

VYTAUTAS MAGNUS UNIVERSITY
AGRICULTURE ACADEMY



4th International Scientific Conference

AgroEco2022: Agroecosystem Sustainability:

Links between Carbon Sequestration in Soils, Food Security and Climate Change

Vytautas Magnus University, Agriculture Academy, Lithuania, 26–27 October, 2022

**Agroecosystem Sustainability:
Links between Carbon Sequestration in Soils,
Food Security and Climate Change**

International scientific conference

AgroEco2022

PROGRAMME AND ABSTRACTS



Kaunas, 2022

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The conference addresses main issues related to soil health and food towards a chemical pesticide-free agriculture

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PROGRAMME

26 October (Wednesday)

CE Time

**(for local EE
Time -1⁰⁰)**

Plenary Session

Moderators: Prof. Dr. Vaclovas Bogužas, Assoc. Prof. Dr. Zita Kriaučiūnienė

9⁰⁰-9²⁰

Opening of the Conference AgroEco2022

Chancellor of Agriculture Academy Prof. Dr. Astrida Miceikienė, *Vytautas Magnus University, Lithuania*; Prof. Dr. Zenonas Dabkevičius, *Lithuanian Academy of Sciences, Lithuania*; Kristina Simonaitytė, *Ministry of Agriculture, Lithuania*, Dean of Agronomy Faculty Assoc. Prof. Dr. Aida Adamavičienė, *Vytautas Magnus University, Agriculture Academy, Lithuania*

9²⁰-9³⁰

Organic farming in the EU: facts and figures

Prof. Dr. Astrida Miceikienė; *Vytautas Magnus University, Agriculture Academy, Lithuania*

9³⁰-9⁵⁰

Stability, robustness, vulnerability and resilience of agricultural systems

Prof. Dr. Christian Huyghe, Dr. Nicolas Urruty, *National Research Institute for Agriculture, Food and Environment, France*

9⁵⁰-10¹⁰

Soil organic matter and its role in the environment

Prof. Dr. Jerzy Weber, *Wroclaw University of Environmental and Life Sciences, Poland*

10¹⁰-10³⁰

Rethinking resilient agriculture: From climate-smart agriculture to vulnerable-smart agriculture

Prof. Dr. Hossein Azadi, *University of Liège, Belgium*

10³⁰-11⁰⁰

Coffee break, poster presentations

11⁰⁰-11²⁰

Fertilization strategies in organic farming – challenges and prospects

Dr. Sabine Zikeli, *University of Hohenheim, Germany*

11²⁰-11⁴⁰

Challenges of predicting regional crop yields and water balance using agroecosystem models at high resolution

Prof. Dr. Claas Nendel, *Leibniz-Centre for Agricultural Landscape Research (ZALF), Germany*

11⁴⁰–12⁰⁰ **Applications of smart technologies for monitoring of food quality and safety to improve traceability and customers trust**

Assoc. Prof. Dr. Imran Aslan, *Bingol University, Türkiye*

12⁰⁰–13⁰⁰ **Lunch, poster presentations**

Oral presentations of Sessions 1–3

Session 1: Soil health and carbon sequestration for sustainability; Session 2: Soil and crop management towards a chemical pesticide-free agriculture; Session 3: Biodiversity, crop and production diversification

Moderators: Assoc. Prof. Dr. Rimantas Vaisvalavičius, Dr. Livija Zarina

13⁰⁰–13¹⁵ **Incentivising the uptake of precision agricultural technologies in grain farming: empirical evidence from choice experimental survey in Spain**

Enoch Owusu-Sekyere¹, Assem Abu Hatab¹, Carl-Johan Lagerkvist¹, Egidijus Šarauskis², Zita Kriaučiūnienė², Manuel Pérez Ruiz³, Manuela Díaz⁴, Enrique Apolo-Apolo⁵, Mhd Baraa Almoujahed⁵, Rebecca L. Whetton^{5,6}, Abdul M. Mouazen⁵, ¹*Swedish University of Agricultural Sciences, Sweden*; ²*Vytautas Magnus University, Lithuania*; ³*University of Seville, Spain*; ⁴*Soluciones Agrícolas de Precisión S.L., Spain*; ⁵*Ghent University, Belgium*; ⁶*University College Dublin, Ireland*

