soil fertility and reduce erosion, which is of utmost importance for the long-term sustainability of agricultural land. Their use has proven useful in various agricultural sectors, including the cultivation of cereals (wheat, maize, rice), pulses (soybeans, lentils), vegetables (tomatoes, peppers, onions), fruit (apples, grapes, olives). The integration of arbuscular mycorrhizal fungi into agricultural systems enables a reduction of the ecological footprint, an increase in plant productivity and the maintenance of soil health. In view of global challenges such as soil degradation and climate change, the use of arbuscular mycorrhizal fungi is one of the solutions for sustainable and environmentally friendly agriculture that ensures stable and long-term food production.

Key words: mycorrhiza, *Glomeromycota*, organic agriculture, agroecology, soil fertility

Genotypic variability for hyperspectral indices in maize inbred lines grown under drought conditions

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Abstract

While chlorophyll fluorescence (ChlF) is a well-established method for analyzing environmental stress in crops, usability of recent high-throughput hyperspectral phenotyping techniques that include analysis of the near infrared (NIR) and ultraviolet-visible (UV-V) spectra is little known. The aim of this study was to determine variability and compare 15 ChlF, NIR and UV-V indices in maize grown under controlled drought conditions. Measurements were taken three times throughout the growing period of 28 days in 168 inbred lines by a fluorimeter and two handheld spectrometers. Three consecutive treatments were conducted by withholding water after 10 days after planting. ChlF indices were maximum quantum yield of primary photochemistry (PhiP0), probability of electron transport beyond QA^- (Psi0), quantum yield of electron transport beyond QA^- (PhiE0), average quantum yield of primary photochemistry (PhiPav), performance index on absorbtion basis (PiAbs). Hyperspectral indices were Normalized Difference Vegetation (NDVI), Simple Ratio (SRI), Zarco-Tejada and Miller (ZMI), Plant Senescence Reflectance a (PSNDa), Renormalized Difference Vegetation (RDVI) as NIR indices, and Modified Chlorophyll Absorption in Reflectance (MCARI), Modified Chlorophyll Absorption in Reflectance 1 (MCARI1), Greenness (G), Gitelson and Merzlyak 1 (GM1) and Gitelson and Merzlyak 2 (GM2) as UV-V indices. In order to analyze genotype x treatment (GxT) interactions for all indices, principal component analysis (PCA) and mixed models were applied. In a mixed model, random intercepts for GxT were extracted as BLUPs (best linear unbiased predictors), capturing the combined effects of genotype, treatment, and their interaction. These BLUPs were then correlated with PCA scores visualized by biplot. Grouping captured by the first principal component was mostly described by PhiPav, and multiple colinear indices captured by both ChlF and spectroradiometric methods. Distinctive values of MCARI1 MCARI and G influenced grouping observed along the second principal component. Tight grouping of NIR indices eigenvectors indicated high levels of correlations between these features. PCA biplot revealed clear association between genotypes under treatment and increasing values of PhiPav, combined by decreasing values of NIR indices such as RDVI and ChlF traits linked to PiAbs. Our results suggest that the effects of water withholding treatments can be effectively screened using a modest set of spectroscopic and ChlF features without sacrifying information content.

Key words: drought, chlorophyll fluorescence, hyperspectral indices, maize, PCA

Effects of essential oils of parsley and tangerine on *Tribolium castaneum* (Herbst)

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Abstract
Tribolium castaneum (Herbst) are polyfagous and cosmopolitan species, pest of the stored products. Intensive use of synthetic pesticides causes numerous negative consequences, and therefore, in search of alternatives that would replace conventional insecticides, essential oils have been increasingly researched. The aim of this study was to perform laboratory tests of the contact (dry film) and repellent effects (Y tube olfactometer) of essential oils of parsley (*Petroselinum crispum L.)*, tangerine (*Citrus reticulata L)* and their mixture with the aim of evaluation of insecticidal and/or repellent effects for *T. castaneum*. Essential oils were applied at concentrations 0.5, 1, 5, 10% and their mixture at 1% in the test dry film. The experiment was performed in four replicates with 10 insects in each, at a temperature of 25 ±1 °C and 65% RH. Contact effects were determined after 24, 48, and 72h. Repellent activity was assessed for 1, 5, 10% and 1% concentrations of mixture oils and expressed in Preference Index (PI /-1.0 to -0.1 repellent; -0.1 to +0.1 neutral; +0.1 to +1.0 attractant/) during the 1, 2 and 24 h. During laboratory testing of the contact effect on *T. castaneum*, essential oils caused 100% insect mortality after 24 to 72 hours. At a 1% concentration of parsley essential oil, the insecticidal effect after 24, 48, and 72 hours ranged from 87.5% to 100%. The mortality of *T. castaneum* after the application of a mixture of parsley and tangerine oils at a 1% concentration was 35–37.5% over 24 to 72 hours. The Preference Index indicates that parsley essential oil at 1% showed repellent activity (-0.8), while at concentrations of 5% and 10%, it showed an attractive effect (+0.2 to +0.4) on *T. castaneum* after 24 hours. Tangerine essential oil at concentrations of 1%, 5%, and 10% showed repellent activity (-0.8 to -0.2), and the 1% mixture also demonstrated repellent activity (-0.4) on *T. castaneum* after 24 hours.

Key words: *T. castaneum,* essential oils, parsley, tangerine, mixtures, effects

Acknowledgement: This research was supported by the Ministry of science, technological development and innovation of the Republic of Serbia, grant No. 451-03-136/2025-03/200117 and 451-03-137/2025-03/200117.

Comparison of methods for determining soil reaction

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Abstract
Soil reaction, or pH value, is one of the most important agrochemical properties and a key analytical parameter for evaluating soil productivity, as well as its physical and chemical condition. This study measured soil pH in H_2O, KCl, and $CaCl_2$ solutions, comparing the standard ISO method (soil-to-solution ratio of 1:5, i.e., 5 ml of soil to 25 ml of solution - v/v) with the more commonly used ratio of 1:2.5 (10 g of soil to 25 ml of solution – m/v). A total of 135 soil samples were analyzed from the arable layer (0–30 cm) in Eastern Croatia. In addition to pH values, the samples were tested for organic matter content (OM), clay content(CL), and cation exchange capacity (CEC) using the $BaCl_2$ method, allowing for an assessment of their influence on soil pH. The organic matter content ranged from 0.83% to 11.80%, CEC varied between 4.1 and 47.50 cmol(+) kg^{-1}, while clay content ranged from 1.83% to 58.86%. The lowest pH value (3.57) was recorded in stagnosol soil using the KCl m/v method, whereas the highest pH value (8.60) was found in gleysol using the H_2O m/v method. The pH values determined with the v/v method were: H_2O from 4.88 to 8.60, $CaCl_2$ from 4.09 to 7.76, and KCl from 4.08 to 7.70. In contrast, the pH values measured with the m/v method were: H_2O from 4.81 to 8.41, $CaCl_2$ from 4.01 to 7.75, and KCl from 3.57 to 7.65. The pH values followed the ranking order: H_2O v/v > H_2O m/v > $CaCl_2$ v/v > $CaCl_2$ m/v > KCl v/v > KCl m/v. The correlation coefficient between the different measurement methods and sub-methods was $r \geq 0.98$. The methods were found to be compatible and the next step in data analysis involves developing regression models and validating data with new samples.

Key words: soil pH, actual acidity, exchangeable acidity

Influence of physiologically active compounds on the antioxidant response in sweet cherry fruit

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Abstract
Sweet cherries are rich in bioactive compounds that contribute to the antioxidant activity, which is crucial for the nutritional value and fruit quality. The aim of this research was to evaluate the effects of some physiologically active compounds on the antioxidant activity of sweet cherries, using the analysis of fruit total phenolic and anthocyanin contents as well as the FRAP (ferric reducing antioxidant power) method. The research was performed in 2022 and 2023, at two locations (Ninski Stanovi and Murvica) in Zadar County, with the Regina variety. The trials included five treatment variants (K - water only, T1 – Ca nutritional supplement, T2 - biostimulant (*Ascophyllum nodosum* L.), T3 - proline solution, T4 - salicylic acid solution), with three replicates and three foliar applications at the fruit development stage. The fruit samples were taken randomly from all sides of the tree, 1 kg per replicate, at full maturity. The content of anthocyanins, phenols and FRAP values in the fruits were determined by spectrophotometric methods in the laboratory. The results confirm statistically significant differences between the locations and particular treatments. The applied treatments resulted with higher values of the analyzed parameters at the location N. Stanovi. The total anthocyanin content was the highest at T3, the total phenolic content was the highest at T2, and the FRAP values were the highest at T2 and T4, respectively.

Key words: anthocyanins, FRAP, phenols, physiologically active compounds, sweet cherry fruit

Session 4

Biodiversity Conservation

Optimization of different trap type and lure ratio on Dalmatia region, Croatia

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Abstract
Cydalima perspectalis (Walker, 1859) is an invasive pest species that originally comes from Asia and is commonly known as the box tree moth. It was discovered in Croatia in 2012 and subsequently spread throughout the country as the most important pest of *Buxus sempervirens* L. The lifespan of the adult insects is around two weeks. The overwintering generation flies from the end of May to the first decade of July, while the adults of the summer generation fly from the first decade of August. In the period from July to October 2024, we investigated different trap types and lure ratios to find out which is the most favorable option for trapping adult male moths. The study was conducted in seven locations in inland Dalmatia in the urban area of Sinj, where *B. sempervirens* is widely distributed as single plants or hedges around private houses or in public areas. We use TRECE pheromones (lure ratio: 3 mg, 6 mg and 9 mg) in two traps Uni trap and Delta trap, 21 of each. We checked the traps at regular intervals (once a week) and counted the catch of adult moths. During the 90-day period, we caught a total of 4022 male adults. Preliminary results show that of the total number of moths caught, the Uni trap is 91.52 % more effective than the Delta trap. The results also show that of all the traps and pheromone doses used, the dose of 9 mg has the highest effect, namely 36.4%. These results strongly suggest that the use of Uni trap can be very effective in moth control.

Key words: invasive insect species, boxwood, pheromone traps, insect generation, urban area

Wild medicinal plants for personal use

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Abstract
For centuries, people have used wild plants for daily nutrition and self-medication while wild and cultivated herbs can have medicinal, nutraceutical, pharmaceutical and health benefits. Nowadays, medicinal plants and herbs are widely used in our daily lives: mostly as medicines, teas, food and cosmetic aids. In recent years, the number of people who know or collect wild herbs has decreased and with it the knowledge about their use. The aim of this study was to gain an insight into the knowledge of the population in Croatia about wild plants, their identification and possible use through an online survey. The survey consisted of 24 questions and 150 people were interviewed. Most of the respondents were female between 18 and 25 years old, had a secondary education and lived in the city. More than half of the respondents are beginners when it comes to knowledge about wild plants. Nevertheless, more than 70% of them had already collected wild plants before participating in this survey. Most of them collect wild plants as a hobby. The best known and most commonly used species are nettles (*Urtica dioica* L.) and dandelions (*Taraxacum officinale* (L.) Weber ex F.H. Wigg). More than 70% of respondents believe that wild plants improve their health or quality of life in some way, either because of their favourable chemical composition and medicinal properties or because no pesticides have been used. A third of respondents also prefer to collect wild plants rather than buy them because they know where they come from. As many as 70% of respondents are aware of the rules for collecting protected wild plants and 97% of them believe that education is important when collecting them. In general, these results show the growing interest of young people in collecting wild herbs and their desire to preserve natural resources for future generations.

Key words: health benefits, herbs, natural resources, online survey, respondents

Preliminary results of the distribution of Red Deer (*Cervus elaphus* L.) in the Kopački rit Nature Park using bioacoustic monitoring within the WatchOut Project

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Abstract

Most animals vocalization consists of a variety of signals that are transmitted from one animal to another. Recording and analyzing these signals can help us understand their spatial distribution and daily migrations in various ecosystems. Furthermore, these informations can allow better understanding of environmental changes and can protection of endangered species.

