



INSTITUTE OF  
AGRICULTURE SKOPJE  
SS. CYRIL AND METHODIUS UNIVERSITY



Ss. Cyril and Methodius University in Skopje  
Institute of Agriculture – Skopje

# BOOK OF ABSTRACTS

SCIENTIFIC CONFERENCE:  
INNOVATIONS IN SUSTAINABLE AGRICULTURE – BRIDGING SCIENCE AND PRACTICE

DECEMBER 2024

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# PLENARY LECTURES

## **THE EU MISSION SOIL DEAL FOR EUROPE: PURPOSE, OBJECTIVES, AND THEIR IMPACT IN THE WESTERN BALKANS**

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Soil mission board member

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EU Missions are a novelty of the Horizon Europe research and innovation programme for the years 2021-2027. They will bring a new way to concrete solutions to some of the greatest challenges the European Union and the whole world is facing. They have ambitious goals and will deliver tangible results by 2030 with great impact by putting research and innovation into a new role, combined with new forms of governance and collaboration, as well as by engaging citizens. A mission is a portfolio of actions across disciplines intended to achieve a bold and inspirational and measurable goal within a set timeframe, with impact for society and policy making as well as relevance for a significant part of the European population and wide range of European citizens. The EU has established 5 of such missions that include: adaptation to climate change, fighting cancer, creating climate neutral and smart cities, restore oceans and water, and protecting **soils** from degradation and mismanagement.

The EU Mission Soil Deal for Europe has the main goal is to establish 100 living labs and lighthouses to lead the transition towards healthy soils by 2030. Life on Earth depends on healthy soils. They are the foundation of the food systems. Furthermore, they provide clean water and habitats for biodiversity while contributing to climate resilience, support cultural heritage and landscapes and are the basis of the EU's economy and prosperity. The need to establish the soil mission comes from the fact that EU soils are under the threat of degradation. It is estimated that 60 to 70% of the in Europe are unhealthy due to current management practices, pollution, urbanisation, and the effects of climate change (EC, 2020) therefore urgent actions are needed to reverse the situation. These actions are also very relevant also for the Western Balkans. The Mission will support the EU's ambition to lead on global commitments, notably the Sustainable Development Goals (SDGs), and will contribute to the European Green Deal targets on sustainable farming, climate resilience, biodiversity, and zero-pollution.

## **MICROBIAL INNOVATIONS FOR SUSTAINABLE PLANT PRODUCTION AND RESOURCE CONSERVATION**

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This presentation will explore how microbial innovations are transforming sustainable plant production and resource conservation. Key challenges in agriculture, such as climate change, soil degradation, water scarcity, and overuse of agrochemicals, highlight the need for alternative solutions. Beneficial microorganisms like plant growth-promoting rhizobacteria (PGPR), algae and mycorrhizae offer natural ways to enhance nutrient uptake, improve soil health, and reduce the need for chemical inputs. Case studies demonstrate successful applications that boost crop yields and conserve resources like water and fertilizers. Finally, biotechnological advancements and international collaboration are critical to overcoming challenges and scaling microbial solutions for global agriculture.



## EUROPE DESERTIFICATION: SOLUTION FOR THE FUTURE FRUIT GROWING INDUSTRY

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Climate change became the reality of our times and besides searching explanations, the scientists in agronomy are invited to offer efficient solutions. Even some parts of Europe have been affected by storms, heavy rains and floods, more and more areas from South and South-Eastern are under the desertification threat. High frequency of tropical days combined with long periods of drought pose serious challenges in front of local farmers and communities. The desertification index rises and the previsions for the next decades are extremely worrying. Three fruit species: Chinese jujube (*Ziziphus jujuba* Mill.), go ji (*Lycium* sp.) and fig (*Ficus carica* L.) are proposed for their high ecological adaptability, resilience to desertification, and for their well-known “Super Fruits” with nutraceutical properties. Besides the history, origin, cultivars and cultivation technologies, fruit quality and uses are presented, including the long research results in Romania.

**STUDIES TO IMPROVE HERBICIDE RESISTANT BREAD WHEAT (*Triticum aestivum* L) AND BARLEY (*Hordeum vulgare* L) VARIETIES AT TRAKYA REGION IN TÜRKİYE**

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This study was carried out to improve imidazolinone herbicide tolerant bread wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.) varieties lines at Trakya Region in Türkiye. Production of imidazolinone herbicide tolerant bread wheat and barley can help to control weeds more efficiently in wheat and barley fields and protect and barley from the residual effect from previous imidazolinone tolerant production system. The first crossing studies were made between local improved wheat varieties with introduced imidazolinone herbicide tolerant wheat varieties in 2011. Studies with mutation breeding to obtain imidazolinone herbicide tolerant wheat and barley lines was started in 2018. Ethyl methanesulfonate was used as a mutagen to obtain imidazolinone herbicide tolerant wheat and barley. Imidazolinone resistant barley lines was obtained from these studies but imidazolinone resistant any wheat plants were not improved. To improve imidazolinone herbicide tolerant wheat, crossing studies were continued. Modified bulk selection method was used during selection both barley and wheat imidazolinone herbicide tolerant breeding program. The selection continued until F6-F7 generation to obtain uniform lines. Promising imidazolinone herbicide tolerant wheat lines are tested in regional yield trial since 2017-2018 growing season, while imidazolinone herbicide tolerant barley lines are tested at F6 generation in 2024

**Key words:** *Imidazolinone, tolerant, wheat.*

**AN OVERVIEW OF AGRICULTURAL POLICIES IN WESTERN BALKAN COUNTRIES:  
CHALLENGES, OPPORTUNITIES AND PERSPECTIVES IN THE CONTEXT OF EU  
INTEGRATION AND SUSTAINABLE DEVELOPMENT**

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In the EU integration process, agriculture is regarded as one of the most important and challenging sectors due to the need to align with European standards and policies. This paper analyzes key aspects of the agricultural policies in Western Balkan countries, with a particular focus on the structure of budgetary support. The analysis uses the Agricultural Policy Measures (APM) approach and the OECD/PSE methodology, enabling a comparison of the estimated budgetary support for agricultural producers (PSEb) between Western Balkan countries and the European Union. The results indicate significant incompatibilities between the budgetary support systems of the region and the EU, as well as differences in the forms of providing such support.

An analysis of agricultural budget structures reveals that Western Balkan countries allocate the largest portion of funds to first-pillar measures—Market and Direct Producer Support, making their agricultural policies more oriented toward production and income support. Given the common priority of enhancing competitiveness and ensuring sustainable sector development, this paper identifies opportunities to reduce regional disparities and align more closely with EU standards through sustainable agriculture, effective utilization of IPARD funds, and the implementation of joint development initiatives.

**Key words:** *Western Balkan countries, agricultural policy, EU integration, budgetary support to agricultural producers*

**THE CZECH EXPERIENCE WITH THE COMMON AGRICULTURAL POLICY: IMPACTS ON  
FARMING AND EMERGING CHALLENGES**

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The contribution is focused on Czech experiences with EU accession for agrarian sector. The most important state from ten new member states in frame of the accession wave in 2004 was Poland, especially if we focus on agriculture. All the new member states got only 25 % of direct payments comparing to the old member states, the situation leveled off in 2013. Two years later in EU was introduced Greening – 30 % of direct payment was conditioned by the strict ecological rules, next ecological change took place in 2022. After EU accession the size of Czech agriculture decreased, decreased the self-sufficiency of food. On the other hand, the profitability increased mainly because of subsidies.

# SECTION 1

# PLANT PRODUCTION AND PROCESSING

## YIELD AND QUALITY OF RED PEPPER (*Capsicum annuum* L. var. *longum*) DEPENDING ON PRODUCTION METHODS

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The fruit of red peppers (*Capsicum annuum* L. var. *longum*) is consumed daily by a large portion of the global population in its fresh or processed state. Farmers aim to achieve the highest possible yield, while consumers seek the best quality of pepper fruit. Therefore, the aim of this research was to investigate a new production method for the red pepper (of the kapyia type) to achieve high yield and good quality. The experiment was set up in the Province of Vojvodina (Serbia) using a randomized block design with three replications. The following treatments were applied in this experiment: C: Transplanting seedlings of pepper (TSP) in single rows, as is standard in farmer practice (control); T1: TSP in double rows; T2: Direct sowing of pepper (DSP) in single rows; T3: DSP in double rows. The results showed that the highest weight of red fruit was observed in T3, while the lowest was in C. The greatest pericarp mass was recorded in T3, and the lowest in T1. The highest yield (total of three harvests) was in T2, while the lowest yield was in T3. The dry matter content of red fruits, depending on the method of direct seeding and transplanting, was ranked as  $T1 > (T2 = T3) > C$ . Based on the results of this study, it can be concluded that direct seeding in single-row and double-row arrangements could be recommended for the production of red peppers.

**Key words:** *Fruit, pepper, sowing, seedlings.*

## MORPHOLOGICAL CHARACTERISTICS OF PEPPER FRUIT IN RELATION TO FERTILIZATION AND PLANT SPACING

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In 2018, on an experimental field in Mali Idoš, Republic of Serbia, the influence of fertilization and plant spacing on the morphological characteristics of fruit in three pepper cultivars (Šorokšari, Amfora, Novosađanka) was studied. The experiment was conducted using a split-plot design with three replications on chernozem soil. The main plots included a control plot without fertilization and a plot with fertigation applied at N50P35K75 in five doses throughout the growing season. Subplots consisted of four plant spacing variants within rows of 15, 19, 25, and 36 cm, with a row spacing of 50 cm. On average, the thickest pericarp was recorded in the Novosađanka cultivar (7.52 mm) and the thinnest in the Šorokšari cultivar (4.57 mm). The application of fertigation increased pericarp thickness by 58.7% in the Amfora variety, 23.7% in Šorokšari, and 17.9% in Novosađanka. All pepper cultivars showed the thickest pericarp at a spacing of 50×36 cm, with a statistically significant difference compared to other spacing variants. The application of fertigation significantly increased pericarp weight in all three cultivars compared to the control. Comparing spacing averages, the highest pericarp weight was recorded at a spacing of 50×36 cm and the lowest at 50×19 cm. On average, the highest central placenta weight was observed in Amfora fruits (10.04 g), while the lowest (5.46 g) was in Šorokšari fruits. The application of fertigation significantly increased central placenta weight compared to the control. Based on one-year research results, it can be concluded that fertilizing peppers with N50P35K75 at a planting spacing of 50×36 cm positively influences the increase in pericarp thickness, pericarp weight, and central placenta weight.

**Key words:** *Plant spacing, fertigation, pericarp thickness, pericarp weight, central placenta weight.*

## ASSESSING MORPHOLOGICAL DIVERSITY OF MACEDONIAN COLLECTION OF LOCAL PEPPER LANDRACES

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The aim of this study was to evaluate the morphological diversity of a pepper collection from North Macedonia, consisting of 19 local landraces belonging to the *Capsicum annuum* group. The analysis was based on data collected for 13 qualitative and 16 quantitative morphometric traits. Principal Component Analysis (PCA) was conducted on the quantitative traits, with the first two principal components accounting for 52.2% of the total variability. The traits most strongly correlated with these components were pericarp thickness (PT), pedicel length (PL), fruit length (FL), plant width (PW), and fruit weight (FWg). Agglomerative hierarchical clustering (AHC) was performed using the traits with the highest correlations to the first two PCA axes, resulting in the classification of the accessions into three clusters. The first cluster grouped accessions with the highest fruit weight (FWg), fruit width (FW), and pericarp thickness (PT). The second cluster comprised four accessions with the smallest plant growth characteristics, including plant height (PH) and plant width (PW). The third cluster included accessions characterized by the greatest fruit length (FL), small fruit weight (FWg), and thin pericarps (PT). This initial assessment of the collection highlights significant variability among the accessions, offering a basis for further genetic and agronomic studies.