13¹⁵–13³⁰ **Stabilizing soil organic carbon in agricultural soils for increase of soil microbial activity as the measure promoting the reduction of mineral fertilization**

Audrius Jakutis, Jūratė Aleinikovienė, *Vytautas Magnus University, Agriculture Academy, Lithuania*

13³⁰–13⁴⁵ **Influence of granular organic fertilizers from meat bone meal with bio-preparations on the growth parameters of pak choy**
Zita Kriaučiūnienė¹, Rita Čepulienė¹, Ernestas Zaleckas¹, Vilma Naujokienė¹, Quirijn de Jong van Lier², Egidijus Šarauskis¹, *¹Vytautas Magnus University, Agriculture Academy, Lithuania*; *²University of São Paulo, Brazil*

13⁴⁵–14⁰⁰ **Isolation and characterization of cellulolytic bacteria from agricultural soil**

Arman Shamshitov, Skaidrė Supronienė, *Lithuanian Research Centre for Agriculture and Forestry, Lithuania*

14⁰⁰–14¹⁵ **Effect of endophytic bacteria associated with *Artemisia* plant on biological control pea rot root pathogen**
Shervin Hadian, Skaidre Supronienė, *Lithuanian Research Centre for Agriculture and Forestry, Lithuania*

14¹⁵–14³⁰ **Productivity of diverse plant species in relation to effective photochemical yield**
Giedrė Samuolienė^{1,2}, Viktorija Vaštakaitė-Kairienė^{1,2}, Kristina Laužikė², Gediminas Kudirka², Akvilė Viršilė^{1,2}; ¹*Vytautas Magnus University, Agriculture Academy*; ²*Lithuanian Research Centre for Agriculture and Forestry, Lithuania*

14³⁰–14⁴⁵ **Results of research on pesticide free weed management using inter-row hoeing in cereals**
Livija Zarina, Dace Piliksere, *Institute of Agricultural Resources and Economics, Latvia*

14⁴⁵–15⁰⁰ **Possibilities to use sludge from aquaculture ponds and recirculation systems as soil improvement measure in agriculture**
Alvydas Žibas, Gražina Žibienė, Laima Česonienė, Mantas Brazauskas, *Vytautas Magnus University, Agriculture Academy, Lithuania*

15⁰⁰–15¹⁵ **Coffee break, poster presentations**

Oral presentations of Sessions 4–6
Session 4: Precision farming and digital technologies
Session 5: Food quality and safety
Session 6: Climate change mitigation
Moderators: Prof. Dr. Kęstutis Romaneckas,
Assoc. Prof. Judita Černiauskienė

15¹⁵–15³⁰ **The productivity of maize, hemp and faba bean multi-cropped cultivations**
Jovita Balandaitė, Kęstutis Romaneckas, Algirdas Jasinskas, Rasa Kimbirauskienė, Austėja Švereikaitė, *Vytautas Magnus University, Agriculture Academy, Lithuania*

15³⁰–15⁴⁵ **Influence of different fertilizers on the water quality of aquaculture ponds**
Gražina Žibienė, Laima Česonienė, Alvydas Žibas, Mantas Brazauskas
Vytautas Magnus University, Agriculture Academy, Lithuania

15⁴⁵–16⁰⁰

Caraway (*Carum carvi* L.) in multifunctional crops and integrated assessment of its impact on the agroecosystem

Aušra Rudinskienė, Aušra Marcinkevičienė, Zita Kriaučiūnienė, Rimantas Velička, Robertas Kosteckas, *Vytautas Magnus University, Agriculture Academy, Lithuania*

16⁰⁰–16¹⁵

Anthocyanins and chlorophylls changes in *Solanum* spp. fruits during ripening

Jūratė Staveckienė¹, Jurgita Kulaitienė¹, Agnieszka Tajner-Czopek²,
¹*Vytautas Magnus University, Agriculture Academy, Lithuania;*
²*Wroclaw University of Environmental and Life Sciences, Poland*