The study aimed to analyze the detection of red deer (*Cervus elaphus*) using bioacoustic devices in Nature Park Kopački rit. A total of 332,302 recordings were collected using passive acoustic devices (AudiMoth). Occupancy analysis can help us understand how ecological and environmental covariants shape the spatial distribution of red deer in Kopački rit. The Results of the occupancy model show a positive correlation for wetlands (1.17) and distance from water (0.94), suggesting that this area could be the preferred habitat. Deciduous forest and recover land showed negative values (-0.71 and -0.45), indicating a low presence of red deer in these habitats. Based on that, red deer prefer wetland habitats over deciduous forests and recovered land. Thus, spatial distribution can be significantly influenced by ecological and environmental covariates. However, further research should include additional ecological variables over a longer period to understand better the long term patterns of spatial distribution and behavior of this species.

Key words: acoustic monitoring, audioMoth, *Cervus elaphus*, Kopački rit, occupancy model

Profile of a Hunter in Croatia

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Abstract
Hunting in the Republic of Croatia is a legally regulated economic activity that encompasses the breeding, protection and hunting of game. It is a traditional, economic, tourist and recreational activity aimed at protecting and preserving biodiversity and the ecological balance of natural habitats, hunting game, and wild flora and fauna. Hunting is also an important part of socio-economic activities, especially in rural areas. Therefore, the aim of this research is to determine the profile of people engaged in this activity considering that hunting population size and its changes over time are important for the management of wild animal populations. The results are based on a literature review and statistical data from the Croatian Hunting Federation, as well as data from the State Statistical Institute, providing a foundation for the socio-economic significance of hunting in Croatia. According to the 2021 Census, the Republic of Croatia had 3,871,833 inhabitants, while according to the Croatian Hunting Federation, there were 59,834 hunters. In other words, there were 60 inhabitants per hunter, and the share of hunters in the total population amounted to 1.54%, which ranks Croatia in 12th place among 35 European countries. Most of them are members of hunting clubs in rural areas, while 15.47% do not belong to any hunting club but are direct members of the Croatian Hunting Federation. The largest number of hunters is registered in the Split-Dalmatia County (9.77%), and the smallest in Međimurje County (1.65%). In Croatia, for legal reasons, one must be an adult to hunt. A significantly higher number of hunters in Croatia are men (98.09%) who belong to the age group over 45 years old (64.41%), while the largest group of female hunters belongs to the age group between 31-50 years (42.20%). A small percentage of female hunters, similar to that provided in Croatian data, is found in most other EU countries. The majority of hunters have a secondary education (75.66%), while a relatively small number are highly educated (8.65%). Regarding their preference for hunting specific species, according to the State Bureau of Statistics for 2023, the most hunted large game species is the wild boar (50,030 animals annually), and the most hunted small game species is the pheasant (62,000 birds annually). The fact that Croatia is also attractive to foreign hunters is evident from the data that 11,362 foreign hunters purchased hunting licenses in 2024. Most of them came from European countries, Italy (47.93%) and Austria (24.24%), with a few from other continents, including Australia and North America (Canada). Although Croatia has a centralized system for managing natural resources, including hunting grounds and wildlife, official data is limited to basic statistical indicators, and there are no extensive studies on the economic significance of hunting.

Key words: hunter, hunting, hunting game, socio-economic significance, wildlife

Blue crab - a new commercially significant species in Croatian fisheries?

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Abstract
The blue crab, *Callinectes sapidus*, is a significant species in commercial and recreational fisheries in the western Atlantic and along the US Gulf Coast. In the United States, it is considered a delicacy, ranking fifth among crustaceans. It was probably introduced to Asia and Europe by ballast water at the beginning of this century. As it is a eurytherm and euryhaline species, it easily establishes a population in new habitats, occupying the niche of an apex predator, and is attributed invasive properties. Despite these characteristics, it has not yet been included in the EU list of invasive species. In Croatia, it was first identified in 2004 in the area of Ston and the Neretva Estuary, from where it spread to a large part of the Adriatic. Scientific research on this species has focused on determining the establishment of the population throughout Croatia and its ecological characteristics. However, although it is clear that only economic exploitation can lead to a decrease in the population of this species and thus the preservation of biodiversity, no significant steps have been made in this direction. In addition to preparing products for the market while respecting all food safety regulations, it is necessary to harmonize fisheries and environmental protection legislation along with the appropriate education of fishermen. The paper analyzes in detail the legal obstacles and good practices from other geographical areas for preparing this species for the market, and provides guidelines that will contribute to achieving economic profit along with preserving biodiversity in the Croatian part of the Adriatic Sea.

Key words: *Calineces sapidus*, biodiversity, commercialization, legislation, market

Guidelines for the design of green areas with low allergic effects Birch pollen in Zagreb, Croatia

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Abstract

Nowadays, the population at risk of pollen allergy is increasingly seeking information about allergenic plants and ways to reduce exposure. Aerobiological monitoring over the past 10 years of the city of Zagreb shows that pollen index values range from 27.872 to 80.253 (av. 47.255). The contribution percentage of birch pollen in the total pollen spectrum is up to 16%. Investment in research and knowledge dissemination activities, including multidisciplinary collaboration and a citizen engagement approach, emphasizes the need to integrate environmental sustainability with public health aspects and urban planning. Guidelines for reducing the risk of pollen allergies emphasize planting insect-pollinated plants compared to wind-pollinated plants. Also, the guidelines include: plant biodiversity enhancement, controlled introduction of exotic or/and invasive species, botanical "gender equality" promotion, low to moderate pollen production species selection, the introduction of management, maintenance, and gardening strategies to ensure the removal of opportunistic and spontaneous species, pollen hotspot prevention, and information based, spatially personalized species selection with reduced cross-reaction risk in line with legal framework strengthening regarding the design and planning of urban green spaces. The project "Climate-proof landscape through renaturing urban areas in Central Europe - GreenScape CE" provides the foundation for integrating green into the gray infrastructure in urban areas through nature-based solutions (NbS).

Key words: aerobiological monitoring, allergy, biodiversity, guidelines, nature-based solutions

Acknowledgement

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Education for a Sustainable Future: Promoting Students' Responsibility for Biodiversity

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Abstract

The preservation of biodiversity is one of the key challenges of modern society, and the education system plays a crucial role in shaping the knowledge, values, attitudes, and behaviors of future generations. Education for sustainability is not merely the transfer of knowledge about environmental issues but also a process of developing ecological literacy, ecological values, critical thinking, and a sense of responsibility and personal engagement. This should not and must not be the sole focus of natural science-oriented study programs but should be integrated into the curricula of all higher education institutions. The aim of this research is to analyze the curricula of social sciences and humanities programs concerning the inclusion of biodiversity-related content and to examine students' experiences regarding their knowledge of sustainability and biodiversity, their attitudes and values, and their potential and current activities related to these topics. In line with the research objective, a qualitative methodological approach was chosen. The research results indicate the absence of biodiversity-related content in curricula, a lack of knowledge and engagement among the surveyed students regarding biodiversity, only a superficial understanding of the concept of sustainability, and relatively well-developed (expressed) values related to biodiversity and sustainability. The integration of biodiversity topics into the curricula of various study programs can be achieved by creating interdisciplinary courses, fostering collaboration between natural science-oriented programs and social sciences and humanities programs through project-based and experiential learning, research-based teaching, and cooperation with local communities. The education system should emphasize a holistic and transdisciplinary approach to learning, where biodiversity is not viewed in isolation but as part of a broader ecosystem interconnected with social, economic, and cultural factors.

Key words: biodiversity, sustainability, higher education, interdisciplinary and transdisciplinary approach

Abundance and distribution of three species of the genus *Trachurus* in the Northern and Central Adriatic Sea

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Abstract

Three species of the genus *Trachurus* are inhabiting the Adriatic Sea: *T. trachurus, T. mediterraneus, T. picturatus.* In Croatia the catches of these species are evidenced together, and as such they account for over 1100 t annually. Considering this, information on their abundance and distribution patterns are important, especially for the management purposes. The aim of this study was to describe the abundance, and spatial and depth distribution of *Trachurus* species in the Northern and Central Adriatic Sea. The data were obtained during MEDITS expeditions held from 1996 to 2022. A total of 36304 *T. trachurus*, 9023 *T. mediterraneus*, and 73 *T. picturatus* specimens were analyzed. *T. mediterraneus* was caught from 21 to 271 m, it was most abundant at the stratum 10-50 m, and abundance and biomass indices decreased with depth. *T. trachurus* was found between 21 and 383 m, and with the highest indices at stratum 100 - 200 m. Similarly, *T. picturatus*, was the most abundant at depths 100 - 200 m, with a depth range from 31 to 318 m. *T. mediterraneus* and *T. trachurus* were distributed throughout the study area, with *T. mediterraneus* being more abundant in the northern, and *T. trachurus* in the central part. *T. picturatus* was generally much less abundant compared to other two species, it was mainly found in the Central Adriatic, and rarely in the northern parts. The results showed wide distribution of *T. trachurus* and *T. mediterraneus*, and distribution of *T. picturatus* being extended to the northern parts of the study area. Trends of the mean annual indices for *Trachurus* species indicate stability of their stocks in the Northern and Central Adriatic Sea.

Key words: *Trachurus*, Northern and Central Adriatic Sea, abundance, distribution

LIFE OrnamentalIAS – First Year of Implementation

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Abstract

As a part of LIFE OrnamentalIAS project, partners from Croatia and Slovenia will deal with invasive alien plant species (IAS), with an emphasis on ornamental plants. Ornamental horticulture has been identified as one of the main pathways for the introduction of invasive plant species. One of the project's goals is to identify potentially invasive plant species on the market and in green areas. Project aims to take action before these species spread into the nature or to control them in the early stages of invasion. In the first year of the research, an analysis of the plant material supply in the Croatian and Slovenian markets was conducted and completed. The list of ornamental plants was prepared for Croatia based on the offers from 15 suppliers, and for Slovenia based on the offers from 13. The analysis of the supply on the Croatian and Slovenian markets revealed that out of a total of 2416 recorded plant taxa, as many as 70% were of foreign origin. Additionally, only 914 taxa were present on the markets of both countries. In the first year, an inventory of plant species on public and private green areas was also initiated, as well as an analysis of current methods of managing IAS and their green waste in Croatia and Slovenia. Analyses of the valorisation of IAS biomass for functional and energy purposes are also being conducted, i.e., research into the possibilities of producing low and high value-added products from IAS. The next project tasks will include assessing the invasive potential of recorded alien plant species and formulating a black, orange and white list of ornamental species. Chemical analyses of the energetic and chemical composition of IAS will be conducted to assess their potential for the production of green energy and high value-added products.

Key words: ornamental horticulture, market supply, invasive plants, waste, green energy

Yield competition and quality parameters of winter wheat trial

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Abstract
In this work, 42 winter wheat varieties known in the Republic of Croatia from 1905 to 2020 were conducted on some yield competition and quality parameters at the testing field of the Croatian Agency for Agriculture and Food in Osijek in the two-growing season, 2022/23 and 2023/24. The trial was sown with a seeder Winterstaiger in three replicates on plot of 11.25 m^2 with a sowing rate of 200 grains m^{-2}. Parameters which were conducted on invested winter wheat varieties are; physical parameters of grain quality (grain yield, hectoliter mass grain and average weight of 1000 grains) quality parameters (protein content, starch content, gluten content and sedimentation value) and plant traits and ear (plant height, ear length, number of grains per ear, quantity of ears, quantity of grains per ear). In two years of testing signification probability has been determined in grain yield, hectoliter mass grain, protein content, starch content, gluten content, sedimentation value, plant height, ear length, number of grains per ear. No signification probability has determinate in average weight of 1000 grains, quantity of ears, quantity of grains per ear.