**Key words:** *pepper, local landraces, diversity, morphological traits*



## THE ROLE OF GRAFTING IN PLANT GROWTH OF TWO KAPYIA-TYPE CULTIVARS

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This study investigated the effects of grafting on plant growth development in two kapyia pepper cultivars, Ariadni F1 and Kaptur F1. A three-year experiment was conducted using three rootstocks: 'SM Tant' (*Capsicum annuum* x *C. chinense*), 'Vital Paprika' (*Capsicum annuum* x *C. chinense*), and '6210' (a cross of two pepper genotypes). All treatments were arranged in a randomized block design with four replications, under greenhouse and open-field conditions. Plant growth was evaluated every 10 days, beginning 15 days after transplanting and continuing until the onset of full harvest. Measurements included stem diameter below the first bifurcation. Data were analyzed using two-way ANOVA with repeated measures to assess the effects of grafting and the environment. Results showed that grafting combinations exhibited different growth rates after transplanting. The rootstock 'SM Tant' demonstrated the fastest and most consistent development from transplanting to ripening, supporting a favourable balance between vegetative and productive biomass.

**Key words:** *grafting, kapyia peppers, plant growth, stem diameter.*

## INVESTIGATION ON PEPPER SEED QUALITY PRODUCED UNDER DIFFERENT FERTILIZER AND TRICHODEMA TREATMENTS

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This study aimed to assess the seed quality characteristics of *Capsicum annuum* L. produced under three different fertilizer schemes and *Trichoderma harzianum* (TRICH) treatments. The experiment included three pepper varieties: Amfora, Sivria, and Vezan Lut. Key quality parameters, including moisture content, analytical purity, germination rate and absolute seed mass were evaluated. Seed analyses were performed at the Laboratory for Seed Testing at the Institute of Agriculture in Skopje. Pre-sowing and post-harvest evaluations were carried out to determine the qualitative status of the seeds and the effects of fertilization and *Trichoderma* treatment. The seed material was divided into two groups: untreated (TRICH/0) and treated with *Trichoderma* (TRICH/1). Separate analyses were conducted for each fertilization and treatment combination. The results revealed that fertilization schemes significantly influenced seed quality metrics across all cultivars. In both regions, the germination rates for Amfora and Sivria varieties without TRICH treatment (TRICH/0) ranged from 96.3% to 99.0%. However, in the Kochani region, varieties treated with *Trichoderma* (TRICH/1) exhibited slightly higher germination rates, ranging from 97.8% to 99.2%. For untreated seeds (TRICH/0) the 1,000-seed mass ranged from 6.72 to 7.25 g, while for treated seeds (TRICH/1) it ranged from 6.36 to 7.13 g. The Vezan Lut variety showed relatively lower germination rates (90% - 97.3%), likely due to its classification as a local landrace commonly cultivated by farmers.

**Key words:** *pepper seed, quality, germination*

## TECHNOLOGICAL SOLUTIONS FOR EXTENDING THE CROPPING PERIOD IN GREENHOUSES OF THE SOUTHEAST REGION

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This review, based on analysis of national statistics, relevant documents, and international best practices, identifies key issues in greenhouse production in the Southeast region. First, overlapping production cycles in glasshouses and PE tunnels create seasonal surpluses—up to 200 tons during peak seasons (May-June, September-November)—causing market saturation, reduced prices, and increased waste. Second, basic agricultural practices limit yield potential and shorten cropping seasons, indicating the need for modern techniques. Third, a lack of traceability and good agricultural practices (such as crop rotation) reduces yield and product quality, underscoring the importance of documented agricultural protocols. To address these challenges, we recommend implementing modern microclimate control systems that improve automation and resource efficiency, thus reducing operational costs. Advanced heating, cooling, and ventilation management decreases energy use and provides stable growing conditions, even in extreme weather, allowing for an extended cropping period. This would enable crop production beyond traditional seasons, boosting market potential and ensuring a consistent supply of fresh produce. In the Southeast region, where PE tunnel and outdoor production overlap, adopting these technologies would optimize timing between greenhouse and outdoor production. Additionally, returning cash crops like tomatoes, cucumbers, zucchini, and hot peppers to protected environments could enhance productivity and market quality, stabilizing the supply and economic returns for local producers.

**Key words:** *PE tunnels, tomato, pepper, cucumber.*

## TRADITIONAL USE OF *SIDERTIS SCARDICA* IN NORTH MACEDONIA

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The North Macedonia abounds with various medicinal plant species that, in addition to their medicinal effects, actively participate in everyday life, culinary and recreational use. Among the medicinal plant species, the Balkan endemic species *Sideritis scardica* has a special place. Wanting to preserve the traditional knowledge of *Sideritis scardica* from oblivion, the purpose of this research is to be recorded its use in everyday life, especially its traditional use. As a part of this research, an ethnobotanical survey was conducted in the period from June to September, 2024 in North Macedonia. 100 respondents from North Macedonia were interviewed, using structural designed questionnaire. Obtained results showed that the respondents are well acquainted with this plant and its performances and uses. For this species, the folk name Mountain tea is the most often used in our country. This plant is mostly used for the preparation of herbal tea. 80% of the informants practiced drinking this tea for recreational purpose, while 20% for medicinal reasons. Interviewed people prefer buying this plant rather than collecting it in nature. Mountain tea is mostly used to treat colds, as well as treatment of the urinary, digestive and respiratory systems. The knowledge we have about the use of plants in human life is mostly due to the transmission of information and experiences from older generations. Hence, it can be concluded that in order to avoid the loss of traditional knowledge, greater efforts are needed to preserve and archive the knowledge of use, not only for this plant but also for other medicinal plants.

**Key words:** *Sideritis scardica*, traditional use, ethnobotany.

## ANALYSIS OF WATER ABSORPTION CAPACITY OF *LOPHANTUS ANISATUS* BENTH. SEEDS FOR USE IN ALLELOPATHIC STUDIES

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The aim of the present study is to compare the water absorption capacity (Ws%) of luphant seeds (*Lophanthus anisatus* Benth.) with lettuce seeds (*Lactuca sativa* L.) - most often used as a test plant in screening laboratory studies to establish allelopathic interference in plant communities. It was established that the water absorption capacity (Ws %) of the seeds included in the study depends on the applied temperature range (15, 20 and 30° C), which is exponentially dependent on the duration of their exposure in water (h imbibition). Non-equivalent seed water absorption (Ws %) of *L. anisatus* (from compared to *L. sativa* seeds depending on the applied temperature range (15, 20 and 30° C) was related to key characteristics (maximum water absorption (h), cumulative values of water absorption capacity (Ws %) and water absorption rate (R – g absorbed H<sub>2</sub>O/h) that can be used in the development and performance of screening laboratory studies to establish allelopathic interference under in vitro conditions. Further research is needed to establish the water absorption capacity (Ws %) of *Lophanthus anisatus* Benth. seeds depending on the type of aqueous extracts used in allelopathic studies (cold or temperate) and application concentrations of weed species with proven allelopathic potential, as well as being able to identify and profile the specific allelopathic compounds in them.

**Key words:** water imbibition, soaking, seeds

## PLANT GENETIC RESOURCES AND MUTATION BREEDING

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Genetic resources for food and agriculture play an important role in conserving biodiversity and serve as valuable gene pool for the breeding activities. Particularly, plant genetic resources are mostly used as material for breeding programmes. Traditional breeding is requesting long periods of time to obtain the results. For that reason, during the last decades, mutation breeding increasingly takes place in these types of activities. Up to this point, in Bosnia and Herzegovina, this type of breeding has never been performed. First step in the mutation breeding has been done for the bean and wheat accessions from the Gene Bank of the Republic of Srpska. In the cooperation with International Atomic Energy Agency (IAEA), 6000 of wheat and common bean seeds has been irradiated. Bean seeds were irradiated with 80 Gy and 200 Gy, while wheat seeds were irradiated with 150 Gy, 200 Gy and 300 Gy. Germination of shown seeds were lower with higher irradiation treatment. Over the course of three years of research, the third mutant generations of the seeds were obtained. Some of the obtained seeds have expressed the phenotypic mutations that represent very important basis for the future research. These results represent the first and preliminary results of mutation breeding in the Bosnia and Herzegovina. Ongoing research will significantly advance the development of mutant lines, thereby ensuring enhancements in crop yield and quality.

**Key words:** *Common bean, wheat, germplasm, irradiation.*

## THE APPLICATION OF BIOSTIMULANTS IN THE PRODUCTION OF ORNAMENTAL PLANTS SEEDLINGS

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There has been extensive research aimed at identifying functional amendments to enhance plant growth, productivity, and quality, as well as to help plants cope with various environmental stresses. In organic agriculture, the use of chemical fertilizers and pesticides is limited, creating a demand for alternative plant amendments suitable for such practices. One promising, environmentally friendly innovation is the use of natural plant biostimulants, which provide a sustainable solution to this challenge. A biostimulant can be defined as any substance or mixture of substances of natural origin or microorganisms that improve crop conditions without causing harmful effects. These substances can be applied to leaves, seeds, or roots to stimulate natural plant defense processes and enhance nutrient use efficiency and tolerance to abiotic stress. In recent years, we have conducted extensive research on the application of various biostimulants in ornamental plant production. The evaluated biostimulants have demonstrated positive effects on vegetative growth, nutrient acquisition, antioxidative capacity, stress tolerance, and flower quality. Overall, the research suggests that biostimulant application could be beneficial in horticultural production, particularly under stressful growth conditions, such as reduced fertilization, especially nitrogen, or other forms of abiotic stress

**Key words:** *biostimulant, abiotic stress, flower plants.*

## THE INFLUENCE OF HYBRID VEGETATION LENGTH AND SOWING DENSITY ON MAIZE YIELD

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These researches were carried out in 2016 and 2017 on the territory of the municipality of Leskovac. The experiment included 6 maize hybrids different vegetation length (ZP 434, NS 4023, ZP 555, NS 5051, ZP 666, NS 6030) and 3 sowing densities (71428 plants per ha-1; 57142 plants per ha-1 and 47619 plants per ha-1). The experiment was set up according to the randomized block system in 3 replications. Differences in yield between hybrids with a shorter vegetation period, are less pronounced than in cases of hybrids with a longer vegetation period. The length of the growing season of hybrids influenced the differences in yield when different sowing densities were in question. Thus, in hybrids with shorter vegetation (ZP 434 and NS 4023), the highest average yield was in the case of the highest densities, while in hybrids with medium vegetation length (ZP 555 and NS 5051), there were no statistically significant differences in average yield between sowing densities. Hybrids with a longer vegetation period (ZP 666 and NS 6030) achieved the highest yields in the lowest and medium densities and they were significantly higher than the average yields achieved in the highest sowing densities. Considering that lately we have more and more dry years, it is necessary to grow hybrids with different length of vegetation, in order to make production safer. In addition, it is absolutely necessary to adapt the sowing density to the length of the hybrid vegetation.

**Key words:** *Maize, vegetation length, sowing density, yield.*



## MORPHOLOGICAL TRAITS AND IMPACT OF HARVEST TIME ON THE HEAD RICE (*Oryza sativa* L.) YIELD

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In this study 13 introduced genotypes were compared with two genotypes used as standards. Seven are Italian varieties, while six are Turkish. The experiment was conducted in 2022, using a randomized block design with 4 replications in Kochani rice production region. Examined parameters were: number and length of productive panicles/m<sup>2</sup>, grain yield/m<sup>2</sup>, 1000 grain mass, hectoliter mass and head rice yield from three consecutive harvest terms regarding seed moisture. The obtained results were processed and analyzed through variance analysis and tested with the LSD test. The variance analysis of the different genotypes for morphological and production traits showed that all genotypes have statistically significant differences for all examined properties. Genotypes 8 and 11 demonstrated the highest values for the number of productive panicles/m<sup>2</sup>, grain yield/m<sup>2</sup> and hectoliter mass but the lowest values for 1000 grain mass. Genotype 15 had the longest panicles and the greatest 1000 grain mass, but the lowest number of productive panicles/m<sup>2</sup>. Regarding the yield parameter all genotypes had the highest yield in the first harvest term while the yield decreased as the harvest time was extended. The highest head rice yield in the first harvest term recorded Genotype 1, while for the second and third harvest term showed Genotype 12. The lowest yield for all three harvest terms was noted in Genotype 9. Following the results, these examined genotypes can be included in breeding programs, as selection process plays a crucial role in enhancing of the genetic potential by introducing high-yielding and quality rice varieties.