16¹⁵–16³⁰

Studies of the variability of biologically active and anticancer compounds in organically grown fermented fireweed (*Chamerion angustifolium* (L.) Holub) leaves

Elvyra Jarienė, Jurgita Kulaitienė, Nijolė Vaitkevičienė, Marius Lasinskas, *Vytautas Magnus University, Agriculture Academy, Lithuania*

16³⁰–16⁴⁵

The value of forest peatlands in Lithuania: the need for restoration

Evaldas Makrickas, Michael Manton, *Vytautas Magnus University, Agriculture Academy, Lithuania*, Mateusz Grygoruk, *Warsaw University of Life Sciences, Poland*

16⁴⁵–17¹⁵

Concluding remarks and discussions

Moderators: *Prof. Dr. Kęstutis Romaneckas, Prof. Dr. Vaclovas Bogužas*

Participants: Assoc. Prof. Dr. Aida Adamavičienė, Prof. Dr. Elvyra Jarienė, Assoc. Prof. Dr. Zita Kriaučiūnienė, Assoc. Prof. Judita Černiauskienė, *Vytautas Magnus University, Agriculture Academy, Lithuania;* Dr. Christian Huyghe, *INRAE, France*, Prof. Dr. Jerzy Weber, *Wroclaw University of Environmental and Life Sciences, Poland;* Dr. Sabine Zikeli, *University of Hohenheim, Germany;* Prof. Dr. Hossein Azadi, *University of Liège, Belgium;* Assoc. Prof. Dr. Imran Aslan, *Bingol University, Turkey;* Prof. Dr. Claas Nendel, *Leibniz-Centre for Agricultural Landscape Research (ZALF), Germany;* Dr. Livija Zarina, *Institute of Agricultural Resources and Economics, Latvia*

27 October (Thursday)

9⁰⁰-11⁰⁰

Seminar “Towards a chemical pesticide-free agriculture”

Coordinators: Dr. Christian Huyghe, *INRAE, France*, Prof. Dr. Vaclovas Bogužas, Assoc. Prof. Dr. Zita Kriaučiūnienė, *Vytautas Magnus University, Agriculture Academy, Lithuania*

9⁰⁰-9³⁰

Growing and protecting crops differently: zero-pesticide as a new paradigm

Dr. Christian Huyghe, *Chair of European Research Alliance “Towards a Chemical Pesticide-free Agriculture”, chair of COST action “Towards zero Pesticide AGRiculture: European Network for sustainability”, National Research Institute for Agriculture, Food and Environment (INRAE), France*

9³⁰-10⁰⁰

No pesticide farming: 26 years experience

Valentinas Genys, *farmer, PI “Sustainable Farming Academy”, Lithuania*

10⁰⁰-10¹⁵

Organic farming in Lithuania: statistics and goals towards 2030

Virginija Lukšienė, *PI “Ekoagros”, Lithuania*

10¹⁵-10³⁰

Practical steps in Lithuanian agriculture towards chemical pesticides reduction

Povilas Drulis, *JSC “Agrotikslas”, Lithuania*

10³⁰-10⁴⁵

Towards a chemical pesticide-free agriculture: opportunities for improving soil microbiological activity and plant nutrient availability

PhD Student Raimonda Mažylytė, Audrius Gegeckas, *Vilnius University, JSC “Bioenergy LT”, Lithuania*

10⁴⁵-11⁰⁰

Research towards a chemical pesticide-free agriculture at the Lithuanian Research Centre for Agriculture and Forestry

Dr. Gražina Kadžienė, *Lithuanian Research Centre for Agriculture and Forestry, Lithuania*

11⁰⁰-11¹⁵

Discussion

11¹⁵-11⁴⁵

Coffee break, poster presentations

12⁰⁰-17⁰⁰

Excursion and cultural program

Coordinators: Dr. Edita Mažuolytė-Miškinė, Assoc. Prof. Dr. Zita Kriaučiūnienė, Assoc. Prof. Rimantas Vaisvalavičius, Junior Researcher Dr. Vaida Steponavičienė, PhD Student Aušra Rudinskienė, *Vytautas Magnus University, Lithuania*