Key words: winter wheat, protein, gluten, starch, sedimentation value

Breeding potential of Croatian maize landraces evaluated by their testcross performance

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Abstract
Today, maize cultivation is dominated by hybrids, which have almost completely replaced landraces and thus contributed to the reduction of genetic variability. To evaluate the breeding potential of Croatian maize landraces in terms of grain yield, 60 test crosses were produced by crossing 30 landraces with two-line testers. During the 2024 growing season, two field trials were sown at three sites (Šašinovec, Rugvica and Osijek), one with 30 landraces and two testers and the other comprising 60 test crosses and 5 commercial hybrids. The average yield of the 30 landraces at the Šašinovec, Rugvica and Osijek sites was 7, 4.4 and 2.3 t ha^{-1}, respectively, while the yield of the test crosses at the same sites was 12.2, 6.9 and 4.4 t ha^{-1}, respectively. In the experiment with landraces and testers, genotypic variance, genotype × environment interaction variance and error variance contributed 55, 18 and 27% to the total phenotypic variance, respectively, resulting in a heritability of 0.84. In the experiment with test crosses and hybrids, the contribution of genotypic variance, genotype × environment interaction variance and error variance to the total phenotypic variance was 13, 31 and 56%, respectively, resulting in a heritability of 0.39%. The average grain yield of landraces varied from 2.5 to 6.5 t ha^{-1} and in the test crosses from 5.7 to 8.8 t ha^{-1}. Seventeen test crosses had grain yields at the level of the average of 5 commercial hybrids, while seven of them were at the level of the highest-yielding hybrid. The analysis of the combining ability showed that the general combining ability in relation to the landrace and the tester contributed 50 and 8% respectively to the total sum of squares of the test cross, while the contribution of the specific combining ability was 42%.

Key words: maize, landrace, hybrid, yield, combining ability

Multilocation monitoring of qualitative and quantitative traits on winter wheat access

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Abstract
The aim of the study was to determine the variability of quantitative and qualitative traits in 173 winter wheat varieties from the Croatian Bank of Plant Genes recognised in the period from 1905 to 2018. The multi-location experiment was set up according to the "augmented" design in five blocks at the Botinec, Osijek and Klis locations in the 2023/24 growing season. Standard agricultural technique for growing wheat in our region was used in the experiment, without the use of fungicidal protection against diseases. In the trial, the grain yield, test weight, 1000-grain weight, number of grains per spike, number of spikes per m^2, number of spikelets and protein content were analysed. Combined analysis of variance across locations revealed a significant effect of variety on all tested traits. Grain yield showed a moderate positive correlation with number of grains per spike (0.33) and number of spikes per m^2 (0.47), while the correlation between grain yield and protein content was moderately negative (-0.65). Analysis of variance by decade with change in the year of variety recognition showed a significant increase in grain yield by 29.9 kg ha^{-1} per year, an increase in the number of spikes per m^2 by 1 spike per year and decrease of protein content by 1% per year.

Key words: wheat, multi- location experiment, Croatian Bank of Plant Genes, analysis of variance, correlations

Detection of potential hybridization zones based on geographical and environmental overlap - a case study of *Satureja* x *karstiana* (Lamiaceae)

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Abstract
In Croatia, there are three *Satureja* species groups (tSsg) that are most widely used as medicinal and melliferous plants: the *S. montana* complex, *S. subspicata* complex and *S. cuneifolia*. In addition, *S.* × *karstiana* Justin, a putative hybrid taxon between *S. montana* and *S. subspicata* has been recorded at several locations in the northwest Balkan peninsula. To assess the habitat suitability of the tSsg and to predict areas of overlap between the parental taxa that may be suitable for their hybrid *S.* × *karstiana*, we used species distribution models (SDMs). We built SDMs using the maximum entropy method (MaxEnt) based on the occurrences of the tSsg, obtained from field surveys in 2018–2021 in combination with Flora Croatica Database records, and six environmental variables selected as predictors (three bioclimatic and three topographic). SDMs of the tSsg under current conditions showed high predictive model performance, with AUC values ranging from 0.890 to 0.910 ± 0.025. To further explore niche differences and to quantify niche overlap between the tSsg in the available environmental space within the study area, we used environmental principal component analysis (PCA-env) and niche quantification approach implemented in the R package "ecospat". The PCA-env revealed that 63.4% of the total variability was explained by the first two principal components. Niche comparisons showed the highest overlap between *S. montana* and *S. subspicata*, allowing for their hybridization, and the lowest between *S. cuneifolia* and *S. subspicata.* This research has demonstrated that SDMs can be used to predict suitable areas for currently unknown but assumed hybrids between parental species that occur in sympatry.

Key words: melliferous plants, species distribution model, MaxEnt, niche overlap

Polymorphism of the *Vkorc1* gene in black rats (*Rattus rattus*) from the Lastovo Archipelago

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Abstract
The black rat (*Rattus rattus*) is an invasive mammalian species threatening seabird populations on various islands in the Adriatic Sea by predating on eggs and chicks. It also serves as a vector of zoonotic diseases, posing risks to wildlife and human health. Rodent control frequently relies on anticoagulant rodenticides, which inhibit blood coagulation by inhibiting the enzyme VKOR, essential for recycling vitamin K - a key factor in blood clotting - encoded by the *Vkorc1* gene. Mutations in the *Vkorc1* gene, primarily in exon 3, can confer resistance to these rodenticides, reducing their efficacy. This study aimed to investigate the polymorphisms in exon 3 of the *Vkorc1* gene in the black rat population of the Lastovo Archipelago to identify mutations associated with anticoagulant rodenticide resistance. DNA was extracted from muscle samples, and PCR amplification followed by the sequencing of exon 3 of the *Vkorc1* gene was performed on 38 black rats from 12 islands around Lastovo. A comparison of the obtained sequences with the published wild-type reference sequence identified mutations at third nucleotide positions of codons 107, 137, and 143, all of which were synonymous. Therefore, our results do not suggest the presence of anticoagulant resistance in black rats from the Lastovo Archipelago. Expanding sampling efforts will provide a more comprehensive evaluation of *Vkorc1* gene variability and its implications for rodent control.

Key words: *Rattus rattus*, *Vkorc1*; Exon 3; Anticoagulant resistance; Seabird preservation

Research on the potential of winter triticale genotypes for the production of green energy

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Abstract
Biomass, whose purpose is the production of biogas, has recently become increasingly important. Triticale is a type of small grain cereal that has a great genetic potential for biomass production. A trial with 15 triticale genotypes was conducted at the Botinec location during the 2023/2024 growing season. One genotype of winter hybrid rye and two genotypes of winter wheat, which are used in biomass production, were included in the experiment as control genotypes. During the growing season we evaluated the properties of the initial growth, date of heading, plant height and resistance to lodging. With the entry of genotypes in the optimal phase of growth and development the above-ground mass we transformed it into biomass. The analysis of the input substrate for biogas production was carried out in the Schaumann BioEnergy research laboratory in Germany. The quality of the raw material was determined using the "NIR" device and "wet chemistry" analysis. Also, a "Batch-test" was conducted to precisely determine the yield and quality of biogas. In the final analyses, two genotypes of winter triticale intended for the production of biomass, with breeding references BC 6860/16 and BC 6864/17 were selected and sent to the recognition process. The mentioned two genotypes achieved a 10.3% and 10.6% better biomass yield compared to rye hybrid standard and 6- and 14-days earlier vegetation with the same or better parameters of the input substrate and biogas compared to the standard varieties.

Key words: triticale, biomass, biogas

Biodiversity conservation in Djerdap National Park – an example of good practice

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Abstract

In recent years, we have witnessed increasing pressure on forest genetic resources, and the conservation of genetic diversity can be considered one of the primary goals of biodiversity conservation. Although national parks represent a form of in situ conservation of forest genetic resources, their areas often lack sufficiently effective methods for conserving the gene pool of individual tree species. Sometimes there is a lack of timely responses to the harmful effects of biotic and abiotic factors, which can lead to a significant decline in numbers or complete disappearance of a species from a given area, directly reducing biodiversity. Djerdap National Park is an area of exceptional biodiversity, where 57 forest and shrub communities have been identified. This research aimed to present the activities on identifying relict, rare, and endangered forest tree species in Djerdap National Park, as an example of good practice, to assess the degree of their endangerment and propose conservation measures. The research was conducted in selected localities with a protection regime of the first degree, where a total of 17 forest tree species, categorized as relict, rare, and endangered in the Serbian Forest Fund, were identified. Based on the results obtained, measures for active conservation and monitoring of individual genotypes or groups of trees were defined, the implementation of which is expected.

Key words: national parks, conservation measures, forest genetic resources, monitoring, biodiversity

Importance of the wing survey for Eurasian woodcock (*Scolopax rusticola*) population management improvement – a sample from western Croatia

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Abstract
Eurasian woodcock is a migratory bird species. Although the species traditionally belong to a game, in the last 20 years most European countries prescribed a lot of measures for its protection, from a complete hunting prohibition to limitation of woodcock hunting quotas.

The analysis was made on 114 wings collected from Eurasian woodcocks hunted during three hunting seasons (2022/2023 – 2024/2025). Birds were hunted by gun dogs on nine sites, with total area of 3616 hectares. Distances among sites varied from 0.54 to 2.1 kilometers. Sites were grouped into two categories: sites with dominance of silver fir (selective) forest stands and sites with dominance of common beech (uneven-aged) forest stands. Aging was made on the basis of wing feathers (hutching year and after hutching year birds). Birds were sexed from feather samples by fragments analysis of the CHD gene of bird sex chromosomes. Although the most often hunted specimens belonged to the group of hutching year females (47 % in hunting bag), during the hunting season number of harvested woodcocks didn't show significant changes in selective and uneven aged stands (R^2 = 0.234, p = 0.08; respectively R^2 = 0.007, p = 0.25). Sex-age structure of hunted birds didn't show significant differences between forest stands (F = 2.017, p = 0.116) as well as between the two types of forest stands and parts of the day (AM and PM) when birds were shot (F = 0.966, p = 0.433). According to the results, forest stands and part of the day didn't play significant impact on Eurasian woodcock harvest structure. Hutching year females had significantly higher body mass (m = 330.06 g, respectively m = 311.07 g; p < 0.05 g; Tukey HSD test) and significantly longer bills than hutching year males (m = 7.42 cm, respectively m = 7.08 cm; p < 0.05; Tukey HSD test). Other sex-age groups didn't show significant differences of the observed traits. Similar analyses should be conducted across other parts of Croatia where European woodcock hunting plays a significant role in hunting culture.

Key words: ageing, avian DNA sexing, body mass, bill length, trends of harvest

Importance of chestnut (*Castanea sativa*) flowers on insect biodiversity and conservation

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Abstract
The male flowers of chestnut (*Castanea sativa* Mill.) are very aromatic and attractive for some insects, which collect pollen or feed on pollen. The aim of theis research is to present a new data on insect species composition during chestnut flowering period. The monitoring of entomofauna on chestnut was carried out in the phenological phase of flowering in five Slovak localities: Arboretum Mlyňany, Nitra, Modrý Kameň, Plachtince and Príbelce. We recorded 70 insect species in the selected localities. They belonged to five orders (*Coleoptera, Hymenoptera, Diptera, Heteroptera* and *Lepidoptera*) and 33 families. Beetles (order *Coleoptera*) were the most diverse insect group with 31 species. The most abundant were groups of insects with chewing and sucking mouth parts. Some species, although not found in large numbers on chestnut flowers, regularly visit this tree during its flowering period. In this way, they contribute to better pollination of inflorescences and better quality of fruits. During flowering, the presence of some mostly harmful species (e.g. *Polydrusus impar, Curculio glandium*) was also found, which moved on the inflorescences, thereby contributing to the pollination of inflorescences together with active pollinators. Chestnut represents significant terrestrial refuge and temporary habitat for numerous insect species, especially in the blooming period. Our ecological research has highlighted the considerable importance of chestnut on insect biodiversity conservation.