**Key words:** *Head rice yield, grain yield, 1000 grain mass, productive panicles, panicle length.*

## EFFECTS OF CALCIUM SPRAYS ON YIELD AND GRAIN QUALITY OF MAIZE (*Zea mays* L.)

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This work aimed to evaluate the effect of calcium as the main component in foliar fertilizer Megagreen, on corn yield at hybrid ZP 677 (FAO 600) and Cu, Mn, Zn and Fe content in corn grain. The experiment has been designed by the method of random block system with four treatments (variants) and three repetitions. Treatments consisted three levels of the fertilizer with in a concentration of 0.3; 0.6 and 0.9 percent of fertilizer Megagreen and control variant (without fertilizing). The three concentrations of fertilizer were applied four times during the growing period, starting from the stage of 7-8 leaves (V7) in a intervals of 10-15 days. The experiment was carried out on experimental site with alluvial soil in Skopje region, during two years.

During the harvest, the samples of corn grain from each variant were collected for chemical analysis. The results showed that the highest yield (10.1 t/ha) had the variant treated with Megagreen in concentration of 0.6%, while the lowest yield was recorded at control variant (9.5 t/ha). The statistical analysis showed significant positive effect of foliar application in concentration of 0.9% on the content of Mn (5-6mg/kg) and Zn (22-26.33 mg/kg) in corn grain. The results revealed that foliar spray of Ca did not significantly affect the concentration of Fe (23.5-25.66 mg/kg) in the grain.

**Key words:** *Megagreen, fertilizer, spray, corn, grain.*

## **BALKAN AUTOCHTHONOUS SWEET CHERRY GENOTYPES – POTENTIAL FOR TEMPERATURE-ADAPTABLE REPRODUCTIVE BEHAVIOUR AND NUTRACEUTICAL VALUE**

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Sweet cherry (*Prunus avium* L.) is among the most popular temperate fruit crops, due to its attractive fruits, nutritional content and suitability for both fresh consumption and processing. Cherry fruits are a rich source of bioactive compounds and other substances with high antioxidant power, as well as neurochemicals (melatonin, serotonin), which especially refers to autochthonous genotypes. Although many sweet cherry breeding programmes are active worldwide, their genetic base remains quite narrow. Therefore, identifying and characterizing valuable, diverse resources is crucial to expanding the genetic pool for current and future programmes. Nowadays, sweet cherry production is directed towards the problems arising from climate change and demands for high-quality, healthy fruits. The reproductive phase is particularly sensitive to temperature stress, which during the blooming time has a detrimental effect on fruit set in commercial orchards. Within the CherrySeRB project, in which the Fruit Research Institute, Čačak is the leading institution among several partners, the focus is on characterization of the indigenous Balkan sweet cherry genotypes for desirable reproductive properties that can face warmer temperature conditions during the flowering. In that sense, the investigation of autochthonous sweet cherry genotypes originating from Serbia ('Canetova', 'G-2') and North Macedonia ('Ohridska Crna', 'Dolga Šiška') has significantly contributed to the characterization of Balkan cherry genetic resources. By combining interdisciplinary modern methodologies – molecular, biological, histological and nutritional, CherrySeRB connects production challenges arising from climate change and the richness of still underutilized Balkan cherry germplasm, which represents a novelty in the breeding approach applicable to other fruit species.

**Key words:** *P. avium*, Balkan, indigenous genotypes, reproductive characteristics, fruit quality

## EVALUATION OF FRUIT QUALITY AND SENSORY CHARACTERISTIC OF 18 CHERRIES CULTIVARS GROWN IN MACEDONIA

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The study aimed to evaluate the fruit quality and sensory characteristics of 18 cherry cultivars grown in Macedonia, focusing on their potential for both local consumption and commercial production. A total of 18 cherry cultivars, were selected from various growing regions of Macedonia. Parameters such as fruit size, color, firmness, soluble solids content (SSC), titratable acidity (TA), pH, and fruit weight were measured to assess the physical and chemical characteristics. In addition, a sensory evaluation was conducted with a panel of trained judges to assess attributes including taste, texture, aroma, and overall acceptance. The results showed significant variation among cultivars in both fruit quality and sensory attributes, with certain varieties exhibiting higher SSC and optimal balance between sweetness and acidity, making them particularly favorable for fresh consumption. Sensory analysis revealed preferences for cultivars with bigger fruits, higher sweetness and firmer textures, although certain cherry cultivars performed well in terms of aroma and overall flavor complexity. This study provides valuable insights into the potential of these cultivars for cultivation in Macedonia, contributing to the development of sustainable cherry production strategies and marketing approaches.

**Key words:** *Organoleptic evaluation, fruits characteristics, consumption needs.*

## PRIMARY EFFECTS OF GAMMA RADIATION (Cs137) ON THE LEAF GLANDS MORPHOLOGY AND LEAF TOOTHING AT SOME SWEET CHERRY VARIETIES

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The study has been conducted based on the presence of atypical leaf glands morphology, in relation to their shape, size, color and number, as well as atypical leaf tothing, as a primary effect product in the first MV1 generation after the gamma radiation with Cs137 on Bigareau Burlat, Pobeda Krimaska and Kozerska cherry varieties. The selected leaf radiomorphosys were used as conservative and accurate signs for early detection of somatic mutations caused by radiation. Dormant buds were exposed with dosages of 25Gy, 35Gy and 45Gy, and grafted onto Prunus mahaleb rootstock.

Gamma radiation caused average reduction of the size, as well as the appearance of new coloration types of the leaf glands in all of the tested varieties, compared to the controls. Leaves with an atypical shape of leaf glands were found in 37,4 % from the analyzed samples, with the highest representation at the dose of 45Gy, while those with an atypical number of leaf glands averaged 17,6 %, with the highest representation at the dose of 25Gy.

Atypical leaf tothing was observed in 14,0 % of the total analyzed leaves. The percentage is the highest for the dose of 45Gy (16,8 %) and for the variety Pobeda Krimaska (19,2 %).

**Key words:** *Prunus avium L., ionizing dosage, atypical leaf glands shape, size and color, atypical leaf margin.*

## APPLE CULTIVARS FROM FACULTY OF AGRICULTURE, UNIVERSITY OF NOVI SAD BREEDING PROGRAM

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The Ivana variety is the result of crossing between Starking and Bihorka varieties, while the Iskra variety originated from a hybrid combination between Prima and Bihorka. Both cultivars were recognized and registered in 2018. Cultivars Ivana and Iskra have medium vigor with a wide pyramidal crown. The most important characteristic of both cultivar is high tolerance to apple scab (*Venturia inaequalis*) and powdery mildew (*Podosphaera leucotricha*), which is attributed to the autochthonous Bihorka variety. Ivana had average fruit weight of 335g in 2024, with some fruits reaching up to 500 g. The fruit is slightly round-flattened, with a yellow-green ground color and 70% covered with bright red uniform blush without russeting. Iskra had average fruit weight of 170g in 2024. The fruit is round-flattened, with a yellow-green ground color completely covered by bright red blush without russeting. The flesh of both varieties is cream-colored, with a sweet-tart flavor, aromatic, and very pleasant to eat. Ivana ripens in the first decade of August while Iskra ripens in the middle of the third decade of August. Both apple varieties are highly tolerant to economically significant diseases and are recommended for cultivation, even under organic production conditions.

**Key words:** *Autochthonous cultivar, tolerance, breeding, organic production*

## ORGANOLEPTIC CHARACTERISTICS IN SOME INTRODUCED STRAWBERRY VARIETIES (*Fragaria ananassa* Duch.) IN THE SKOPJE REGION

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The study presents the results of the investigation on organoleptic characteristics of fifteen strawberry varieties: Idea, Camarosa, Belrubi, Evita, Honeoye, Tethis, Chandler, Onda, Miranda, Paros, Elsanta, Eris, Madeleine, Favette and Marmolada, as well as two standard varieties: Pocahontas and Senga Sengana.

The experimental orchard was performed on open field in the Institute of Agriculture –Skopje, on black polyethylene foil in form of double file set on banks and at the distance of 40x30cm between the plants, irrigated by control drip irrigation system.

This study covers the external and internal qualitative characteristics of the fruit and the possibility of separating the stalk from the fruit. The external characteristics that were examined are: appearance, size, shape and skin color attractiveness. The internal characteristics that were examined include: taste, aroma, consistency, flesh color and the size of the internal cavity.

All properties are rated on a scale of 1-5.

Strawberry varieties are ranked according to their general assessment of the above-mentioned qualitative characteristics.

The varieties Marmolada, Belrubi and Tethis have the highest general grade (4.0), and the Chandler and Onda varieties have the lowest general grade (3.1).

**Key words:** *External characteristics, internal characteristics, quality, ranking, strawberry varieties.*

## **NUTRITIONAL COMPOSITION AND HEALTH BENEFITS OF WALNUT FRUIT (*Juglans regia*): A COMPREHENSIVE REVIEW**

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Walnut fruit (*Juglans regia*) is a nutrient-dense food with a broad spectrum of bioactive compounds, making it a valuable dietary component for promoting health and preventing disease. Walnuts are particularly rich in polyunsaturated fatty acids (PUFAs), with omega-3 alpha-linolenic acid (ALA) being a standout constituent, known for its cardiovascular benefits. Studies indicate that regular walnut consumption can reduce LDL cholesterol and improve endothelial function, contributing to a lower risk of heart disease. In addition to fats, walnuts provide significant amounts of protein, dietary fiber, and essential micronutrients such as magnesium, copper, and vitamin E, which are crucial for overall metabolic health.

Walnuts also boast high antioxidant activity, primarily due to their polyphenolic compounds, which have been shown to reduce oxidative stress and inflammation, factors linked to chronic conditions like cancer, diabetes, and neurodegenerative diseases. Recent research suggests walnuts may support cognitive health, with potential neuroprotective effects that help preserve memory and cognitive function, particularly in aging populations.

In our review we present detailed data on the nutritional profile of walnuts, discussing their major bioactive compounds and health benefits. We also present data on their role in reducing the risk of cardiovascular disease, improving metabolic markers, and promoting brain health.

**Key words:** *Polyunsaturated fatty acids, omega-3 alpha-linolenic acid, cognitive health, antioxidant activity, cognitive health*



## NUTRITIONAL VALUE OF SWEET CHESTNUT FRUITS AND HEALTH BENEFITS OF THEIR CONSUMPTION: A REVIEW

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Sweet chestnut (*Castanea sativa* Mill.), native to Europe and widely cultivated in Mediterranean regions, has long been recognized for the unique nutritional profile of its fruits, for which they are considered as an important food source. These fruits are rich in carbohydrates, particularly starch, making them a valuable source of energy. Unlike most other nuts, chestnuts are relatively low in fats predominantly composed of unsaturated fatty acids, contributing to cardiovascular health benefits. They have (a low) protein content but are notable for their content of essential vitamins and minerals, including vitamin C, potassium, and magnesium. Their composition also includes dietary fiber, which plays a key role in promoting digestive health. The fruits also provide a rich source of bioactive compounds, including phenolic acids, flavonoids, and other antioxidants, which have been linked to various health-promoting properties such as anti-inflammatory and cardio protective effects. Their glycemic index is lower than other starchy foods, making chestnuts a suitable choice for individuals managing blood sugar levels. This review highlights the nutritional value of sweet chestnuts, emphasizing their role not only as a dietary staple in traditional diets but also as a functional food with potential health benefits. The increased interest in chestnut cultivation and consumption, driven by their unique nutritional properties, underscores the importance of further research into their bioactive compounds and potential uses in modern nutrition.