17⁰⁰

Closing of the conference program

POSTER PRESENTATIONS

Soil health and carbon sequestration for sustainability

- 1. Influence of bio-carbonisate on the soil organic matter quality**
Aleksandra Ukalska-Jaruga, Bożena Smreczak, Joanna Ciepiel, Pasternak Urszula, *Institute of Soil Science and Plant Cultivation - State Research Institute, Poland*
 - 2. Long-term different intensity tillage effect on soil structure**
Inga Andruškaitė, Vaclovas Bogužas, *Vytautas Magnus University, Agriculture Academy, Lithuania*
 - 3. Impact of soil biostimulants and tillage practices on carbon and nitrogen dynamics of soil under wheat crop**
Lina Marija Butkevičienė, Vaida Steponavičienė, Rita Pupalienė, Lina Skinulienė, Vaclovas Bogužas, *Vytautas Magnus University, Agriculture Academy, Lithuania*
 - 4. The change of soil physical properties in different soil substrates after the use of biological preparation**
Sidona Buragienė, Aida Adamavičienė, Egidijus Šarauskis, *Vytautas Magnus University, Agriculture Academy, Lithuania*
 - 5. Effect of soil crust breaker on the emergence of some vegetable seeds**
Davut Karayel^{1,2}, Zita Kriaučiūnienė¹, Egidijus Šarauskis¹, *¹Vytautas Magnus University, Agriculture Academy, Lithuania; ²Akdeniz University, Türkiye*
 - 6. Changes of soil organic carbon and mobile humic acids content under long-term red fescue (*Festuca rubra* L.)**
Aida Skersienė, Alvyra Šlepetienė, Vaclovas Stukonis, *Lithuanian Research Centre for Agriculture and Forestry, Lithuania*
 - 7. Nitrogen fertilizer rates optimization with urease inhibitors and biological preparations in maize crops**
Povilas Drulis, Zita Kriaučiūnienė, Vytautas Liakas, *Vytautas Magnus University, Agriculture Academy, Lithuania*
 - 8. Effect of biological preparations on the biometric properties of 'Futura 75' hemp stems**
Arnas Vansevičius, Vytautas Liakas, Zita Kriaučiūnienė, *Vytautas Magnus University, Agriculture Academy, Lithuania*
-

9. **The influence of different long-term crop rotations on soil hydrophysical properties in spring barley crops**
Lina Skinulienė¹, Vaclovas Bogužas¹, Vaida Steponavičienė¹, Edyta Hewelke²; ¹*Vytautas Magnus University, Agriculture Academy, Lithuania*;
²*Warsaw University of Life Science SGGW (WULS-SGGW), Poland*
-

10. Soil properties after long-term reduced tillage, no-till and residue management
Giedrius Žiūraitis¹, Vaclovas Bogužas¹, Vaida Steponavičienė¹, Lina Skinulienė¹, Aneta Perzanowska²; ¹*Vytautas Magnus University, Agriculture Academy, Lithuania*;
²*Warsaw University of Life Science SGGW (WULS-SGGW), Poland*
-

11. **Long-term impact of reduced intensity tillage systems combinations on soil properties**
Vaida Steponavičienė¹, Vaclovas Bogužas¹, Lina Skinulienė¹, Marta Wyzinska²; ¹*Vytautas Magnus University, Agriculture Academy, Lithuania*;
²*Institute of Soil Science and Plant Cultivation – State Research Institute: Puławy, Poland*
-

Soil and crop management towards a chemical pesticide-free agriculture

12. **Effects of biopesticides and undersown cover crops on soil biological properties in the organic farming system**
Aušra Marcinkevičienė, Arūnas Čmukas, Rimantas Velička, Robertas Kosteckas, Lina Skinulienė, *Vytautas Magnus University, Agriculture Academy, Lithuania*
-

13. **Effect of different organic mulches on onion crop**
Alfредas Sinkevičius, Brigita Lebedytė, Aušra Sinkevičienė, Vaclovas Bogužas, *Vytautas Magnus University, Agriculture Academy, Lithuania*
-