Key words: chestnut, flowers, insect, pollination, blooming

Honey weed Plants in the Area of the City of Mostar (BiH)

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Abstract
Weed plants, which are often considered pests in agriculture, play an important role in the ecosystem. Honey weed species are most commonly found in ruderal habitats (along road edges, paths, ditches, on embankments, river and stream banks, in hedges, abandoned gardens, settlements, farmyards, and thickets), as well as on cultivated areas (vineyards, orchards, gardens, arable lands) and on grasslands (meadows and pastures). The aim of this study is to identify honey weed plants in the area of the City of Mostar (Bosnia and Herzegovina), determine their life forms, lifespan, and mark the locations where they were found. During the vegetation periods of 2023 and 2024, a floristic survey of honey weed species was conducted at 8 locations. The survey recorded 22 honey weed species growing in this area, classified into 12 families. Taxonomic analysis of the honey weed species recorded in the City of Mostar area reveals a dominance of members from the *Asteraceae* family, with 7 honey weed species. In terms of life span, herbaceous perennials are the most represented. Hemicryptophytes and therophytes are the most abundant life forms. The long flowering period of weed species, from early spring to late autumn, provides a continuous source of pollen and nectar for bees. Most species provide significant amounts of pollen and nectar, and major bee forage species such as *Taraxacum officinalis* F. H. Wigg are recognized. The results of the study highlight the importance of weed species for honey production and for pollinators, as they create additional sources of pollen and nectar during periods when other plants are not flowering.

Key words: honey plants, weeds, Mostar

Preliminary research of European brown hare (*Lepus europaeus* Pall.) ticks in the Brijuni National Park

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Abstract

Brijuni National Park encompasses the Brijuni archipelago in the northern Adriatic Sea. Within the park, the European hare (*Lepus europaeus* Pall.) inhabits the islands of Veliki and Mali Brijun. On Veliki Brijun Island, ticks were collected from culled hares (*Lepus europaeus* Pall.), fallow deer (*Dama dama* L.), and axis deer (*Axis axis* Erx.) as part of regular population management during autumn. Additionally, ticks were collected from the environment using a flagging method during spring. A total of five hares, two axis deer, and five fallow deer were examined. Ticks were found on all sampled hares, with a total of 180 ticks collected—84 nymphs and 96 adults. The ticks were predominantly located on the head and neck of the hares, with an average of 36 ticks per individual. Tick identification was performed based on morphological characteristics. The tick species identified on hares were *Ixodes gibosus*, *Ixodes ricinus*, and *Ixodes hexagonus*. Ticks collected from deer species included *Ixodes gibosus*, *Ixodes ricinus*, and *Hyalomma marginatum*. The presence of these tick species was also confirmed in the environment. This preliminary study conducted on Veliki Brijun Island identified four different tick species, with all *Ixodes* species, both nymphal and adult stages, parasitizing hares.

Key words: tick, NP Brijuni, brown hare, *Ixodes* sp.

Enhancing natural enemies population to control maize pests

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Abstract
Maize is the leading arable crop in Serbia, accounting for one-third of the country's total agricultural production area. However, maize production is often challenged by pest outbreaks. One of the most significant maize pests is the European corn borer *Ostrinia nubilalis* Hübner, 1796 (Lepidoptera: Pyralidae), which causes substantial damage to maize plants, leading to yield losses in both quality and quantity. Natural enemies, such as *Trichogramma* wasps, serve as important biological control agents for ECB management worldwide. This study aimed to evaluate the effectiveness of mass-produced *Trichogramma brassicae* as a biocontrol solution for suppressing ECB populations in Serbian maize fields. *T. brassicae* was applied using capsules, each containing approximately 2,000 wasps, which were distributed via a DJI Matrice 300 RTK drone equipped with an adapted applicator for capsule release. The study was conducted at two locations, Banatsko Karađorđevo (BK) and Novi Sad (NS). At BK, the study focused on a single maize hybrid, while at NS, it included two different maize hybrids. At both sites, 125 capsules per hectare were applied, delivering a total of 250,000 wasps per hectare. Egg parasitism rates were assessed before and five days after wasp release. Prior to treatment, parasitism rates were 8.8% in BK and 36.4% and 38% in NS. Five days after the release, parasitism rates increased to 84% in BK and 86.4% and 96% in NS. These results indicate that parasitism rates increased by 75.2% in BK and by 50% and 65% in NS following the inundative release of *T. brassicae*. During the study, intensive monitoring of ECB at both sites showed that native populations of *T. brassicae* contribute to ECB control, but their population levels are insufficient to achieve effective ECB management. However, the inundative release of *T. brassicae* significantly increased parasitism rates, demonstrating its potential as an effective biocontrol strategy for managing ECB not only in Serbia but also in similar agroecological niches across the Western Balkans region.

Key words: Biological control, drone, natural enemies, *Ostrinia nubilalis*, *Trichogramma* spp.

Diversity of microalgae community kept under unsanitary conditions

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Abstract
Microalgae are used in various fields of industry, e.g. as food supplements, organic fertilizers, food and feed additives. For biotechnological applications, the production of substantial biomass requires large quantities of microalgae culture, which in turn increases the risk of contamination. The aim of the study was to determine the diversity of microalgae communities kept under unsanitary conditions. For this study, eight samples of microalgae cultures were experimentally kept in unsanitary conditions to simulate improper open ponds culturing conditions and four samples were taken from a commercial facility for growing microalgae in the closed system. Microalgal samples were collected using an automatic micropipette, taking 0.5 mL of each culture and were placed in a 2 mL cryotube. The cryotube was then filled with ethanol to a volume of 2 mL. DNA extraction was performed using the Dneasy Power Soil Pro Kit (Qiagen, Germany) according to the manufacturer's instructions. After this step, the samples were sent to Novogene for further analysis. The diversity of the microalgae community was determined by next-generation sequencing (NGS) using the V4 region of the small subunit (18S) ribosomal RNA. Preliminary results showed significant contamination of the culture in both sample types, commercial and experimental. In five experimental samples, the genus *Uronema* was the most abundant, while the relative abundance of the sole culture of the commercial facility, a microalgae from the genus *Tetradesmus*, was lower than 70%.

Key words: microalgal cultures, contamination, NGS

Invasive orange spiny whitefly *Aleurocanthus spiniferus* is still spreading in Montenegro

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Abstract

The orange spiny whitefly (OSW) *Aleurocanthus spiniferus* (Quaintance) originated in south-east Asia. Following the first detection in Europe (Italy, 2008) it has spread in Croatia, Montenegro, Greece, Albania, France and is included in the EPPO A2 list. Although highly polyphagous, particularly is damaging to citrus. This paper provide an update of distribution in Montenegro and revised list of host plants. After the first detection in 2013 in citrus plantations in area of Boka Kotor Bay, in the following years it has gradually spread and successfully established across the most of Montenegrin coast. Following its latest record in 2023 in area of the city Ulcinj which is, together with area of city Bar, the most important for citrus production, the OSW is considered established along entire coastal area. Except citrus it has been found on *Vitis vinifera*, *Punica granatum*, *Pyrus communis*, *Rosa* spp., *Rosa canina*, *Hedera helix*, *Laurus nobilis*, *Wisteria sinensis*, *Eriobotrya japonica*, *Pyracantha* sp, *Parthenocissus* sp., *Ailanthus altissima* so far. Among these *Citrus* spp., *Rosa* spp., *H. helix* and *Pyracantha* sp. are particularly susceptible and *V. vinifera* very favorable host. On *Citrus japonica* only adults were found with no eggs or larvae. After detection in urban area of the city Podgorica on citrus, *Rosa* spp., decorative banana (*Musa* sp.), *P. communis*, *V. vinifera*, *A. altissima*, *Parthenocissus* sp. in 2023 and 2024, it can be concluded that *A. spiniferus* is spreading from coastal area northern, to inland.

Key words: *Aleurocanthus spiniferus*, spreading, host plants, Montenegro

In vitro assessment of the nematicidal potential of selected plant extracts against root-knot nematode *Meloidogyne incognita*

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Abstract
Meloidogyne incognita is one of the most widespread root-knot nematodes, causing significant yield losses in a wide range of crops and vegetables. Accurate identification of *Meloidogyne* species and the implementation of effective control measures remain challenging. While the use of synthetic nematicides raises concerns regarding human health and environmental safety, plant-based alternatives offer a more sustainable approach to nematode management. The nematicidal potential of various plant extracts has been demonstrated in previous studies, including those derived from *Tagetes* sp., *Azadirachta indica*, *Origanum* sp., *Thymus* sp., *Ocimum* sp., *Mentha* sp. and *Allium sativum*. The aim of this study was to assess the effect of aqueous plant extracts on the hatching of *M. incognita* eggs *in vitro*. The experiment was conducted using four replicates per treatment, with extracts from *Tagetes erecta*, *Origanum vulgare, Allium sativum* and an untreated control. Three concentrations (0.5%, 1.0%, and 3.0%) and three exposure durations (4, 7, and 10 days) were tested. All plant extracts exhibited nematicidal activity, with *T. erecta* showing the strongest inhibition of egg hatching (67–92%), while *A. sativum* had the weakest effect (33–52%). These findings suggest that plant extracts could serve as a safer alternative to chemical nematicides and contribute to the development of sustainable nematode management strategies.

Key words: root-knot nematodes, *Meloidogyne incognita,* nematicidal activity, plant extracts.

QTL enrichment analysis of candidate regions identified in Croatian Holstein cattle

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Abstract
Holstein cattle, as the most widespread dairy breed, have undergone intensive artificial selection, leading to reduced genetic diversity and the need for genetic monitoring in local populations. Understanding the genetic basis of economically important traits requires identifying genomic regions under selection and assessing their functional impact. This study focused on QTL enrichment analysis within candidate regions under selection in Croatian Holsteins. A total of 417 cows were genotyped using the Illumina BovineSNP50 BeadChip, with 26,887 autosomal SNPs retained after quality control. Using four complementary selection detection methods (eROHi, iHS, nSL, and HRiD), nine candidate regions were identified across different chromosomes, with 1,592 mapped QTLs. Among these, 68.22% were linked to milk production traits, with significant enrichment confirmed through functional analysis. The strongest selection signal was an eROHi region on chromosome 6, while HRiD regions on chromosomes 4, 21, and 23 were associated with QTLs related to health, exterior, production, meat, and carcass traits. These findings highlight the dominant selection pressure for milk production while revealing its impact on other economically relevant traits, contributing to a better understanding of the genetic architecture and breeding dynamics of Croatian Holsteins.

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Key words: Holstein, Selection, QTL enrichment

Red Deer (*Cervus elaphus*) post-release behaviour after hard reintroduction

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Abstract
Reintroduction or restocking refers to the process of translocation and releasing wild animals to areas where they were previously extinct or considered endangered and where conditions are still favorable for their survival. The red deer *Cervus elaphus* is a deer species native to Europe and the most frequently manipulated ungulate species. Deer's are often reintroduced using farmed animals, which require less effort compared to live-captured animals, but these animals can find it difficult to acclimatize to life in the wild and to predators. In addition, reintroduction can be carried out in a soft or hard way. In soft reintroduction, the animals are acclimatized in an enclosure for some time before release, while in hard reintroduction there is no acclimatization phase, and the animals are released immediately. The study was conducted in central Croatia, in the Sisak-Moslavina County, on the westernmost slopes and parts of the Zrinska Gora massif and is named the Prolom forest complex. During the study (2017-2024), the spatial behavior of a total of 16 collared red deer (6 ♂ and 10 ♀) was analyzed after hard release. The animals were handled on the farm without anesthesia and all animals were fitted with GPS telemetry collars. The results show that the animals are much more widely dispersed during the hard release; the largest dispersal was up to 54 km for males. The average annual home range was similar to that described in the literature, averaging 2322 ha for hinds and 2419 ha for stags. Finally, we found that our animals lose the behavior to defend against predators and are less aggressive, so mortality is more frequent. Of the 16 collared red deer in our study, we lost 70%, mainly through predation and poaching.

Key words: *Cervus elaphus*, dispersal, home range, restocking, telemetry, ungulate

Evaluating the impact of an online app introduction on the quality of angler catch data in Croatia

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Abstract
Anglers in Croatia are mandated to record annual data on retained fish and submit their reports to the Ministry of Agriculture via the Croatian Sports Fishing Association. This data is used as a supplement to the national monitoring program of freshwater fisheries. Until 2020, the data was recorded in a paper logbook and submitted to the Ministry by the end of each year. In 2020, the Ministry introduced the 'mRibič' app, making it mandatory for anglers to store data electronically. The aim of this paper was to compare data collected during the final three years of using the logbook (2018–2020) with the first three years of using the 'mRibič' app (2021–2023). Improvements were noted in specific species tracking, as anglers were given a choice of 39 species in the app (compared to 25 in the logbook), but this list needs revision due to listing of several protected fish species. It appears that technological inexperience among anglers is impacting data quality, as a significant amount of unrealistic data has been reported during the app usage period. This degradation in data quality makes it difficult to compare the new data with the previous period and complicates sound interpretation of the findings. Improvements to the app are recommended after this transitional period, including at least some AI-based data validation. As anglers become more familiar with the system, data quality is expected to improve, benefiting all parties involved.