**Key words:** *Castanea sativa, Carbohydrate content, starch, fatty acids, dietary fiber*

## INFLUENCE OF SOME MYCORRHIZAL PRODUCTS ON VINE PLANTING MATERIAL PRODUCTION

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During the period 2018 - 2020, a field trial was carried out to establish the influence of some mycorrhizal products (Rhizo vam basic and Dynocarb MYC) on the quantity and quality of standard vine planting material obtained from Cabernet Sauvignon variety grafted to Berlandieri X Riparia SO4 rootstock. Rhizo vam basic was applied in two ways - by mixing the particles with the soil during the bed formation (dose 0.2 l/m<sup>2</sup>) and introducing the product directly to the root formation area (dose 0.005l per cutting). Dynocarb MYC was applied through the irrigation water by means of the drip irrigation system. The variants were set in beds without mulching the surface with polyethylene film. The dynamics of shoot growth was monitored and the ratio of standard rooted vines was reported. An analysis was made of the biometric indicators characterizing their habitus. The application of the mycorrhizal product Rhizo vam basic resulted in increase in the yield and quality of the vine planting material as the effect was more significant when the carrier clay particles were evenly mixed in the cultivated soil layer during the bed formation. Dynocarb MYC stimulated shoot growth and the formation of mature growth with greater length and mass, but no significant increase in the ratio of standard rooted vines was found after triple treatment with the product.

**Key words:** *Vine, planting material, mycorrhiza, growth.*

**STUDY OF THE INFLUENCE OF GREEN PRUNING OPERATIONS ON THE RATE OF MATURATION AND STRENGTH OF GROWTH OF SUMMER PLANTS IN THE VARIETY MUSKET KAILASKI**

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The study was conducted at the Experimental Base of the Institute of Viticulture and Enology - Pleven during the period 2017 - 2020. The influence of some basic green pruning operations on the degree of ripening and the strength of growth of the shoots of the Misket kailashki variety was studied. It was established that the vines without applied green pruning operations and those with thinning of the clusters and lightening in the zone of the clusters are characterized by a stronger growth, as in all reported indicators - average length of one shoot, average length and thickness of one internode and mass of a one-year mature growth, the differences compared to the variants with performed crushing are mathematically proven. On the other hand, following the same trend, the growth strength of the vines in all variants was significantly greater during the wetter and cooler years 2017 and 2020 and significantly less during the medium-dry and very hot vegetation of 2019. In terms of length of the mature part of the shoot and the percentage of the mature part in relation to the total length of the shoot, determining the degree of maturation of the shoots, the opposite trend is observed in the values of the reported indicators. Pruning, like green pruning, contributes to better shoot maturation, with the highest values measured in the dry and hot climate of 2019.

**Key words:** *Vine, green prunings, degree of ripening, growth vigor, one-year mature growth, variety Misquet Kailashki.*

## PRODUCTIVE AND UVOLOGICAL CHARACTERISTICS OF RESISTANT TABLE CULTIVARS NADA AND LJANA

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Table grapes yields depend greatly on cultivation and climatic conditions but also vary from one variety to another. This paper summarize productive (in 2024) and uvological characteristics (in 2023 and 2024) of table cultivars Nada and Ljana in Fruška Gora wine region. Nada is seedless and fungus tolerant cultivar with rose berries released in Sremski Karlovci; Ljana is also tolerant cultivar with green-yellow berries originated from Moldova. Vines were planted in 2009, Guyot pruned and plant density was 2.7 x 1m. There was no difference in cluster weight between the cultivars, but Ljana had higher number of clusters per vine and thus higher yield. Nada had higher both, sugar and acids in the grape must compared to Ljana. Ljana had significantly higher berry weight compared to Nada (3,29 and 1,48 g, respectively). Larger berries of both Nada and Ljana had higher berry firmness compared to smaller berries. Both varieties showed some positive characteristics and Ljana could be recommend for table grape production in Fruška Gora while Nada should included some treatments in the field such as irrigation or plant hormone application to increase berry size.

**Key words:** *Nada, Ljana, yield, cluster, berry, sugar, firmness.*

## AMPELOGRAPHIC CHARACTERISTICS OF SEEDLING CLUSTERS OF THE BLATINA VARIETY – PRELIMINARY RESULTS

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Blatina, as an indigenous grapevine variety of Bosnia and Herzegovina, possesses good traits of yield, grape quality, and wine quality, but with the disadvantage of a female flower type. To obtain progeny with hermaphroditic flowers, controlled hybridization of the Blatina variety was carried out during the 2016-2017 period, using pollen from the Vranac, Žilavka, Trnjak, and Alicante Bouschet varieties. In 2018, many seedlings from different combinations were obtained, including a smaller number with hermaphroditic flowers (total number of seedlings/seedlings with hermaphroditic flowers): Blatina x Vranac – 120/11; Blatina x Trnjak – 100/7; Blatina x Žilavka – 120/4, and Blatina x Alicante Bouschet – 40/3. The aim of this study is to analyze the characteristics of seedling clusters obtained from these crossing combinations in their third year of growth. The experimental vineyard with the seedlings was established in the spring of 2020 at the Experimental-Educational Center of the Faculty of Agriculture in Aleksandrovac (Laktaši). During September 2023, at the time of optimal ripeness, grape samples were collected, and the ampelographic characteristics of the clusters were analyzed in the Laboratory for Ampelography and Winemaking at the Faculty of Agriculture, University of Banja Luka. The analysis of the economic and technological characteristics of the seedlings was conducted by examining the basic characteristics of the grapes (mechanical composition of the cluster and berry) and the quality of the grape juice (sugar and acid content). Cluster weight ranged from 178.8 to 339.8g, and the number of berries per cluster ranged from 87 to 159. Sugar content, depending on the crossing combination, ranged from 19.4 to 22.5 °Brix. The research results and conclusions represent preliminary studies, which will continue with the aim of selecting significant seedlings, their propagation, and further evaluation to obtain a new genotype.

**Key words:** *Hybridization, Pollinator, Seedling, Quality.*

## THE EFFECT OF DIFFERENT TRAINING SYSTEM ON BERRY COMPOSITION IN CABERNET SAUVIGNON GRAPEVINE VARIETY (*Vitis vinifera* L.)

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Grapevine training systems are essential for managing the growth, productivity and quality of the vine and its grape. A training system is a structure or method used to support grapevines and manage their growth by positioning the shoots, leaves and grape. The effects of different training system on berry composition in Cabernet Sauvignon grapevines were studied during the 2024 growing season in the Kratovo vine district area. The two different training system were compared: Double Guyot (DG) and Double Cordon (DC). The following parameters of berry were measured: weight of 100 berries, weight of skin, total soluble solids, content of total acid in the must, pH of the must, total anthocyanins, total flavan-3-ols and total phenols. The results showed that different training system had an impact on quality grape parameters (technological and phenolic): weight of berries, weight of berry skin, total soluble solids and total anthocyanins, total flavan-3-ols and total phenols. The DG -treated vines had higher berry weight, weight of skin, total soluble solids and extractable anthocyanin and polyphenol content, while those in the DC treated vines.

**Key words:** *Cabernet sauvignon, training system, berry composition.*

**APPLICATION OF INNOVATIVE CYTOGENETIC METHODS FOR PROVING THE AUTHENTICITY OF SOME REGIONAL GRAPEVINE VARIETIES (*Vitis vinifera* L.)**

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In our research, several innovative cytogenetic methods and techniques have been developed, which are applied in the analysis of some autochthonous and regional grape varieties in the Republic of North Macedonia. These cytogenetic methods are included in the list of descriptors according to the OIV and are open to further addition and reformulation with other new scientific methods in the field. These methods include: examinations of chromosomes (chromosomal package - length, width, number of chromosomes, karyotype and karyogram), ploidy level, pollen viability, meiosis chromosome associations - metaphase I, cytological characters - e.g. stomata density and size, identified genes - describe any known specific mutant present in the accession, analyzing the genomic map, etc.

The aim of the examination is to observe and compare some genetic predispositions and characteristics at the cellular level and to predict some anomalies that can be used in a positive direction in the future (for example polyploidy, some aberrations in the construction of chromosomes, etc.). Cytogenetic tests are also important for analyzing groups of properties that will contribute to proving the authenticity and similarity of the varieties and their grouping according to parents and centers of origin in certain groups - for example the Black Sea group of varieties (Convarietas pontica, subconvarietas balcanica), eastern varieties (Convarietas orientalis, subconvarietas antasiatica) and others.

Specifically, the main goal is to determine certain characteristics and features that contribute to grouping varieties according to similarity and their mutual origin.

**Key words:** *cytogenetic, chromosomes, varieties, authenticity, meiosis, origin*

## **ANALYSIS OF GENOTYPIC AND PHENOTYPIC VARIABILITY IN THE VARIETY AFUS ALI AS A POSSIBILITY FOR THE CREATION OF ITS CLONES**

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The Afus Ali variety has been cultivated for many years, in some commercial and individual plantations, in several wine-growing regions in our country. It is a variety originating from the Middle East and was obtained by natural hybridization between table varieties from the eastern geographical group. From there it was transferred to other wine-growing countries in the world. According to the ecological-geographical classification, it belongs to the group *Convarietas orientalis*, *subconvarietas antasiatica*. It is one of the most widespread table varieties in the world. Since, scientific research in the world is moving towards obtaining superior table varieties (attractive, resistant, with excellent flavors, with stable biological properties, etc.), it is necessary to work on its refinement and improvement. That's why in our long-term studies we saw the possibilities of using its genetic capacity and analyzed the genotypic and phenotypic variability. In this context, analyzes of the genetic material at the cellular level (somatic and sex chromosomes, nucleus, DNA) were performed, where some possible changes were observed and monitored. Some changes in the phenotype (shape, size and color of the grain, shape of the cluster, percentage of fertilization and phenophase - epoch of ripening) were also analyzed. Changes in the shape of the grains were registered in individual plants, they were marked, the changes were observed and through selection, material was taken for propagation in the following years. For now, in our country and in the world, it is assumed that at least 3 improved clones of this variety can be distinguished.

**Key words:** *hybridization, genotype, phenotype, clone, selection*



## CHEMICAL COMPOSITION OF JUICE AND MADZUN (GRAPE MOLASSES) PRODUCED FROM STANUSHINA GRAPE VARIETY BY TRADITIONAL MEANS

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The main goal of this study was determination of 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 R. N. Macedonia in the past decade and mostly in Eastren Mediterranean countries. These products are important dietary food for humans in terms of minerals content and high energy content (carbohydrates). Comparative analyses have been conducted to one sample juice (S1) and two samples madzun (S2, S3). From the conducted analyses, following data have been obtained: soluble dry matter ranges from 29.41 (juice) to 82.98% (madzun); the total sugar content ranges from 28.04 (juice) to 67.99% (madzun); the total phenols content ranges from 875 (madzun) to 1212 mg/L (juice). The content of hydroxymethyl furfural (HDM) was determined in the range of 5.25 mg/kg (juice) to 723.05 mg/kg (madzun). In the analyzed samples, the content of macro minerals K, Ca and Mg are ranged from 386-640 mg/kg (S1)- 111.7-375 mg/kg (S3), 111.7 mg/kg (S3) –375 mg/kg (S1) and 205.5 mg/kg (S2)-297 mg/kg (S1). For the content of the microminerals following data have been obtained: Fe content ranges from 11.26 to 15.18 mg/kg, Mn content ranges from 2.42 to 4.90 mg/kg, Zn content ranges from 7.34 to 17.47 mg/kg, B content ranges from 35.2 to 39.9 mg/kg and Ba content ranges from 0.35-0.84 mg/kg. Regarding the content of heavy metals (Pb and Ni), sample C1 and C2 are above the permissible limits for this type of food. Due to the obtained data, the content of the minerals in grapes, mainly is influenced by the lithogenic distribution of the minerals in the geographical microregion.

**Key words:** Grape juice, madzun (grape molasses), chemical composition, minerals.

## FLAVONOIDS AND NONFLAVONOIDS PROFILE OF KRATOŠIJA WINES DETERMINED

BY HPLC- ESI-Q TRAP-MS/MS

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In this study, flavonoids and nonflavonoids have been determined in Kratošija wines produced by inoculation of two commercial yeasts (Zymaflore™ Xpure (Laffort) and Lalvin ICV D80 (Lallemand)). Analyses have been performed by high performance liquid chromatography (HPLC) coupled to tandem mass spectroscopy (MS/MS) operated in electrospray ionization (ESI) and quadrupole linear ion trap (Q TRAP) negative mode using a Phenomenex Luna C18(2) column (3 μm, 100 Å, 100 x 2 mm), with flow rate at 0.2 mL/min and column temperature at 30°C. The gradient elution was composed of 8 mM formic acid in water (eluent A) at pH 2.8 and acetonitrile (eluent B). A total of 27 phenolic compounds, including 13 nonflavonoids (10 phenolic acids, 2 stilbenes and 1 stilbenoid) and 14 flavonoids (6 flavan-3-ols, 4 flavonols, 2 flavones, 1 flavanone and 1 flavanone) have been determined. Gallic acid was the dominant phenolic acid, followed by p-coumaric and syringic acids. Resveratrol-3-glucoside (piceid) was present in highest amount compared to resveratrol and viniferin. From the group of flavonols, myricetin was the dominant component and from flavan-3-ols, procyanidins B1 and B3 dominated in wine. Concerning the effect of yeasts, it was found that flavan-3-ols were present in higher content in the wine fermented with Lalvin ICV D80, as it was expected since this yeast influence on intense fine grain tannins, while wine fermented with Zymaflore Xpure presented higher content of the other phenolic compounds. Flavones chrysin and luteolin, flavanone naringenin and flavanone taxifolin were reported for the first time in Macedonian red wine.

**Key words:** *Flavonoids, nonflavonoids, yeast, HPLC- ESI-MS/MS, Kratošija wine.*

## DETERMINATION OF FREE HYDROCYANIC ACID IN FRUIT BRANDIES PRODUCED UNDER INDUSTRIAL AND HOMEMADE CONDITIONS

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Fruit brandy is a traditional alcoholic drink in the Republic of N. Macedonia, but also in other Balkan countries. The presence of free hydrocyanic acid in fruit brandies is a significant due to its toxicological effects on human health. HCN is a natural byproduct of fermentation and distillation processes, especially in fruit brandies produced from stone fruits (apples, cherries, plums) that contain cyanogenic glycosides. The determination of free hydrocyanic acid levels in fruit brandies is crucial for ensuring consumer safety and compliance with regulatory standards. In this study, the content of free hydrocyanic acid was determined in 10 homemade samples of fruit brandies and 10 samples of fruit brandies produced in industrial conditions (rectification column) in order to determine safety for consumption. The free HCN content was determined spectrophotometrically using a pyridine-pyrazolon reagent. From the obtained results it can be observed that the content of free hydrocyanic acid depends on the type of fruit (stone fruit or seed fruit), the type of fermentation, the contact time between the seed and the pulp during the fermentation as well as the distillation process. The content of free HCN in brandies produced in homemade conditions showed higher values (mean value 9,345 µg/L), compared to brandies produced in industrial conditions (mean value 0.098 µg/L). It was also observed that all brandies contained free hydrocyanic acid below the maximum allowed limit (< 70 µg/L) and were safe for consumption.

**Key words:** *Fruit brandies, free hydrocyanic acid, spectrophotometry.*

## AROMATIC AND ORGANOLEPTIC PROFILE OF WHITE WINES AGED IN OAK BARRELS

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A study was carried out on the influence of oak wood on the volatile aromatic and organoleptic profile of white wines. The study was focused on three white dry wines, purchased from the commercial network, from different producers and regions of Bulgaria. All samples were aged in barrels of various wood and different duration of contact. The studied wines showed a complex and diverse volatile composition and tasting properties due to the varietal features of the grapes, the soil and climatic conditions of the vintage and the region, the specific influence of the used method of contact with the wood. Riesling, 2021 vintage was found to have the highest ratio of total volatile compounds, total higher alcohols and terpenes. High levels of total esters were identified in Chardonnay, 2020 vintage. Main quantitatively dominant higher alcohols were 2-methyl-1-butanol, 3-methyl-1-butanol and 1-propanol, while esters were represented by ethyl acetate and isopropyl acetate. The aldehyde fraction was dominated by acetaldehyde in concentrations that positively affected fruit sensory. The terpenes linalool and geraniol were found in two of the studied wines – Riesling (2021) and Chardonnay (2020). Methanol was identified in all samples, with levels well below the acceptable threshold for white wines. The tested samples had different organoleptic characteristics in terms of color, aroma and taste, due to the diverse type and quantity of oak wood used, as well as the duration of the contact.

**Key words:** *White wine, oak wood, volatile composition, organoleptic characteristics.*

**AROMATIC PROFILE OF WINE RECEIVED FROM THE NEWLY INTRODUCED VARIETY REBO  
(*Vitis vinifera* L.)**

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One of the most important characteristic of wine is aromatic profile, composed of a huge number of aromatic components, mainly divided into several groups: alcohols, esters, terpenes, fatty acids, aldehydes and ketones. The aromatic components obtained from the gas chromatographic analysis in this investigation are divided into three groups: alcohols, esters and acids. The following components were identified from the group of higher alcohols: 1-butanol; 2,2 dimethyl-1-propanol; 3-methyl-1-pentanol; 1-hexanol; 3-hexanol; 3-methylthiol-1-propanol; 2,3-butanediol; phenyl ethanol; benzyl alcohol. Among them, 2-phenyl ethanol and benzyl alcohol stand out as aromatic components with a fairly high detected concentration and a low sensory threshold of perception. The aim of this research is determination of aromatic components in newly introduced grape variety Rebo, that originates from Trentino – Alto Adige, North Italy and it is obtained as a result of crossing the varieties Merlot and Teroldego, by the researcher Rebo Rigotti. It is grown on terroirs with higher altitude and characterized by good resistance to low temperatures. The purpose of the research is to give an expert opinion on the wine quality of the Rebo variety, grown in Macedonian agro-ecological conditions. The vineyard for this investigation is located in the north part of Macedonia on the mountain German near the town of Kriva Palanka area typical for growing frost resistant varieties. The research focuses on comparing the aromatic profile of wines, following by sensorial analysis, using commercial lactic acid bacteria of the species of the species *Oenococcus oeni* (Lavin PN4) and *Lactobacillus plantarum* (Lavin ML – PRIME).

**Key words:** *Rebo*, *Rebo Rigotti*, *Oenococcus oeni*, *Lactobacillus plantarum*.

## SECTION 2

# SUSTAINABLE AND PRECISION AGRICULTURE

## STATUS AND VISIONS FOR THE DEVELOPMENT OF ORGANIC PRODUCTION IN RN MACEDONIA

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In May 2020, the European Commission published its 'Farm to Fork' strategy – 'for a fair, healthy and environmentally friendly food system' – along with the EU biodiversity strategy, where 25 % of the EU's agricultural land should be under organic farming by 2030. Although some of the EU countries even now have exceeded or are quite close to the specified percentage (Liechtenstein, Austria and Estonia), the plan is quite ambitious and means that by 2030 the EU should triple its organic land area (compare with 2019), increase its overall CAP expenditure 3-5-fold by 2030, and dedicate 9-15% of the CAP budget to organic (instead of 1.8% as it now and the 5% forecasted for period 2023-2027). In RN Macedonia, organic farming represents just 0.83% of total arable land, according to 2023 data from the State Statistical Office — well below the 2% target set by the National Strategy for Agriculture and Rural Development (2021-2027), and the 4% envisioned in the National Plan for Organic Production (2013-2020). Between 2015 and 2023, expenditure on organic production subsidies totaled €12.3 million, ranging from €520,000 (0.4%) in 2015 to €1.68 million (1.2%) in 2023, out of the total agricultural policy budgetary transfers. To meet at least 2% organic arable land goal by 2027, significant reforms are necessary. These include increasing farm productivity, expanding market development, improving certification and control mechanisms, adopting scientific approaches, fostering technical support and innovation, boosting political backing and subsidies, and enhancing national and international cooperation. If these measures are properly coordinated and implemented, the country can achieve its organic farming objectives.

**Key words:** *Organic, productivity, education, cooperation, market.*

## IMPLEMENTING GOOD AGRICULTURAL PRACTICES IN MUSHROOM CULTIVATION IN NORTH MACEDONIA

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Good Agricultural Practices (GAP) in mushroom cultivation emphasize sustainable and efficient methods that promote healthy, high-quality yields. By properly implementing GAP, producers can reduce the risk of contamination, enhance food safety, and protect the environment through comprehensive soil and water management. To maintain the effectiveness of GAP, it is essential to review the results of these practices annually. This ongoing evaluation allows for continuously updating plans and procedures, ensuring alignment with the latest agricultural standards. Key aspects of good agricultural practices in mushroom cultivation include the selection and reception of quality raw materials, proper pasteurization temperatures, optimal incubation and fruiting conditions, and rigorous hygiene protocols throughout the process. It is crucial to prepare detailed procedures and record sheets for each critical control point, which should always be readily accessible. Additionally, the paper addresses the utilization of spent substrate after mushroom harvesting. This substrate not only serves as an excellent base for vermicomposting but can also enrich the soil, be used as firewood, and serve as a component in growing substrates in horticulture. Implementing Good Agricultural Practices facilitates traceability and control throughout all cultivation stages, enhancing competitiveness and sustainability in the mushroom cultivation sector.

**Key words:** *GAP, circular economy, spent substrate, sustainable agriculture.*



## VALORIZATION OF ONION SKIN WASTE FOR BIOACTIVE COMPOUNDS

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Annually, approximately 47 million tons of onions are produced worldwide, generating significant biowaste. About 37% of fresh onions are discarded during industrial processing, primarily as onion skins and peels. These skins are a valuable agricultural by-product rich in bioactive compounds, making them beneficial in various sectors, including agriculture, the food industry, and bioplastics. They contain high levels of flavonoids and antioxidants, particularly quercetin, which can enhance soil health when composted or used as organic fertilizers, thereby promoting sustainable agricultural practices. This study aims to optimize extraction methods for bioactive compounds from onion skins and evaluate their potential applications in food, bioplastics, and agricultural biostimulants. Various extraction techniques were employed to identify the most effective method for extracting bioactive compounds using solvents such as ethanol, methanol, and water. Ultrasound-assisted extraction was utilized to enhance the release of these compounds and compare its efficiency with traditional methods like maceration and Soxhlet extraction. Characterization of the extracted components was conducted using FTIR spectroscopy to identify major bioactive compounds based on functional groups. The findings provide a comprehensive understanding of the multifaceted applications of onion skins, emphasizing their role as a sustainable resource rich in bioactive compounds with potential benefits across health, agriculture, and industry. By repurposing onion skins in these applications, agricultural waste can be minimized, contributing to a more sustainable and circular economy.

**Key words:** *Bio waste, onion skin, extraction, waste management.*

## BIOMASS AGRICULTURAL WASTE FOR PRODUCTION OF SECOND GENERATION ETHANOL

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The bioeconomy in Europe is consistently pushing towards an industrial, economic, and social increase of sustainable agricultural feedstocks as a replacement for fossil-based materials, whether it is a crude oil or polymers. This has led to an immediate and trending need for locally produced industrial crops, with wide applications and broad suitability to different pedo-climates. Furthermore, strict European laws prioritize production of industrial crops as sustainable feedstock which are not competing with food ones, with focus on possibility to grow them on marginal land. One of the most promising biomass sustainable feedstock is lignocellulosic material since it is a natural and renewable resource that is eligible as a raw material that can be used in biorefinery. In agricultural activities, lignocellulosic material is produced in an enormous amount as waste by-product. Nowadays, lignocellulosic biomass residues has attracted the attention of researchers because of its renewable nature and because significant reduction of CO<sub>2</sub> emissions can be achieved. The huge amounts of lignocellulosic biomass residues can potentially be converted into different high value products including bio-fuels such as bioethanol, value added fine chemicals, polymers and cheap energy sources for different purposes. It represents a feasible alternative source of sugars (which can serve as a replacement of starch and sugar feedstock), it is abundant and it doesn't compete with food production and last but not the least, it represents a low-cost feedstock.