Key words: freshwater fish, freshwater fisheries, recreational fishing, technology in fisheries

Potential for the control of *Ceratitis capitata* Wied. (Diptera, Tephritidae) using entomopathogenic nematodes

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Abstract
Ceratitis capitata Wiedemann (Diptera, Tephritidae), commonly known as the Mediterranean fruit fly, is a polyphagous invasive pest that causes significant damage to various fruit crops, including peach (*Prunus persica*), fig (*Ficus carica*), and mandarin (*Citrus reticulata*). Due to its major economic importance, it is regulated by an official Order on the Prevention of Spread and Control, as well as an Action Plan implemented in the Neretva Valley. Peach and fig are important host plants that, during the growing season, provide a suitable environment for the development of new pest generations before the ripening of mandarin fruits (*C. reticulata*). While pest control is a common practice in peach production, figs, as one of the preferred hosts, have traditionally not been treated with insecticides. The fig's fruiting period (August – September), supports the fly's reproductive cycle, leading to mandarin infestation. This ecological relationship is known as the "fig-mandarin bridge". According to the Action Plan for the period 2023–2025, *C. capitata* typically overwinters as a larva inside infested fruits and as a pupa in the soil, with the first adult individuals emerging in April. One of the newly researched and commercially available effective biological control methods against *C. capitata* is the use of entomopathogenic nematodes (EPN), particularly the species *Steinernema feltiae*. The aim of this paper is to provide an overview of previous studies on the effectiveness of EPN application. Laboratory and field trials have shown that the use of *S. feltiae* can reduce fly populations by up to 65%, making it one of the most promising candidates for inclusion in the Action Plan. Integrating this control method into the overall strategy of the Action Plan would involve soil treatments in peach orchards from June to August, as well as around individual fig trees, to reduce pest populations during the season, particularly before the mandarin ripening period. The application of EPN in early spring or autumn offers an effective and eco-friendly addition to current pest managment strategies, helping to break the cycle of continuous infestation and improve integrated control measures.

Key words: *C. capitata*, EPN, Action Plan, fig, peach, mandarin

Variability of mitochondrial DNA control region in the Adriatic populations of European sardine *Sardina pilchardus* (Walbaum, 1792)

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Abstract

The European sardine (*Sardina pilchardus*) is a small pelagic fish that plays a crucial role in the Croatian economy. A key challenge in the management of sardine stocks and catches to ensure the balance of the Adriatic ecosystem. The identification of fish stocks is an important first step towards effective management and the conservation of biodiversity. This study revealed exceptionally high haplotype diversity in European sardine populations from the Croatian Adriatic, with each individual exhibiting a unique haplotype, as revealed by mtDNA analysis. This indicates a high degree of genetic variation within these populations. However, despite this diversity, molecular analysis of variance (AMOVA) showed minimal genetic differentiation between the two sampled locations, Ližnjan and Dugi Otok, with 92.82% of genetic variation occurring within populations and not between them (Fst = 0.072). Additionally, the median-join network showed no clear separation of haplotypes between the two locations. These findings suggest high gene flow between the sardine populations in Ližnjan and Dugi Otok, likely due to the proximity and high dispersal potential of the sardine larvae. Although overall genetic differentiation was low, the presence of unique haplotypes in individuals from each location, along with slight differences in haplotype frequencies, could indicate potential local adaptations or micro-evolutionary processes within the sardine populations. Further research, involving larger samples from a wider geographical area are needed to investigate this possibility.

Key words: Clupeidae, molecular markers, haplotype diversity, genetic variation

Drought and hydrological relations in the Plitvice Lakes National Park

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Abstract
A lack of precipitation causes drought, which affects surface water supplies, water levels and water flow in watercourses. The objectives of the study were to calculate drought indices, trends in climate elements, drought indices and watercourse water levels, and to show the relationship between the drought index and watercourse water levels. Meteorological drought was analysed using the methods of rain anomaly index, percentage of normal, and length of the dry period. Changes were analysed using the Mann-Kendall trend test. The analysis was conducted for the period 1981–2022. There were 25% of dry years in total. In the study area, over a multi-year period, the average values of the rain anomaly index and percentage of normal were in the "normal" category. Precipitation amounts and mean annual air temperatures increased. Drought index trends statistically significantly increased toward wetter conditions. The Crna Rijeka stream had a significant trend of decreasing water levels. A significant correlation was found between the drought index (r=0.37*) and the length of the dry period (r=-0.32*) and the water level of the watercourse. Considering the trend of precipitation, drought index and water level, the fundamental phenomenon of the national park is not threatened because there should be enough water in the ecosystems. Changes in climatic elements, drought index and water level also depend on the length of the time period.

Key words: drought, Plitvice Lakes, water levels, hydrological relations

Morphological Differentiation of Wax Moths and Implications for Beekeeping Management

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Abstract
The greater wax moth (*Galleria mellonella*) and the lesser wax moth (*Achroia grisella*) are major pests in beekeeping, causing structural damage to hive components, stored honey, and wax combs. When both species occur simultaneously, distinguishing their eggs and larvae is challenging, making accurate identification based on specific morphological traits essential for effective monitoring and pest management. Key distinguishing traits include egg surface texture, larval head capsule morphology, spiracle structure, and pigmentation patterns. The eggs of *G. mellonella* exhibit a more pronounced reticulated surface, whereas those of *A. grisella* have a smoother texture with reticulation limited to the anterior pole. *G. mellonella* larvae have well-developed simple eyes (stemmata), which are absent in *A. grisella*. The spiracles of *G. mellonella* are uniform in shape with a light peritreme, whereas those of *A. grisella* are darker and asymmetrical. Additionally, *G. mellonella* larvae are typically larger and more robust, with a yellowish-white body, whereas *A. grisella* larvae have a more slender, translucent appearance. Adults can be differentiated by size and wing structure, with *G. mellonella* having a wingspan of up to 31 mm and mottled forewings, while *A. grisella* is smaller (10–13 mm) **with narrow, uniformly colored wings.** By improving species identification through detailed morphological characterization and advanced imaging techniques, this study contributes to enhanced wax moth monitoring and control strategies in beekeeping. Accurate differentiation will aid in the development of targeted management approaches, reducing colony losses and promoting sustainable apiculture.

Key words: advanced imaging, beekeeping pests, morphological differentiation, pest management, stereomicroscopy

Genetic studies of wild grapevine (*V. vinifera* L. *subsp. sylvestris*) in Slovenia

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Abstract

The wild form of the cultivated grapevine (*Vitis vinifera* L. subsp. *sylvestris* Gmelin) is still present in European and West Asian regions. However, due to the intensification of agriculture or the introduction of various pests and pathogens, its presence in these growing areas has been decimated. Sylvestris is now considered an endangered subspecies and is protected by law in many European countries. In this project, a sample of 83 accessions was analyzed using 24 SRR markers, and 3 markers used to determine the sex of the flowers. Their genetic diversity and structure were compared with autochthonous and unique varieties of subsp. vinifera from old vineyards in Slovenia and with rootstocks that escaped from abandoned vineyards into the wild. Most accessions were found in forests on the left bank of the Sava River in Slovenia, at 4 different sites, some of which were described for the first time. Female plants dominated at two of the sites, while the ratio was balanced at the other sites. Sylvestris was clearly separated from vinifera and rootstocks. In the meantime, a complete genetic copy of the wild grapevine has been established in the gene bank of the University of Maribor, Faculty of Agriculture and Life Sciences, UC Meranovo. Given the climatic challenges, preserving the biodiversity of Sylvestris could prove to be the key to climate-resilient adaptation in breeding programs. The protection and study of the remaining wild specimens is therefore a key element in the conservation of our wine-growing landscape.

Key words: Slovenia, *V.v. subsp. sylvestris*, SSR markers, conservation, genetic fingerprinting

Geometric-morphometric characteristics and phylogenetic relationships of juvenile Scombridae individuals

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Abstract

Bullet tuna (BLT) *Auxis rochei*, Little tunny (LTA) *Euthynnus alletteratus* and Atlantic bluefin tuna (BFT) *Thunnus thynnus* are pelagic top predators of significant ecological and economic value for fisheries and, in the case of BFT, also for aquaculture. Identification of juvenile Scombridae species can be challenging due to similar morphological features; thus, this study aimed to use geometric morphometric (GM) and molecular techniques to identify important characteristics of three investigated species. In the eastern Adriatic, juveniles of all three species were sampled from recreational fisheries in 2018-2019, while eggs and larvae of BLT and LTA were sampled in 2019-2020 using standard vertical plankton tows for the purpose of phylogenetic analysis. Landmark-based GM was utilized to determine body shape from digital images using 19 fixed landmarks and 8 samilandmarks. Amplification of the mtDNA cytochrome oxidase subunit I gene region was performed on 49 individuals per species, including both eggs and larvae. Phylogenetic analysis identified three distinct clades that align with the three species studied. The GM analysis indicated that primary differences between the species are in body width and head shape, allowing species identification with high accuracy. Overall, both methods proved effective for species delimitation, highlighting their potential application in fisheries management, which is particularly significant for BFT as an International Commission for the Conservation of Atlantic Tunas - regulated species.

Key words: Scombridae, geometric morphometrics, phylogeny, COI, mtDNA

Session 5

Agribusiness and Smart Agriculture

Assessing sustainability and impact of rural tourism on local communities in North-West Region of Romania

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Abstract
Sustainable tourism and agribusiness are crucial for the development of rural communities as they enable economic diversification and environmental protection. In addition, a large body of literature emphasises the importance of sustainable solutions in these sectors, which have significant social and cultural impacts. The aim of our research is to assess the perceptions and practises of agritourism operators regarding sustainability and the impact of these initiatives on the community. We created a structured questionnaire and conducted a survey in September-October 2024 among 64 subjects, i.e. farm owners involved in tourism activities and rural tourism operators in North-West Region of Romania. The results show that most operators offer various activities such as farm accommodation, guided tours and tastings of local products, while implementing sustainability measures such as the use of renewable energy and efficient waste management. The responses reveal significant challenges, such as high costs, insufficient financial and informational support, but also difficulties in attracting and retaining tourists and the need for training, marketing and cooperation. The conclusions emphasise the importance of financial and educational support, but also the need to develop local partnerships involving all stakeholders to ensure long-term sustainability. In terms of future research directions, we suggest evaluating the long-term impact of these measures or identifying strategies to maximise the economic and social benefits of sustainable rural tourism.

Key words: sustainable tourism, agribusiness, economic diversification, environmental conservation, community impact

Challenges and opportunities of rural tourism: A study on community perceptions in North-West Region of Romania

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Abstract
Rural tourism represents a significant opportunity for local economic and social development, but it also brings with it difficulties and undesirable effects. Our study aims to identify both the benefits and the associated challenges by assessing the perceptions and experiences of local community members regarding rural tourism and sustainable agribusiness in the North-West Region of Romania, thus providing a basis for sustainability policies and strategies that support harmonious rural development. In this context, from September to October 2024, we conducted a survey-based research among more than 200 local residents (excluding tourism business owners and their employees) from 23 rural communities where tourism activities take place. The questionnaire covered the impact of rural tourism, perceived benefits and problems, sustainability measures and suggestions for improving cooperation. The results show that rural tourism brings significant benefits, such as increased local income, business opportunities and the promotion of regional culture and traditions, but also challenges like pollution, rising prices and loss of authenticity. Sustainability measures are diverse, but perceptions of their effectiveness are unclear, ranging from indifference to moderate enthusiasm, and require improvements in both actual impact and community awareness. Overall, respondents consider cooperation between tourism businesses and the local community to be moderate and suggest regular meetings and partnerships for better collaboration. They emphasise the importance of financial, educational and organisational support for sustainability measures and close cooperation between the community and local businesses.