**Key words:** *By-products, agro-waste, circular economy, bioethanol, biomass processing.*

## **BINDING THE CIRCLE: WASTEWATER TREATMENT BY USING WASTE**

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Industrialization has led to vast advantages such as an increased productivity, lower product cost and rapid evolution. However, the global energy used for industrial purposes caused high energy consumption, increased emission of greenhouse gasses, climate change, water pollution, thermal pollution and solid waste disposal. The generated waste poses a threat to the environment, so new green techniques are developed constantly. Waste valorization is one of the trending concepts that is a part of sustainability strategies that lead to reduction of CO<sub>2</sub> emissions. Among wastes that can be value added products is waste from potato processing. Potato exploitation due to mass production of chips, hash browns, frozen food and starch leads to a formation of high waste load. There are several available ways for potato peel valorization: as a biofertilizer, as a substrate for microbial growth, as an adsorbent, for extraction of antioxidants and for extraction of enzymes. One of the enzymes that are abundant in potato peel is peroxidase. This enzyme is well known for its oxidizing properties, and it can be used for wastewater treatment for decolorization of dyes, and for polymerization of toxic phenols which can be also found in wastewater. Using enzymes isolated from potato waste for treatment of another waste provides effective waste management and fits in the concept of circular economy.

**Key words:** *Potato peel, peroxidase, dye biodegradation, wastewater treatment.*

## THIRTY YEARS OF GENETIC MODIFICATIONS IN AGRICULTURE - WHAT'S NEXT?

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When the first genetically modified agricultural crop was created in 1994 (the Flavr-Savr tomato with an extended ripening time), despite its short history, no one could even guess in which direction genetic modifications in agriculture would take place. In the past three decades, humanity has witnessed many interventions in the genomes of agricultural crops that have created tolerance to herbicides, resistance to viruses, bacteria, fungi and insects, improved nutritional characteristics, etc. In the meantime, instead of single modifications, approaches were taken to modify agricultural crops and produce GM food by introducing more genes through the so-called stuck genes. Also, in the last decade, the so-called CRISPR technology in genetic engineering was widely applied, which ultimate goal is editing in genomes, in terms of activating or deactivating certain genes. In parallel with the application of genetic modifications in agriculture, an efficient system for the identification and monitoring of GMOs was established. On the other hand, the application of genetic modifications has not yet achieved the expectations in creating agricultural crops adaptable to extreme conditions (drought, low temperatures, salty soils, etc.), in the production of so-called edible vaccines, as well as in mass application of GM agricultural crops in the phytoremediation of contaminated soils. At the moment in the world, GM crops are grown on over 200 million hectares, while in Macedonia the production of genetically modified agricultural crops has not yet started. The hope remains that in the coming period, the efforts of the research teams will be intensified in the areas in which the expected progress has not been achieved so far.

**Key words:** *GMO, agriculture, achievements, perspectives.*

# SECTION 3

# PLANT PROTECTION

## OCCURRENCE OF PATHOGENS ON SEED WHEAT IN REPUBLIC OF SRPSKA

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Production of seed wheat in the Republic of Srpska is conducted by two institutions and plays an important role in the agriculture sector. The seed wheat produced in Republic of Srpska is subject to quality control according to the domestic standards. However, there are many pathogens that could affect the seed quality and quantity where the most dominant are fungal. In surveys of seed wheat conducted in June 2024 in two locations of the seed wheat production sites (Laktasi-Mahovljani and Bijeljina) in fields *Fusarium* head blight like symptoms were observed with evident epidemic (30% incidence) in two varieties Nova Bosanka (Laktasi) and Renesansa (Bijeljina). Moreover, on Nova Bosanka and Julija varieties from Laktasi symptoms of leaf and stem rust were abundant. Identifying symptoms were dusty, orange fruiting bodies that were appeared on the leaf surface and stem. In the laboratory, microscopic observation revealed presence of oval-shape uredinospores about 20 micrometers in diameter specific for those of *Puccinia graminis*. Additionally, symptomatic spikelets from each spike were excised and surface-sterilized prior to placing individual florets on potato dextrose agar (PDA) plates. Two isolates (FREN and FNBO) were selected for DNA extraction and later PCR amplification of protein coding TEF 1-alpha gen with primer pair ef1/ef2. Sequences of TEF gene from the selected isolates showed the highest 99-99,5% nucleotide identity with sequence of *Gibberella zeae* isolate deposited in NCBI GenBank. Amplification of the barcoding region of *F. graminearum* genome of seed wheat isolate, contributes to the fast and accurate identification and characterization of *Fusarium* species in Republic of Srpska.

**Key words:** *Seed wheat, Quality control, Fusarium graminearum, Puccinia graminis.*

## VIRUS DISEASES OF STONE FRUITS IN SERBIA

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Stone fruits account for more than 60% of fruit production in Serbia. The most important *Prunus* species in Serbian agriculture are plums, sour cherries, peaches, apricots and sweet cherries. Stone fruits are propagated in a vegetative manner and are hosts of numerous viruses. Virus diseases are difficult to control, and in sensitive cultivars they may cause significant yield losses and reduce fruit quality.

The research of stone fruit viruses in the Fruit Research Institute in Čačak has started during the 1950s. Due to its great economic significance, the major topic in research is the plum pox virus. With the development of novel molecular tools, several viruses were characterized for the first time in the country, and new hosts were reported. The focus of the research in the last decade is viruses primarily infecting cherries, including little cherry virus 1, little cherry virus 2, cherry virus A, cherry necrotic rusty mottle virus, prune dwarf virus, *Prunus* necrotic ringspot virus, and cherry green ring mottle virus. The research was also focused on quarantine viruses (cherry leaf roll virus, cherry rasp leaf virus, tomato ringspot virus, and tomato black ring virus) confirming their absence from Serbian stone fruit orchards.

In this paper, the results of the research on stone fruit viral diseases in Serbia obtained in the last two decades will be presented.

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**Key words:** *Prunus* sp., virus, fruits, molecular detection.

## DISTRIBUTION OF PERSIMMON CRYPTIC VIRUS IN PERSIMMON IN MACEDONIA

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Persimmon (*Diospyros kaki* L.) is a significant fruit crop in Asian countries. It is also cultivated in Europe, mainly in Mediterranean countries. Persimmon cultivation in Macedonia is estimated to be 500 ha. More than 10 viruses and viroids had been identified infecting persimmon. Persimmon cryptic virus (PeCV) is considered the most common virus in persimmon trees, reported in Italy, Korea, Macedonia, Spain, Turkey, and the USA. PeCV was reported for the first time in Macedonia in 2019. The aim of this study was to investigate the PeCV distribution in Macedonia.

A survey was performed in June 2024 in persimmon orchards in the localities Bogdanci, Valandovo, and Strumica. Forty five leaf samples from cultivars 'Rojo Brillante', 'Jiro', 'Hachiya', 'Kostata' and two samples from rootstock (*Diospyros lotus* L.) were collected. Collected samples were analyzed for the PeCV presence by RT-PCR. Total nucleic acids were extracted from fresh leaves with the CTAB method. RT-PCR reactions were carried out using a set of PeCV primers amplifying a 526 bp coat protein gene fragment. The presence of PeCV was confirmed in 29 samples (61.7%) in all surveyed locations. PeCV was detected in symptomatic samples showing extensive necrosis of the leaf veinlets, interveinal chlorosis and leaf yellows. PeCV was also detected in three asymptomatic samples of 'Rojo Brillante'.

Obtained results confirmed wide distribution of PeCV in persimmon orchards in Macedonia. Further studies are planned to investigate the presence of other viruses infecting persimmon, which may also have a role in the appearance of the observed symptoms.

**Key words:** *Diospyros kaki* L., PeCV, leaf necrosis, molecular detection.



## **DETERMINING THE VIRUS STATUS OF SOME MACEDONIAN AUTOCHTHONOUS EMBROIDERED PEPPER LANDRACES**

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The Institute of Agriculture is holder of the Macedonian National Gen Bank, where the seedling material of many autochthonous, newly created, introduced and high potential varieties and populations of cereals, vegetable, fodder and industrial crops are preserved. All these plant genetic materials represent the basis for biodiversity conservation, starting material in selection programs for creating new varieties and for examination and evaluation of the agro-biological and technological properties of the introduced and already established varieties and populations. That is why, it is of crucial importance that this material is in good condition, especially the health status of the conserved seeds, since some of the diseases can be seed-transmitted. Because the collected plant material in the Gen Bank had never been tested for seed-transmissible pathogens, as a pioneer examination, 13 autochthonous embroidered pepper landraces from the National Gen Bank were selected and tested for two viruses: Alfalfa Mosaic Virus (AMV) and Tobacco Mosaic Virus (TMV). Virus detection was conducted with the use of the DAS-ELISA method. After the evaluation, it was determined that AMV was the most prevalent virus. While TMV infection was observed in only few of the tested samples, in most of the examined material AMV was detected. The infected seeds were excluded from further regeneration.

This type of investigation should be continued on other crops, in order to determine virus-free material that will be used for further regeneration.

**Key words:** *Alfalfa mosaic virus, Tobacco mosaic virus, seed-transmission, autochthonous pepper landraces.*

## FIRST REPORT OF *DRYOCOSMUS KURIPHILUS* ON EUROPEAN CHESTNUT (*Castanea sativa*) IN KOSOVO

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In the spring of 2024, *Dryocosmus kuriphilus*, a globally significant pest of chestnut trees, was identified for the first time in Kosovo. The discovery was made on a single young *Castanea sativa* forest tree near Gochaj in the municipality of Junik, where characteristic galls were observed on the tree's shoots. These galls, which are induced by the chestnut gall wasp, represent the early stages of an infestation that can severely impact chestnut production and tree vitality. Following the field discovery, galls were collected and adult insects were successfully reared in controlled and secured conditions in our entomology laboratory.

This find marks a concerning development, as *D. kuriphilus* is known invasive species with rapid spread and ability to cause significant damage to chestnut trees across Europe, affecting both the ecological stability of chestnut forests and the economic viability of chestnut production. The presence of this pest in Kosovo raises important questions regarding its distribution, potential pathways of introduction, and the necessary measures for management and control. In our report we provide information on the identification process, rearing method, and the implications for chestnut cultivation in the region, with an emphasis on early detection and integrated pest management strategies.

**Key words:** *Chestnut gall wasp, invasive pest species, adult insect, chestnut production.*

## ANTIFUNGAL ACTIVITY OF SOIL BACTERIAL STRAINS FROM THE GENUS *BACILLUS* ISOLATED FROM CONTAMINATED SOIL FROM THE BITOLA REGION (REK)

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In recent years, there has been a growing focus on developing bio-based products, with species from the *Bacillus* genus frequently utilized due to their high production of antimicrobial compounds and their resilience to harsh environmental conditions through endospore formation. In this context, the antifungal potential of bacterial isolates from contaminated soil in the Bitola region, with a focus on the genus *Bacillus* was investigated. The isolates were tested against several phytopathogens, including *Plasmopara viticola*, *Erysiphe necator*, *Podosphaera xanthii*, *Alternaria alternata*, *Aspergillus ochraceus*, *Penicillium* spp. and *Monilinia fructigena*. The methodology involved bacterial isolation from soil samples, followed by antifungal activity assays utilizing the agar well-diffusion method. The findings revealed that *Bacillus* isolates exhibited considerable antifungal activity across all tested pathogens, with the most pronounced effects against *Alternaria alternata* and *Erysiphe necator*. Efficacy varied between intracellular and extracellular fractions, with intracellular fractions demonstrating stronger activity. This suggests that *Bacillus* isolates possess antifungal metabolites with potential applications as natural pesticides. The results suggest potential for developing alternative methods to control phytopathogens, particularly given the increasing resistance to synthetic fungicides. These findings highlight the potential of bacterial agents as sustainable antifungal resources, contributing to eco-friendly agricultural practices within and beyond the Bitola region. Further research is necessary to identify and characterize specific *Bacillus*-derived metabolites to support innovative, environmentally sustainable plant protection strategies.

**Key words:** *Antifungal activity, soil microorganisms, Bacillus, plant pathogenic fungi, secondary metabolites.*

## POST-EMERGENCE CHEMICAL WEED CONTROL IN DIRECT WET-SEEDED RICE (*Oryza sativa* L.)

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Weeds present a serious abiotic problem in rice paddy fields and severely affect rice (*Oryza sativa* L.) yield and quality. About 40% of world rice production and 55-60% of rice production in Europe decreases due to weeds competition. In the Republic of North Macedonia rice yield loss due to uncontrolled weeds ranged from 40-60%. In this perspective an experiment was conducted to establish the efficacy of different POST-em herbicides for weed management in lowland flooded rice system in North Macedonia. The field trials were carried out on rice fields at two localities in Kochani and Probishtip region. In addition, herbicide selectivity and impact on rice grain yield were evaluated. Azimsulfuron, bensulfuron-methyl + profoxydim, cyhalofop-buthyl + bentazone, penoxulam + cyhalofop-buthyl were tested. The efficiency of all herbicides was above 90% and is statistically highly significant compared to the untreated control. Herbicide efficacy ranged from 91% at azimsufuron in the Kochani locality to 96% at penoxulam + cyhalofop-buthyl in both localities. The high efficiency of herbicides leads to a reduction of the rice fields weed population, which further results in rice yield increasing. In both Kochani and Probishtip localities, the lowest yield was measured at the untreated variant (2980 kg/ha and 3200 kg/ha, respectively). In the herbicides variants the lowest yield was measured at the bensulfuron – methyl + profoxydim in Probishtip locality and highest yield was measured at the penoxulam+cyhalofop-buthyl variant (6270 kg/ha and 6290 kg/ha) in the both localities, respectively.

POST-em application of any herbicide resulted no phytotoxicity to rice plants.

**Key words:** Rice, weeds, herbicides, efficacy, phytotoxicity.

## MICROBIAL ABUNDANCE IN SOIL AFTER HERBICIDE LUMAX APPLICATION

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Lumax 537.5 SE is a selective herbicide that suppresses all types of annual and broadleaf weeds as well as most perennial broadleaf weeds in maize. The use of herbicides not only has a positive impact on crop production, but also leads to environmental degradation in the form of soil and groundwater contamination. Microorganisms, as a living component of the soil, play an important role in soil fertility and represent the potential of pesticide tolerance in the environment. The aim of the study was to determine the microbiological activity of the soil after the application of herbicides (Lumax) and to isolate bacteria that are able to grow in the presence of herbicides. The number of bacteria, fungi and actinomycetes determined by the agar plate method increased compared to the control at 10 days after herbicide application. Seven isolates were isolated from the herbicide-treated soil sample using the enrichment method. The tolerance of the bacterial isolates was determined by growth on nutrient agar medium enriched with different herbicide concentrations. Two isolates (A1 and D1) showed high tolerance to the herbicide and grew best at an initial herbicide concentration of 25 mg/l. These bacterial isolates could have potential applications in the bioremediation of soil and water contaminated with the Lumax herbicide.

**Key words:** *Microorganisms, Lumax, soil, microbial abundance.*

## CONTROL OF VARIOUS DISEASES ON CUCUMBER AND TOMATO WITH THE USE OF FLUXAPYROXAD+ DIFENCONAZOLE

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Macedonia is an agricultural country, with an intensive vegetable production. One of the most important vegetable crops are tomatoes and cucumbers. They are susceptible to various fungal diseases, such as powdery mildew, downy mildew, early blight etc. Their control is essential in order to get high quality yields. Economically it would be more sound if more of the diseases could be controlled with the use of one pesticide. That is why, the goal of this trial was to study the efficiency of the fungicide SERCADIS PLUS (fluxapyroxad+ difenconazole) in the control of powdery mildew (*Erysiphe cichoracearum*) in cucumber and powdery mildew (*Erysiphe lycopersici*) and early blight (*Alternaria solani*) in tomato. The trials were conducted in glasshouses, on two tomato hybrids and two cucumber hybrids, in the regions of Dojran and Obleshevo, Kochani. In the untreated variants in both regions, a high level of disease severity varying from 6.52% for *Alternaria solani*, to 45.9% for *Erysiphe cichoracearum* was observed, leading to destructive damages on the inspected crops. The tested fungicide combination provided high level of efficacy in the control of the inspected diseases. In both regions, the fungicide efficacy varied from 100% for *A. solani*, to 95.13% for *E. lycopersici*. This shows that the active ingredients fluxapyroxad+ difenconazole (SERCADIS PLUS) are extremely efficient in controlling of powdery mildew of tomatoes and cucumber and early blight of tomato, with preventive and curative mode of action, leading to more cost effective production.

**Key words:** *Erysiphe cichoracearum*, *Erysiphe lycopersici*, *Alternaria solani*, fluxapyroxad+ difenconazole.

**FIRST EVIDENCE OF BIOCONTROL EFFICACY OF *VERTICILLIUM NONALFALFAE* AGAINST THE INVASIVE *AILANTHUS ALTISSIMA* IN RN MACEDONIA: *IN SITU* STUDY**

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The tree of heaven (*Ailanthus altissima* (Mill.) Swingle) is a rapidly growing deciduous tree native in China that has become a widespread invasive species across all over the world. No data has been found on how this species appeared in the dendroflora of RN Macedonia, only some assumptions for the early 20th century as a species suitable for erosion control, and in certain urban areas for ornamental purposes. Here, it is quite widespread on almost every land surface in the cities and villages, and is increasingly spreading as a weed on agricultural lands and in low-stemmed forest areas.

In order to repress or eliminate these invasive tree species, different mechanical, chemical or combined control methods have been considered for use. However, these methods are very expensive and laborious, often not successful, non ecological, or even prohibited (e.g. in water protection areas or in national parks). Thus, biological control of *Ailanthus* using the wilt-inducing fungus *Verticillium nonalfalae* might become a promising alternative.

In order to test the applicability and efficacy of soil suspension containing fungal spores, the soil that was located immediately around the infected trees was collected in sterile containers and a soil suspension was prepared in laboratory conditions. Then, it was conducted with two methods: 1.foliar infection; 2.soil infection around the *Ailanthus altissima* trees. The changes were followed and compared over one year.

This result will help for further development and formulation of a biological preparation for the control of the invasive growth of *Ailanthus altissima* in RN Macedonia.

**Key words:** *Tree-of-heaven, Verticillium, mycoherbicide, biological control.*

## SECTION 4

# CLIMATE CHANGES AND NATURAL RESOURCE MANAGEMENT



## FRUIT TREE CULTIVATION SYSTEMS AS A SEGMENT OF CLIMATE CHANGE ADAPTATION

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Production of fruit crops has been significantly impacted by climate, as an increasingly important environmental factor in recent years. Lower fruit quality and reduced production volumes can be observed as results of changes in plant physiology (vigour, canopy development), reproductive characteristics (fruiting ability and reduction in fruit size), and qualitative characteristics (reduced color development, low juice content, decreased shelf life, and higher pest attacks). Adaptation of continental fruit species to climate changes is possible by considering the biological and agronomic characteristics of cultivated plants and applying available modern cultivation methods. The fruit tree cultivation system, as a coherent set comprising training system/variety/rootstock, is an important segment of adaptation to climate change. New varieties with improved traits that are more adaptable to emerging conditions, combined with appropriate rootstocks, can partially overcome the major challenges posed by climate change (low temperatures during the growing season, temperature extremes, heavy rainfall, and water scarcity, etc.). Implementing two-dimensional training systems in fruit orchards facilitates the integration of modern tools, such as protective nets and precision irrigation, while enhancing compatibility with automation and digital monitoring technologies. The paper presents initial results on new two-dimensional training systems for the most important continental fruit species (plum, cherry, pear, and apple), with an assessment of their advantages and disadvantages compared to traditional training systems.

**Key words:** *Training system, cultivar, rootstock, efficiency.*

## BIOCHEMICAL INDICATORS OF DROUGHT AND HEAT STRESS IN THE LEAVES OF TABLE GRAPE VARIETIES

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Climate changes and increasingly frequent drought periods present a significant challenge for grapevine cultivation. Drought and heat stress directly affect the yield and quality of table grape varieties, threatening the economic sustainability of their production. Therefore, it is of utmost importance to identify varieties that are highly tolerant to drought and heat stress to minimize yield loss and preserve fruit quality. Research on the resistance of different varieties to drought conditions is crucial for understanding plant adaptive mechanisms and facilitates the implementation of effective agronomic practices in arid regions. The research was conducted in 2024 in a collection of table grape varieties at the Faculty of Agrobiotechnical Sciences Osijek, located in Mandićevac, Đakovo vineyards, eastern continental Croatia. Two biochemical defense mechanisms against drought and heat stress in grapevine leaves were analyzed. The accumulation of free proline in cells is associated with defense against the harmful effects of osmotic stress caused by water deficiency, while the accumulation of phenolic compounds is often an indicator of the antioxidant response to heat stress. The Sonja variety was characterized by a high content of chloroplast pigments and the lowest accumulation of proline, along with a high phenol content and high antioxidant activity determined by the FRAP method. The Juliana variety showed relatively low proline and phenol content, with the lowest antioxidant activity. The lowest total chlorophyll and carotenoid content was observed in the Szindikat and Suzi varieties, with Szindikat also characterized by the highest accumulation of proline in the leaves. Analyses of biochemical stress indicators as markers of adaptability to different climatic conditions can provide guidelines for the further breeding process of table grape varieties.

**Key words:** *Grapevine, table varieties, adaptability to climate change, abiotic stress*

## ALTITUDE AS A FACTOR ON THE AMPELOMETRIC CHARACTERISTICS OF THE LEAVES OF VRANEC VARIETY

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One measure to mitigate the climate change impact in grape production is the selection of a higher altitude location for vineyards. In that direction, the aim of this study was to investigate how does the altitude affects the ampelometric characteristics of the leaves of the wine grape variety Vranec. Findings demonstrate that the terroir of the specific microlocation related to the altitude of the vineyard has a mathematically proven influence on the leaf ampelometric descriptors. This is especially expressed in the vineyard located in Skopje, as a location with highest vineyard altitude among the studied sites. The research included three different vineyards located around Skopje, Veles and Gevgelija. According to the obtained results, the vineyards in Veles and Gevgelija are characterized by relatively similar values and a noticeable tendency of growth in the vineyard located on higher altitude. Comparative statistical analysis reveals that the absolute values of the indicators length of vein N1, N2, N3 and N4 in the vineyard located around Skopje, have higher values compared to the same parameters of the vineyards in Veles and Gevgelija. In addition, the length petiole sinus to upper lateral leaf sinus and length petiole sinus to lower lateral leaf sinus from both halves of the leaf in the vineyard located around Skopje, have higher values compared to the same parameters of the vineyards in Veles and Gevgelija. However, no significant differences between the size of the angles  $\alpha$  and  $\beta$  (OIV code 607 and 608) for all vineyard locations were determined in this study.

**Key words:** *Vineyard location, ampelometric characteristics, altitude, Vranec, ampelometric descriptors.*

## CONTENT OF HEAVY METALS OF SOILS FORMED ON ANDESITE ROCKS FROM THE AREA OF KRATOVO

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The investigation aimed to determine the total concentrations of heavy metals (Pb, Cd, Cu, and Zn) and the available forms of copper and zinc in soils developed on andesite rocks in the Kratovo area. Soil samples were digested using a microwave furnace (Ethos Easy model). The available forms of heavy metals were extracted using the DTPA method. Heavy metal concentrations were measured with an Agilent 55 atomic absorption spectrophotometer. The results showed that total concentrations of zinc, lead, and copper in all soil samples were below the reference values, while cadmium levels exceeded the reference values but remained well below the intervention threshold. Available copper ranged from low to high, whereas available zinc was classified between very low and low.

**Key words:** *Soils, andesite rocks, heavy metals, Kratovo.*

## TILLAGE SYSTEMS AND THEIR IMPACT ON CROP YIELD AND SOME PHYSICAL AND CHEMICAL SOIL PROPERTIES

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Land cultivation systems through several methods of cultivation in one time continuity, can fulfill very different requirements from agronomic to economic, whereby they are required to provide optimal conditions for sowing, growth and development of plants with the least expenditure of resources. Today, these requirements have been extended in the ecological sense, considering that land is a natural resource that needs to be preserved for future generations.

The height of the yield of cultivated plants largely depends on the selected tillage system, and the tillage system represents the connection of individual methods of basic and supplementary tillage into one agrotechnically harmonious whole.

The choice of soil cultivation system depends on numerous factors: climate characteristics, soil types and properties, relief characteristics, fertilization system, crop requirements, place in the crop rotation, hereditary basis of the plant species. Based on this, it can be seen that soil and climate are constant factors, and everything else is variable. Therefore, there is no universal land cultivation system for the entire agrosphere, it is regional and sometimes local."