Key words: rural tourism, sustainable development, local communities, benefits, challenges

Use of Spectroscopy for Real-Time Anaerobic Digestion Monitoring

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Abstract
Anaerobic digesters process organic substrates to produce biogas which can be used as a renewable fuel. If anaerobic digesters are organically overloaded, instability in the microbial consortium can occur, resulting in decreased production of biogas. Following the breakdown of proteins and carbohydrates, the next step of the microbial consortium results in the production of volatile fatty acids (VFAs). If VFAs are produced in too high of a concentration they will negatively affect the microbial system. This will result in reduced biogas production. Near-infrared (NIR), mid-infrared (MIR), and full spectrum Fourier transfer (FTIR) spectroscopy can be used to monitor anaerobic digestion parameters digitally in real-time. These techniques measure the vibrations of molecular bonds by attenuating total reflectance of a sample to create spectra determining both composition and concentration. Specifically, NIR and MIR are spectroscopic techniques widely used as they are non-invasive, and can be useful for indirectly monitoring the health and activity of the microbial consortium. NIR monitoring has been shown to provide information on solids' content and biodegradability. MIR is useful for identifying specific compounds like VFAs, such as butyric and acetic acids, through distinctive peaks on its spectra reflecting peak intensity. This presentation will showcase how MIR and NIR techniques are used to monitor the anaerobic digestion process.

Key words: biogas, NIR spectroscopy, MIR spectroscopy, anaerobic digestion.

Emerging Microchip-Based Diagnostics for Rapid Pathogen Detection in Shrimp Aquaculture

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Abstract
Pathogenic microorganisms are one of the most persistent and critical challenges that shrimp aquaculture faces today. In addition to requiring a laboratory with specialized equipment, traditional diagnostic methods (e.g. PCR and ELISA) typically require more than 4 to 6 hours to confirm the presence of pathogens, in addition to the time required to ship the samples to a laboratory. Early pathogen detection is critical for effective disease management and mitigation strategies aimed at reducing economic losses. Portable microchip-based diagnostic platforms that can provide rapid (within 30 minutes), digital on-site detection are being developed for use by shrimp producers. These digital diagnostic platforms can detect multiple, major shrimp pathogens such as White Spot Syndrome Virus (WSSV) and *Vibrio* spp. These systems integrate microfluidic technology with isothermal amplification to identify the pathogen-specific genetic material within 30 minutes and provide results comparable to laboratory-based methods. Because these systems have a compact design and low power consumption, rendering them suitable for application in remote or resource-limited aquaculture settings. By enabling early-stage diagnosis and monitoring of many major pathogens, microchip-based sensors provide an effective solution for the rapid detection of shrimp pathogens in farmed shrimp production systems.

Key words: aquaculture, disease surveillance, pathogen detection, microfluidic chip, shrimp pathogens

Selective breeding vs. precision fermentation: Croatian consumers' attitudes towards innovative dairy products

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Abstract

In recent years, the dairy market has witnessed the emergence of innovative dairy products driven by evolving consumer preferences, technological advances and sustainability concerns. These innovations fall into two distinct categories: products derived from selective breeding, such as A2 milk, and those developed through technological innovation, such as precision fermentation milk. The market success of these innovative dairy products will ultimately depend on consumer acceptance, which can be influenced by factors such as perceived quality, sustainability and health benefits. The aim of this study is to compare the attitudes of Croatian consumers towards two types of innovative dairy products: A2 milk and those developed through modern technological processes, such as precision fermentation milk. The study examined which of these innovations is perceived more positively by consumers. In autumn 2024, a representative online survey was conducted among 801 respondents in Croatia. The questionnaire included questions on awareness of and attitudes towards the two types of milk mentioned. A descriptive analysis and a Wilcoxon signed-rank test were used to analyse the data collected. The results showed that 15.7% of respondents had heard of A2 milk before participating in this study, and 18.2% had heard of precision fermentation milk. After reading the information about both types of milk, consumer attitudes towards A2 milk and precision fermentation milk were predominantly neutral, with an overall mean score of 3.15 for A2 milk and 2.97 for precision fermentation milk. However, respondents had a statistically more positive attitude towards A2 milk. The results provide a useful basis for further research into the acceptance and promotion of this milk in the market analysed.

Key words: innovative dairy products, A2 milk, precision fermentation milk, Croatia, attitudes

Infrared Drone Imaging to Measure Biodegradable Plastic Mulch Fragmentation

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Abstract

Biodegradable plastic mulches (BDMs) are a sustainable alternative to polyethylene (PE) mulch films in specialty crop production. They provide similar benefits (weed suppression, moisture retention, erosion control) and, unlike PE, fragment and biodegrade in soil after the season, eliminating the need for disposal. However, quantifying BDM fragmentation in the field is challenging. The standard method (burying plastic samples in mesh bags) is laborious and yields inconsistent recovery for analysis. We present a novel *in situ* imaging method leveraging near-infrared (NIR) photography and the Wood effect (IR reflectance of foliage) to distinguish BDM fragments from soil and crops. Using monochrome IR-sensitive film with a sensitivity up to 820 nm and an R72 filter, we captured high-contrast images where BDM fragments appear black, soil as light gray, and vegetation as bright white. These images were suitable for automated processing to quantify fragmentation metrics (crack length, fragment area, fragment count) for evaluating BDM breakdown *in situ*. Image analysis concluded that the average crack length from the images was within 5% of the measured value (4.2 cm calculated vs. 4.4 cm measured for a curved crack). After testing our ground-based NIR imaging, we also explored applying this approach to multispectral drone imaging for hectare-scale monitoring. Distinct NIR signatures of different BDM materials (PBAT, PLA) could enable mapping of mulch types and their degradation rates but could be complicated by a plant canopy or soil moisture, especially at larger scales. This cost-effective method could enable farmers and researchers to track BDM degradation, supporting greater BDM adoption and soil health assessment.

Key words: plastic mulch, soil health monitoring

EIP-AGRI Operational Group „InOli“

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Abstract
The European Partnership for Innovation in Agriculture (EIP-AGRI) is part of the Common Agricultural Policy (CAP) programme (2021-2027) in Croatia. The EIP-AGRI bases its implementation on the so-called “interactive approach”, in which different actors work together to better disseminate innovative solutions in farms and rural areas. For this purpose, an Operational Group (OG) called “InOli” was established in 2024. This OG consists of partners with different backgrounds, e.g. a scientific partner as a team lieder, an NGO dealing with weather forecasting, a PR and design agency and olive growers. Over a period of 2 years, this OG will conduct a series of climate-friendly olive crop management practices in the partners' olive groves, such as: no tillage, mulching of pruning residues, supply of organic material and irrigation. The olive oil obtained from the olive groves of the experiment will then be analysed in the laboratory, organoleptically examined by a panel of experts and tested by a consumer panel. At the end, the PR and design agency will design 3 labels for olive oil to communicate the use of climate-friendly practises and the most favourable label will be selected by means of a questionnaire sent to a sample of olive oil consumers. At the end of the project, the most appropriate climate-friendly practises and the most adequate label for olive oil will be identified.

Key words: EIP-AGRI, Operational Group, climate friendly practices, label, olive oil

A general assessment of organic food with retail price premiums in Turkey

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Abstract
Organic agricultural production has emerged as an alternative to conventional production and aims at a sustainable production approach based on soil, nature and human factors and is an environmentally friendly production method. It is a production method that combines traditional production with innovation and science in order to protect the natural environment and promote a good quality of life for all. Organic agricultural products, which have gained a certain momentum in the world and reached wide markets, are mainly produced for export in Turkey. The growth of the organic market depends on the balance between supply and demand. In this respect, the aim of this study is to examine the market prices of the products. They are the most important factor influencing consumer buying behaviour in order to promote the growth of the organic market and reach the desired level. Retail price premiums were analysed for the following food groups: cereals/legumes, fruits, vegetables, milk, dairy products and eggs, dried fruits and nuts. The data in this study is based on secondary data and an internet search was carried out on the relevant websites to determine retail prices. The results show that the price premium calculated by comparing the prices of organic and conventional foods for selected foods was in favour of organic products. This price premium was particularly high for pasta, dry beans, buckwheat and rice from the cereals/legumes group; grapefruit, apple and pear from the fruit group and yellow chickpeas, pumpkin seeds from the nuts group. These results can serve as a guide for food producers, marketers and policy makers when making decisions about organic food.

Key words: organic, food products, retail price premiums, Turkey

The production of products with a geographical indication from the farmer's perspective: Kelkit dry beans

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Abstract
The supply of high-quality food from local production is considered practical and advantageous. Geographical indications (GIs) help consumers to recognise products from specific regions. Therefore, GIs create intellectual property rights for certain products that are linked to their production area. Nevertheless, the acceptance of this type of labelling by small farmers in agricultural production is low. GIs play an important role in improving regional competitiveness and supporting the agricultural economy. They also ensure the sustainable development of agriculture and the revitalisation of rural areas. The applicability and sustainability of GIs are directly linked to both the positive experiences of farmers involved in the production and marketing of GI products and the motivation of farmers who are not involved in the process. The aim of this study is to analyse the production and marketing processes of GI products from the farmers' perspective. This study, which was carried out using the example of Kelkit dry beans, an agricultural product with a geographical indication in Turkey, aims to show how geographical indications affect farmers in terms of production and marketing. In addition, this study also examines the motivational factors that may be effective in the participation of non-GI dry bean producers in the GI production process. The primary data of this study were obtained from face-to-face interviews with dry bean farmers in Kelkit, Şiran and Köse districts in Gümüşhane province, Turkey. During the 2021 survey, a total of 100 dry bean growers were interviewed. 50 of them used GI-registered seeds and 50 did not use GI-registered seeds. The results of the study show that yield, selling price and contract farming are the most important motivating factors influencing farmers' transition to GI-labelled production.

Key words: GIs, farmers’ perspective, Kelkit dry beans, Turkey

Skills for new generation of agronomists and farmers fastering innovation and entrepreneurship

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Abstract

Food systems at global and national levels are under tremendous pressure from the drivers of change. The first is geopolitical, with the balance of economic power between key players shifting, leading to changes in trade flows and supply chains. The second factors are technological in nature, with digitalisation and economic optimisation changing price relationships and intensifying competition. Increasing concentration in input production, processing and trade is also contributing to this. The third factor results from agriculture's confrontation with the consequences of climate change, the biodiversity crisis, changing eating habits and the demands of public health. All of these factors require adjustments and innovations in the production, processing and supply of food to the population. This affects all players in the food system, from farmers to processors and retailers, who must develop entrepreneurial solutions and business models in addition to new technologies in order to survive. Research and educational institutions, especially universities, have an important role to play in this development, as does knowledge transfer and, of course, farmers. It is necessary to improve the skills and competences of all those involved, especially those of agricultural professionals and farmers themselves. In this roundtable we aim to i) explain why and in which direction changes are needed in the area of innovation and entrepreneurship in food systems, especially in the area of agronomic education and farmer training. And ii) how this can be supported and implemented, how deep the changes needed in research priorities, curricula, knowledge transfer and farmer education need to be. We start from the assessment that it is the capacity of national food systems to transform and adapt to new conditions that will determine their future development, with all the implications for the achievement of national objectives in relation to food security and the management of natural and human resources. Only knowledge, combined with innovation and entrepreneurial solutions, can support and develop food system actors. This requires significantly greater investment in knowledge systems and a greater social role for universities in the creation and transfer of knowledge in agriculture and related activities. With the exception of the most developed ones, most agricultural faculties have a problem attracting (quality) students, which may contribute significantly to the gap between supply and demand for top quality human resources for the economy and the public sector in this field. We want to test the thesis that a more reform-oriented approach is needed to transform research, higher education and knowledge transfer by strengthening international comparability and excellence, implementing bolder curriculum reforms, multidisciplinarity and improvements in andragogy and pedagogical approaches, with closer links to the economy and society.

Key words: professional competences, food systems, university curriculum, farmers training

The Role of Optoelectronic Sensors in Collecting Real-Time Data to Monitor the Fermentation of Grape Must into Wine

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Abstract

Traditionally, enologists measure the density of grape must twice per day during the active fermentation process to track sugar and ethanol content. This paper reviews the operation and effectiveness of low cost optoelectronic sensors in achieving desired wine flavor profiles by measuring refractive index *n*, chromatic properties, and temperature. Optoelectronic systems operate by shining light from laser diodes through samples of grape must. Position sensitive detectors (PSDs) on the other side of the sample collect data on the location of photons passing through, and photodiodes record the light intensity emitted to determine the refractive index of the wine with an absorbance accuracy of ±0.003. When the LEDs transmit light, the photodiodes also capture absorbance at different wavelengths to monitor chromatic characteristics, which are especially important in red wines. Temperature is digitally measured as well since warmer conditions correlate with reactions proceeding successfully. A switch from steadily decreasing to increasing refractive index with time due to varying glucose and ethanol concentrations indicates that the reaction has reached its conclusion. At concentrations of 20% alcohol or less–which encompasses most wines–a linear relationship between refractive index and ethanol content is observed with an R^2 value of 0.997. Data on chromatic properties can be used to determine the best time to remove grape skins from the must based on peak intensity. Analysis of this data is conducted by the enologist. Using automated optoelectronic sensors can reduce labor costs, eliminate human error, and provide more precise modifications to fermentation factors to ensure consistent and high quality wine using real-time data.

Key words: wine fermentation, real-time monitoring, optoelectronic sensors, refractive index, chromatic analysis

Investigation of precision spreading of organic fertilizers toward sustainable agriculture

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Abstract

Soil conservation and environmental protection are essential for ensuring efficient plant nutrition and achieving competitive crop yields. While mineral fertilizers are commonly used to enhance soil fertility, organic fertilizers should also be applied in accordance with specific agronomic guidelines. Given the heterogeneous nature of soil composition across a field, one of the most effective fertilizer technology is variable-rate application. This study evaluates the uniformity of pellet distribution during variable-rate application of organic fertilizers using a centrifugal spreader to promote sustainable agriculture. The experiment focused of cylindrical manure-based granular fertilizers tested on loamy soils in Northern Europe. The spreader was tested at varying operational speed of 10 and 14 km h^{-1} during variable-rate application. The findings indicated that when applying organic pellets at a rate of 400 kg ha^{-1}, uneven distribution occurred on both sides of the spreader as the coefficient of variation exceeded 14.74%. This variability in distribution was by the operational speed of 14 km h^{-1}. Conversely, when the fertilizer was applied at a rate of 700 kg ha^{-1}, the distribution became more uniform, with the coefficient of variation remaining below 9%. In conclusion, adopting organic fertilizers with variable-rate application at 700 kg ha^{-1} reduces environmental impact, promotes environmental sustainability, and encourages responsible agricultural practices.

Key words: organic fertilizers, spreading, variable-rate, sustainable agriculture

Performance Analysis of Crop Harvesting using Telemetry data across Different Crops

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Abstract

Automated driving systems are increasingly being utilized in agricultural operations to enhance the efficiency of various tasks. These systems contribute to optimizing farming processes by improving the utilization of energy resources and reducing environmental pollution. The primary objective of this study is to analyze crop yield data from different plant species and to explore methods for enhancing the operational efficiency of combine harvesters. The data used in this research pertains to the Lexion 770 TT harvester, which is equipped with a remote monitoring system that tracks machine parameters. This study examines the temporal distribution of agricultural tasks and analyzes fuel consumption patterns associated with the harvester's performance according to the harvester performance remote data. The analysis of harvester data revealed that the most productive 67% of the harvester's operational time occurred during the oat harvest. Oat threshing and grain release from the hopper accounting for 64% and 3%, respectively. In contrast, the lowest efficiency (45%) was observed during wheat harvesting. The harvest data differences between oat and wheat harvest were influenced by crop density, selection of machine parameters, and technological solution implementation options. The highest fuel consumption occurred during engine idle mode, with the engine load remained below 10% and the engine rotation frequency from 1000 to 1200 rpm. Additionally, the largest portion of CO_2 emissions was generated during direct harvesting, when the engine operated at a rotation frequency between 1800 and 2000 rpm. In conclusion, efforts should be directed toward minimizing the inefficiencies in harvester operation time. Telemetric data analysis makes it possible to estimate the number of failures during the season, better organization of yield transportation from the fields and review of daily work with operators would allow reduced engine idling time.

Key words: telemetry, combine harvester, crop, performance data, harvest efficiency

From Waste to Resource: Innovations in Creating Value Chains from Agricultural Residues

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Abstract
Rapid population growth has intensified the demand for natural resources, particularly non-renewable ones, leading to pressing environmental and social challenges. To mitigate these global issues, a transition from linear to circular economy is pivotal. As circular bioeconomy is a key pillar of this transition, a shift in perception of biomass by-products is needed. Regional inclusive biobased entrepreneurship solutions (RIBES) project addresses this challenge by developing innovative value chains aimed at utilizing agricultural by-products from Croatia's Pannonian region. For the project, short and long-term efforts are identified. Pannonian region, as a wine-producing area, offers great potential in utilization of grape pomace. This solid by-product could be transformed into valuable products for various industries, thus helping the wine industry shift toward a near-zero-waste model. Similarly, with 41% of the country's sheep being bred in this region, annual wool production offers untapped opportunities for new products. Crop residues also show potential for various applications. In the short term, they could be used as an alternative heating fuel, animal feed and bedding material (agropellets) and in long-term, in bioplastics and sustainable construction. Additionally, freshwater fish industry in the region generates 300 tons of residues annually, which could be repurposed for collagen extraction. By promoting sustainable innovation and awareness, the RIBES project contributes to resource efficiency and greener production, showcasing how agricultural by-products could be transformed into valuable resources.

Key words: circular bioeconomy, innovative value chains, biomass by-products, resource efficiency, sustainability

Precision Irrigation in Greenhouses: Leveraging Sensor Applications for Efficient Water Use and Crop Growth

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Abstract

The objective of this review was to investigate the benefits of sensor-based irrigation systems. It was found that automated, sensor-based irrigation enhanced water efficiency, boosted yields, and lowered labor in greenhouse production. These systems typically use wireless networks and Internet of Things tools to track substrate water content (θ) in real time via capacitance or time-domain transmission substrate moisture sensors. Probes are placed in containers or root zones and calibrated for specific substrates and desired moisture conditions. Microcontrollers or dataloggers are used to process analog or digital readings and compare them to preset thresholds, triggering irrigation with solenoid valves or pumps. Most systems follow threshold-based rules, supplying water via drip emitters or rings when θ falls below the threshold. Some initiate repeated cycles if the substrate moisture stays low. In addition to moisture sensors, environmental data (light, temperature, vapor pressure deficit) can be integrated to better estimate daily water use and refine irrigation timing. Central web interfaces like µlogger or customs graphical user interfaces (GUIs) allow remote oversight, manual operation, and system tuning. These methods have shown up to 70% water savings while preserving or improving plant quality. Yet, manual threshold tweaks based on visual cues can cause excess watering, stressing the need for training producers in selecting optimal moisture content thresholds and increasing producer confidence. Overall, sensor-based irrigation systems offer precise, scalable, and adaptive solutions for sustainable greenhouse production. Effectiveness relies on calibration, responsive automation, and engaged growers.

Key words: Precision irrigation, sensor-based irrigation, greenhouse production, water efficiency, automated systems

Collaboration of organic producers and preferred sales channels in the development of short food supply chains

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Abstract
Collaboration among producers plays a crucial role in the development of efficient and sustainable short food supply chains (SFSC), especially in the context of organic agriculture. This paper explores the willingness of organic producers in Croatia to collaborate in different business areas and investigates how they perceive the potential benefits of such collaboration in terms of business management and market performance. The aim is to gain a deeper understanding of the dynamics and limitations of producer collaboration in order to inform future policies and support mechanisms. The research was conducted in 2023/2024 using a structured questionnaire distributed to 374 certified organic producers. The results show that producers are most willing to collaborate in the exchange of knowledge and experience (M=4.05) and in areas related to quality assurance systems (M=3.76). Moderate levels of willingness was found for joint promotional efforts (M=3.57) and sales (M=3.46), while production (M=3.13) and processing (M=3.10) showed less potential for collaboration. In terms of perceived benefits, collaboration is seen as moderately helpful for improving business management practises (M=3.29) and increasing sales opportunities (M=3.51). However, benefits such as achieving higher prices (M=3.10) and strengthening competitiveness against conventional producers (M=3.25) are perceived less strongly. The results suggest that while there is a favorable attitude towards certain forms of collaboration, concrete institutional and structural support is needed to realise the full potential of collective action. The paper concludes with specific recommendations to strengthen collaborative models as a key strategy for the sustainable development of local organic food systems.

Key words: organic agriculture, short food supply chains, producer cooperation, perceived benefits, market access

Olives & Electrons: How AI is Teaching Solar Panels to Share the Sun

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Abstract
AI-enhanced olive agrivoltaics present the opportunity to generate additional revenue while providing a climate-smart solution for Mediterranean agriculture, where water scarcity and land pressure threaten traditional farming. These systems combine elevated solar panels with olive groves, using artificial intelligence to manage panel positioning dynamically. Machine learning algorithms process real-time data (solar irradiance, soil moisture, and canopy growth) to autonomously reposition panels, optimizing shade levels (30–40% coverage) to reduce evapotranspiration by 20–40% and potentially improve olive yields under drought stress. By continuously analyzing sunlight, soil moisture, and plant health data, the AI optimizes shade levels to reduce water stress on trees while maintaining solar energy production. This intelligent balance allows farmers to harvest crops and renewable energy from the same land. Though requiring significant initial investment, the approach demonstrates how adaptive technology can help agriculture and clean energy coexist in water-stressed regions. The system's automated monitoring and adjustments also reduce long-term labor demands, offering a practical model for sustainable intensification.

Key words: agrivoltaics, artificial intelligence, precision agriculture, renewable energy, olive production

The structure of agricultural land on dairy farms operating as legal entities in the Republic of Croatia

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Abstract
This paper analyses the agricultural land practices of Croatian dairy farms, focusing on the primary purpose of the agricultural land. In particular, it examines whether these farms allocate more land for pastures to graze the cows or whether they focus on arable land for crop cultivation and which crops are predominantly used as animal feed. The analysis includes all 62 dairy farms operating as legal entities in Croatia. In 2022, these farms were responsible for 42.03% of total milk deliveries and cultivated 128,723.74 ha of agricultural land, representing 62% of the total land used by dairy farms in Croatia. A breakdown of land use reveals that arable land dominates with 124,426.09 ha (97%). This is followed by vineyards with 3,277.75 ha (3%). Other land uses are minimal and account for less than 1% of the total area (pastures 0.34%, karst pastures 0.28%, meadows 0.16%, cleared vineyards 0.01%). Among the arable crops, corn is the most widely cultivated with 47,995.32 ha (39%), reflecting its importance as a primary source of energy for livestock feed. Other important crops are winter wheat (26,606.38 ha, 21%), winter barley (10,879.98 ha, 9%), fodder soybeans (10,082.64 ha, 8%) and sugar beet (9,703.14 ha, 8%), all of which can be used as additional fodder. The data clearly shows that large Croatian dairy farms operating as legal entities prioritise the cultivation of arable crops to ensure a reliable and high quality feed supply for their livestock. Effective land management is crucial for the profitability of farms and influences not only productivity and cost efficiency, but also environmental sustainability. In order to remain competitive and sustainable, Croatian dairy farming must continue to adapt its land use strategies in response to climate and market fluctuations. Future agricultural policy measures should place greater emphasis on land management practises, as these are key to ensuring resilient and sustainable dairy production systems.