**Key words:** *Tillage system, soil, yield.*

# SECTION 5

# RURAL DEVELOPMENT AND AGRO-ECONOMY

## **INCENTIVE POLICIES FOR AGRICULTURAL PERFORMANCE AND RURAL DEVELOPMENT: EVIDENCE FROM NORTH MACEDONIA, BOSNIA AND HERZEGOVINA AND CROATIA**

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Agriculture is a vital sector in North Macedonia, Bosnia and Herzegovina and Croatia, playing a significant role in economic development, food security and rural livelihoods. Each country has implemented various incentive policies tailored to their unique contexts and EU schemes to enhance agricultural performance and promote rural development. This article examines agricultural incentive policies, assessing their effectiveness and the challenges faced in each country, focusing on the distinctions between Croatia as an EU member and North Macedonia and Bosnia and Herzegovina as non-EU countries. The study conducts a comparative analysis of agricultural data from 2011 to 2021, focusing on key indicators such as Gross Value Added (GVA) in agriculture, trade balances of agri-food products, employment in the agricultural sector, agricultural land use and the value of agricultural incentives in North Macedonia, Bosnia and Herzegovina and Croatia. The findings reveal that agricultural policy incentives in North Macedonia and Bosnia and Herzegovina have not been fully effective, leading to persistent issues such as a significant decline in agricultural employment (34.9% in Bosnia and 24.7% in North Macedonia) and underutilization of land resources (4.9% and 12.4%, respectively). These challenges limit the growth and competitiveness of agriculture and rural development in the countries. Meanwhile, Croatia benefits from EU agricultural subsidies and market access, improving its agricultural performance. However, it still faces structural challenges, requiring modernization, enhanced competitiveness, and increased investment in sustainable practices. Structural reforms are equally critical in North Macedonia and Bosnia and Herzegovina to achieve agricultural and rural development.

**Key words:** *Agricultural Incentives, Agricultural Performance, Structural Policy Reforms, Comparative Analysis, Sustainability.*

## CHANGES IN THE STRUCTURE OF BULGARIAN AGRICULTURAL HOLDINGS PRODUCING WINE GRAPES DURING THE YEARS OF EU MEMBERSHIP

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The tendencies in the development of viticulture and specifically the production of wine grapes in Bulgaria in the years after the country's accession to the EU were directly related to the changes in the structure of agricultural holdings growing vines with wine grape varieties. The processes of concentration and specialization of production largely determined the potential for sustainable development of the sector both nationally and regionally. The aim of the study was to identify the changes in the structure of the farms producing wine grapes from the point of view of the concentration of land resource and economic size. The official data from the censuses of agricultural holdings during the period 2007-2020 have been analyzed. The ongoing structural changes in the wine sector in the years after the country accession to the EU lead to consolidation of the areas under vines in farms, with their average size per unit increased. The intensity of the changes in the regional plan was different, with average sizes of vineyard holdings producing wine grapes in the Southwest, Northwest and South Central regions were smaller than the average for the country, and of the holdings in the Northeast, North Central and Southeast regions were a larger. Consolidation processes took place more intensively in the groups of holdings with a utilized agricultural area between 10 and 100 ha, which increased their percentage participation in the wine grapes production. The dynamics were more pronounced during the second application period of the Common agricultural policy.

**Key words:** *Vineyards, wine grapes, holdings, structural changes.*



## INTERNATIONAL MARKETS INFLUENCE ON WINE PRICES IN THE REPUBLIC OF NORTH MACEDONIA

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The wine and viticulture sectors are important to the Macedonian agri-food industry, with a 17-20% contribution to agricultural GDP. In 2021, vineyards are planted on 23,776 ha, occupy around 4.6% of total cultivated land, and produce 270,700 tons of grapes (2021 SSO, 2022). Most of the grapes are used for wine production. Around 70% are wine varieties, primarily Vranec and Smederevka (MAFWE, 2021). The focus of the paper is to estimate the influence of international markets on Macedonian wine prices, considering that agri-food product prices in Macedonia are under the strong influence of international market trends, political processes, and preferences of the country, which are defined and regulated by trade agreements signed by Macedonia. An aggregate series of 204 monthly wine price data from January 2005 to December 2021 for Macedonia, EU, Greece, Italy, and Spain were analyzed and compared using empirical and statistical approaches. The results show that the wine prices in Macedonia are lower than those in the EU. On average, Macedonia has the lowest wine price (125.79 euro/hl), while Italy has the highest (408.12 euro/ hl). Unlike the EU countries, Macedonia's wine prices are relatively stable and show a slightly growing trend, with the lowest variation and lowest standard deviation (20.62). The analyses show a low interaction of Macedonian wine prices with international markets and a low correlation of Macedonian wine prices is noticed with the EU (0.12) and Italy (0.11). A more intensive correlation can be observed about Spain (0.50), but still, this is not statistically significant.

**Key words:** *Wine prices, international markets, correlation coefficient, lag length, forecasting.*

## TRADE BALANCE AND FOOD SECURITY IN MACEDONIAN AGRICULTURAL SECTOR

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Agriculture in North Macedonia is crucial for the country's economic and social development, contributing approximately 10% to the GDP alongside forestry, fishing, and the food industry. The country adopts an open trade policy, imposing customs duties on most imports while offering preferential tariffs for countries with which it has established bilateral Free Trade Agreements or participates in multilateral agreements, including the EU Stabilization and Association Agreement (SAA), EFTA, and CEFTA.

This study investigates the trade balance (exports minus imports) and import dependency within the agricultural sector of North Macedonia, specifically focusing on the 0-24 tariff classification over a 15-year period from 2009 to 2023. The data reveals a persistent increase in the agricultural trade deficit during this timeframe, escalating by 453.4 million EUR. The Macedonian society exhibits a significant import dependency for essential food items, with a notable average trade deficit of -95.9 million EUR for meat and edible meat offal. Additionally, dairy products and cereals reflect deficits of -41.1 million EUR and -22.2 million EUR, respectively.

Conversely, certain sectors demonstrate positive trade balances, including tobacco (83.5 million EUR), edible vegetables (56.7 million EUR), and beverages and spirits (30.7 million EUR), indicating areas of competitive production. This study emphasizes the urgent need for policy interventions to mitigate North Macedonia's agricultural import dependency.

To enhance food security and reduce reliance on imports, it is recommended that the country strengthens the domestic agricultural production, invests in sustainable farming practices, and diversifies local crop production. Implementing these measures is vital for fostering a resilient agricultural sector capable of withstanding global trade fluctuations and ensuring food security for the population.

**Key words:** Food trade, import, export, trade balance, food security.

## **THE DEGREE OF INCOME DIVERSIFICATION AMONG RURAL HOUSEHOLDS IN NORTH MACEDONIA: A CASE STUDY OF POLOG AND PELAGONIA REGIONS**

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Traditionally, rural development was closely linked to agricultural growth; however, modern strategies emphasize the importance of non-farm rural employment (NFRE) for enhancing rural livelihoods. This study examines income diversification in rural households in North Macedonia, with a focus on the Polog and Pelagonia regions. This research employs the Shannon Equitability Index (E) to measure the degree of income diversification across various household income sources. Derived from the Shannon Index, the Equitability Index considers both the number and equity of income sources, offering a comprehensive perspective on income distribution within households. The index ranges from 0 to 100, where higher values indicate greater income diversification.

Data for this study were collected through field interviews with 140 rural households in Pelagonia and Polog in 2018, categorizing income into five groups: crop production, livestock production, non-agricultural activities, off-household income and transfers. Households were classified based on their poverty status, distinguishing those above and below the poverty line. Findings reveal low income diversification levels in both regions, with Shannon Index values of 32.9 for Pelagonia and 35.2 for Polog. Notably, households below the poverty line tend to have a more equitable income distribution among various sources than wealthier households. These results highlight the tendency of poorer households to distribute their income sources more evenly, contrasting with wealthier households that show greater reliance on specific income streams. This study thus contributes to a better understanding of income diversification's role in rural development and poverty alleviation in North Macedonia.

**Key words:** *Shannon Index, Polog, Pelagonija, Equitability, Rural households.*

## RURAL CHANGES AND PROCESSES IN MACEDONIA

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The Macedonian village is emerging from its isolation, setting up increasing demands for the development of (non-economic) institutions and services that will meet the needs of current and future standards of living. However, the development process in rural areas does not generate enough quality jobs and diversity to retain young people who wish to remain in the community. Agriculture is still the only source of income, which cannot sustain the micro-system and the diverse needs of the rural population. Rural areas that rely solely on natural resources have always struggled with economic progress and cohesion. The lack of a clear development policy for rural areas has led to the lagging of many rural regions, especially those that have retained an agricultural character and lie outside the gravitational zones of urban centers. This has resulted in severe depopulation and, in some places, real social and demographic depression. The population that leaves its birthplace also takes with it future births, deaths, marriages and divorces that would have occurred within the lifespan of that population had they remained in their place of origin. The social space that empties gradually becomes lifeless, increasingly devoid of players from everyday life. There are rural areas that, economically and socially, lag behind others, making it difficult for them to integrate into society. Such areas contribute to the disruption of social relations and the emergence of dependency of one area on another within the same society. The subject of this paper is an analysis of changes and processes and their impact and significance for the rural community.

**Key words:** *Rural changes, rural processes, urbanization, depopulation, cohesion.*

## **YOUNG FARMERS AS A CHALLENGE POLICY: AN OVERVIEW IN THE EUROPEAN UNION COUNTRIES, WESTERN BALKANS AND THE REPUBLIC OF NORTH MACEDONIA**

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The issue of young farmers encompasses various perspectives, including farm inheritance and the potential for agricultural policy to foster generational renewal. Countries in the Western Balkans are aligning their agricultural and rural development policies with EU principles, particularly those supporting young farmers. The EU introduced support for young farmers in the 1970s under the Siko Mansholt Plan. This support was formalized with the 2008 CAP reform, which included incentives for young farmers. The 2014-2020 CAP reform aimed at integrating young farmers economically and socially, with a focus on sustainability and competitiveness. Support for young farmers was integrated into Priority 2 of the CAP and Focus Area 2B, which facilitates their entry into agriculture. In the Western Balkans, each country has developed its own support mechanisms for young farmers. Serbia implemented a support program in 2017, offering grants for agricultural development. Bosnia and Herzegovina's strategy (2003-2012) included measures to increase competitiveness and encourage youth involvement in agriculture. Montenegro's IPARD II program (2014-2020) also targeted young farmers. Albania's rural development strategy (2007) provided support for young farms.

In North Macedonia, the agricultural policy is aligned with the EU through direct payments and rural development measures. For example, measure 112 refers directly to young farmers, for start-up businesses in agriculture. There are other measures related to this activity as well, such as measure 113, which gives incentives to older farmers to leave the farm and hand it over to young people. However, despite these efforts, support remains insufficient, highlighting the need for more targeted measures for young farmers.

**Key words:** *Young farmers, agricultural policies, support measures.*

## THEMATIC NETWORKING WITHIN THE AGRI-FOOD SECTOR TO GENERATE AND TRANSFER KNOWLEDGE READY TO PRACTICE

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Thematic network is an excellent way to compile and share knowledge, based on the sextuple helix principle refers to the collaboration and interaction among five key stakeholders: academia, industry, government, civil society and farmers in an environmental context. There is still gap between researchers and stakeholders, especially business and policymakers. Creating thematic network to facilitate knowledge exchange, research collaboration and dissemination of best practices is an excellent way to promote a holistic and multi-dimensional approach to address the challenges of sustainable agriculture and food security. The key is to provide multiple stakeholders engagement, with the aim to compile technical, economic, environmental and social knowledge based on participatory and consultative approach, establishing Co-learning framework consisted of several circles (research–farmers and business, business–society/consumers, society–policy, research–policy). By implementing this concept, the main outcome will be achieved – Networking for stakeholders learning, community education and policy advancement, leading to a more sustainable and environmentally friendly Agri-Food sector.

**Key words:** *Agri-Food, thematic networking, knowledge, sustainability.*