Key words: agricultural land, dairy farms, legal entities, land management

Empowering the position of women innovators in rural areas

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Abstract
The social reality for women and men in rural areas is very different and gender-specific. Women and men introduce different types of innovations, are motivated by different factors, face different obstacles and generally have different experiences of starting and running businesses. One of the aims of the research was to find solutions that could support women innovators and break down the prejudices they face. The methodology included two focus groups of women innovators and two focus groups of men to understand their attitudes towards women innovators. Each group consisted of 6 to 10 participants. In addition to the focus groups, 12 interviews were conducted with experts who provide support in the areas of agriculture and rural development and whose innovations contribute to the empowerment of women innovators. The research was conducted as part of the Horizon Grass Ceiling project at the end of 2023. The research findings showed that gender gaps and barriers should be recognised as a policy, development and demographic issue at all levels of government and that women-led economies should be included as a development indicator to be implemented at the state level. One of the solutions proposed in the study was the introduction of additional measures or support specifically for women through the CAP (Common Agricultural Policy) Strategic Plan to emphasise the importance of women in rural areas and provide financial support.

Key words: women, rural areas, innovations

Application of activity-based costing (ABC) method in agricultural production

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Abstract
Effective cost management is the key to the sustainability and competitiveness of agricultural production. Conventional approaches to cost accounting often ignore the complexity of agricultural production processes and do not allow costs to be precisely allocated to individual activities. Activity-based costing (ABC) method is an innovative approach that focuses on activities as the basis for cost monitoring and provides a detailed insight into the cost structure and opportunities for optimisation. Conventional systems allocate costs based on criteria such as arable land or labour hours, ignoring the actual complexity of the activities that generate costs. This can lead to unfair allocation of overhead costs, resulting in incorrect product pricing and poor business decisions. The ABC method enables a more precise cost allocation by identifying the most important cost-causing activities and linking them to products or services. The aim of this paper is to investigate the application of an ABC method in agricultural production. The results show that the application of the ABC method enables more accurate identification of unprofitable activities, better cost management and more accurate cost calculation. For example, depreciation costs for machinery are allocated according to the actual use of the machinery, while administrative costs are allocated according to the number of transactions. The ABC method adds value through the accurate allocation of overhead costs, which has a direct impact on the quality of calculations and decision-making. Its application is particularly important for diversified activities with a high proportion of overhead costs in the total costs.

Key words: activity-based costing, agricultural production, cost management, profitability

The role of knowledge and skills in the transformation of rural tourist destinations

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Abstract
Rural tourism strengthens the local community by gathering new information and developing specific skills, bringing numerous benefits to the rural environment and its visitors, while strengthening the identity and recognisability of rural tourism destinations. The modernisation and transformation process in rural tourism underlines the importance of knowledge that includes training in destination management as well as skills in the application of digitalisation, marketing and strategic and cultural management. Therefore, the ability of rural communities to adapt new trends and utilise new technologies is one of the key components for their long-term sustainability and success in the market. The aim of this research is to analyse the socio-demographic characteristics of rural tourism entities in Osijek-Baranja County in correlation with the economic, environmental and socio-cultural determinants defined in the research. The results show that the transformation of rural destinations requires a synergy between local communities, entrepreneurs and different institutional participants, focusing on the transfer and application of specific knowledge, competences, innovations and sustainable practises. By developing local human resources, rural destinations improve the quality of their services, diversify their offer and create added value, which is essential for long-term economic success. Innovation and the application of digital technologies as well as ecological practises are the foundations for the creation of authentic experiences and the competitiveness of rural destinations in the global market. In this context, the development of knowledge and skills among local communities and tourism stakeholders helps to better matching the offer to the needs of tourism demand while preserving cultural heritage and natural resources.

Key words: rural tourism, transformation, knowledge, skills

Application of COD Analysis for Biomass Characterization in Anaerobic Digestion

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Abstract
Chemical oxygen demand (COD) is an indicative measure of the amount of oxygen that can be consumed by chemical reactions in each sample. It is commonly used to assess the organic pollution of wastewater, but its application to solid biomass characterization remains underexplored. Knowledge of COD values in biomass is crucial for the optimization of anaerobic digestion (AD) processes, as it provides information on the total oxidizable organic matter and potential methane yield, thus supporting the transition to sustainable bioenergy production in line with EU targets. In this study, the applicability of the COD method according to ISO 6060:1989 for the determination of organic matter content in solid biomass was evaluated, focusing on three energy crops: *Miscanthus* × *giganteus*, *Panicum virgatum* and *Arundo donax*. The results showed that the standard protocol was not suitable for solid samples and led to inconsistent and underestimated values. A modified approach was tested, but this also did not provide reproducible results. To overcome these challenges, an optimized methodology was developed to improve COD determination for solid biomass and provide a more reliable assessment of biodegradability. The developed method offers a precise alternative to conventional COD determination for lignocellulosic biomass and improves the accuracy of feedstock assessment in AD systems with COD ranging from 600 to 950 mg O_2 g^{-1}. Future research should focus on the refinement of standardization protocols to support large-scale implementation in bioenergy production.

Key words: chemical oxygen demand, biomass, anaerobic digestion, biodegradability, modified methodology

What determines consumers' intention to eat game meat?

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Abstract
Game meat offers considerable nutritional and environmental benefits, e.g. a higher protein content, low fat and a favourable fatty acid profile, while production can be considered more environmentally friendly compared to intensive livestock farming of beef, pork or poultry. Despite the advantages mentioned above, the consumption of game meat in Europe is significantly lower compared to other types of meat. It is therefore important to identify the factors that influence consumers' intention to eat game meat. The aim of this study was to investigate the factors underlying the intention to eat game meat by using an extended model of theory of planned behaviour (TPB). A sample of 603 respondents from Croatia was interviewed via an online survey. Structural equation modelling with partial least squares was used to test the hypotheses. The results showed that positive attitudes, subjective norms and subjective knowledge significantly increased consumption intentions, while attitudes towards African swine fever had a negative influence on consumers' intention to eat wild game meat. A significant correlation was found between attitudes towards hunting and the intention to consume game meat. Of all factors, attitudes towards game meat had the strongest influence, while perceived barriers played a minor role. Another important result of our study is that we found a higher predictive power of the extended TPB compared to the baseline model. These results provide valuable information for policy makers and industry representatives to develop targeted strategies to promote game meat consumption.

Key words: game meat, intention to eat, theory of planned behaviour, consumers, attitudes toward hunting

Consumer behavior and attitudes towards donkey milk as a functional food

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Abstract

One of the most important consumer trends in the food sector is the growing demand for functional foods, especially dairy products. The aim of the study was to determine consumer behaviour in relation to donkey milk consumption and attitudes towards donkey milk. An online survey was conducted with a sample of 288 respondents. The majority of respondents (83.7%) do not consume donkey milk, which is associated with a lack of habit and insufficient availability. In the group of respondents who answered that they consume donkey milk, the majority (44.7%) consume it several times a year, while 14.9% of respondents consume it several times a week and most frequently in the winter months (40.4%). When buying donkey milk, the most important characteristics were the consistent quality at the time of purchase, organic production origin and the balance between flavour and quality. Consumers believe that donkey milk has a high nutritional value and a positive effect on the immune system. The results could support the efforts of producers and authorities to develop strategies that promote the consumption of functional foods, especially donkey milk.

Key words: functional food, donkey milk, consumers, attitudes, behavior

The role of sustainable finance in the green transition of the agribusiness sector

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Abstract
Sustainable finance plays a crucial role in supporting the environmental, social and governance (ESG) transformation of agribusiness and is in line with global sustainability efforts. The transition to a green circular economy in agriculture, forestry and food systems offers the opportunity to reduce emissions, improve the resilience of ecosystems and contribute to economic stability. However, small and micro enterprises in the agribusiness sector face major challenges in adopting sustainable practises due to financial constraints. This study explores how sustainable finance can drive the green transition in agribusiness in Hungary and Croatia, where policy frameworks favour sustainability but provide limited emphasis on green financial mechanisms. A mixed methods approach combining surveys, semi-structured interviews and secondary data analysis is used to assess the impact of sustainable finance on the adoption of green practises. The study assesses the regulatory framework, stakeholder needs and investment effectiveness to identify barriers and intervention points for improving sustainability in agribusiness. Preliminary results suggest that targeted financial instruments and supportive policy measures significantly influence the implementation of ESG-aligned practices, driving both environmental and economic benefits. The study contributes to a deeper understanding of the role of sustainable finance in agribusiness and provides recommendations for strengthening financial strategies to support the green transition in the sector.

Key words: ESG, finance, agribusiness, Hungary, Croatia

Session 6

Youth and Education in Life Sciences

Enhancing agribusiness education through digital innovation: the e-agriMBA project

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Abstract

AgriMBA is a university network that supports and accredits the MBA programs in agribusiness. In collaboration with the Technical University of Moldova (TUM), six AgriMBA member universities have initiated the ERASMUS+ project Electronic Pan-European Learning System for Sustainable Agribusiness MBA Education (e-agriMBA). This initiative focuses on the development of a digital learning platform for the AgriMBA members and other stakeholders while also supporting the launch of a new executive MBA program in Moldova. The project has three key objectives: (1) the creation of an AgriMBA e-learning system, (2) the expansion of the MBA course portfolio via this system, and (3) the integration of TUM into the AgriMBA network. Since its launch in 2022, the project has achieved several important milestones. An initial analysis of best practices, user needs, and preferences formed the development and implementation of the AgriMBA online learning platform. Supporting materials, including the written and video user manuals as well as training, have been made available. Nine core AgriMBA courses have been adapted for an online delivery, and an executive MBA program at TUM has been successfully launched. By the time of the project's conclusion in 2025, all teaching and learning materials for both the core AgriMBA subjects and the new MBA program will have been uploaded to the platform. The accreditation by Moldova's national authority and the AgriMBA network is also planned. The project's successful implementation will play a significant role in the modernization and expansion of AgriMBA programs, increasing accessibility for the future professionals in the agribusiness sector.

Key words: agribusiness, executive MBA, e-learning, sustainable education

Support mechanisms for enhancing the involvement of girls and young women in forestry education and careers

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Abstract

Attracting forestry students and retaining their numbers is crucial to ensuring a skilled workforce and preserving the existing and future capacities of forest-based organizations. This paper aims to explore how female forestry students view their career readiness and the effectiveness of current mechanisms to prepare them for an employment in forestry. The data were collected in 2024 via an online survey involving 105 female participants, including 57 forestry students (forestry high schools and the Faculty of Forestry). The most frequently requested support (voiced by 70% of respondents) was the one requiring a more hands-on field experience. Career counseling and job placement were seen as necessary by 42% of students, while 37% saw the internships as crucial for the enhancement of their forestry education and career preparation. Only 30% of students were confident about their readiness for the forestry sector subsequent to the graduation (10% had doubts and 60% were unsure). Confidence in finding employment abroad was relatively high—that is, 21% of respondents were extremely confident about it. In contrast, only 9% of them were extremely confident about finding a job domestically. Most students (51%) felt to be moderately informed about the skills required for a career in forestry. Future education was seen as very important by 54% of students, while a similar number (58%) saw career advancement as a priority for their professional development. An increased practical training, career counseling, and partnerships with industry could better prepare the students for their future careers.

Key words: forestry, education, career orientation, gender, policy instruments

Self-evaluation in higher education: pathway to the enhancement of teaching/learning quality

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Abstract

In higher education, self-evaluation serves as an important tool for the improvement of teaching and learning quality. This research aims to analyze the teaching staff's self-evaluation reports at the Faculty of Agrobiotechnical Science Osijek (FAZOS) to identify the key areas requiring improvement, ultimately striving to increase the quality of teaching and learning process. The results presented in this paper are derived from the self-evaluatory assessments carried out during the period from the academic year 2020–21 to the academic year 2023–24. The aforementioned self-evaluation involved the teachers with varying degrees of experience, averaging approximately eighty-five participants each year. The results showed that nearly 70% of the evaluated teachers have completed psychological-pedagogical-didactical training. However, 34% of them indicated that they lacked proficiency with regard to the utilization of digital tools for teaching purposes, and 25% of them expressed a desire for further training in the psychology of teaching and learning. Furthermore, a self-evaluation among teachers encourages them to critically assess their pedagogical methods, identify the areas suitable for improvement, and develop a deeper understanding of student needs. From a quality-management perspective in a teaching process, this practice provides concrete feedback to those responsible for quality assurance, empowering them to identify the types of additional training that teachers require and the areas in which they need support the most.

Key words: teaching/learning quality, higher education, self-evaluation

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