14. **Effect of humic acid and silicon on winter wheat**
Darija Jodaugienė, Rita Čepulienė, Edita Mažuolytė-Miškinė, Irena Pranckietienė, Ilona Vagusevičienė, *Vytautas Magnus University, Agriculture Academy, Lithuania*
-

15. **Analysis of soil texture in different tillage systems**
Ieva Erdberga, Krišjānis Veinbergs, Ilze Vircava, *Latvia University of Life Sciences and Technologies, Latvia*
-

16. **Effect of sowing date on competitiveness of spring rapeseed against weeds**
Silvija Kosteckienė, Rimantas Velička, Lina Marija Butkevičienė, Rita Pupalienė, Robertas Kosteckas, Zita Kriaučiūnienė, *Vytautas Magnus University, Agriculture Academy, Lithuania*
-

Biodiversity, crop and production diversification

17. **Influence of sowing time and seed rate on productivity of winter wheat (*Triticum aestivum* L.)**
Ilona Vagusevičienė, Darija Jodaugienė, Gintarė Sujetovienė, Arvydas Kanapickas, Irena Pranckietienė, *Vytautas Magnus University, Agriculture Academy, Lithuania*
18. ***Monilinia* spp. prevalence in berries of European cranberry (*Vaccinium Oxycoccus*)**
Jolanta Sinkevičienė, Laima Česonienė, Remigijus Daubaras, *Vytautas Magnus University, Agriculture Academy, Lithuania*
19. **Morphological characterization of almond accessions (National Collection) in Afghanistan**
Rahmatullah Atefi¹, Qudratullah Soofizada²; ¹*University of Baghlan, Afghanistan*; ²*University of Florence, Italy*
20. **Content of arabinoxylan in barley and wheat grains depending on N rate used and year**
Mailiis Korge, Maarika Alaru, Kaidi Möll, Evelin Loit, *Estonian University of Life Sciences, Estonia*
21. **Increasing the resilience and resource efficiency of cropping systems**
Kristjan Tiideberg, Evelin Loit, Tõnu Kaste põld, *Estonian University of Life Sciences, Estonia*
22. **Influence of sowing method and seed rate of milk thistle (*Silybum marianum* L.) on crop and weed density**
Rita Pupalienė, Kęstutis Romaneckas, Aiva Stankaitytė, *Vytautas Magnus University, Agriculture Academy, Lithuania*
23. **Phytosanitary condition of *Sedum* L. collection in the VMU Botanical Garden**
Sonata Kazlauskaitė, Arūnas Balsevičius, Indrė Lukšytė, Ričardas Narijauskas, *Vytautas Magnus University, Lithuania*
24. **Use of organic granulated manure compost in grassland and orchard**
Adrija Dorbe, Amanda Bernharde, Gatis Jaunzems-Vītums, Oskars Ādams, Agris Zanders, *Latvia University of Life Sciences and Technologies, Latvia*

Precision farming and digital technologies

25. **The short-term effects of autonomous robotic weeding system on soil physical properties**
Indrė Bručienė, Egidijus Šarauskis, *Vytautas Magnus University, Agriculture Academy, Lithuania*
-
26. **Investigations of a non-destructive on-field method to detect missing nutrients vital for crop growth**
Ernestas Petrauskas¹, Vytautas Petkus², Mantas Lukoševičius², Paulius Mykolaitis², Andrius Stankevičius³, Ernestas Zaleckas¹, ¹*Vytautas Magnus University, Agriculture Academy*, ²*Kaunas University of Technology*, ³*Vilnius Gediminas Technical University, Lithuania*
-
27. **Precision farming as element of plant production optimization**
Marek Marks, Stanislaw Bielski, *University of Warmia and Mazury, Poland*
-
28. **SAR images for crop evaluation**
Jakub Dvořák, Kristýna Balážová, Karel Starý, Zdeněk Jelínek, Jan Chyba, Jiří Mašek, Jitka Kumhálová; *Czech University of Life Sciences, Czech Republic*

Food quality and safety

29. **Crop potential and the essential oils yield of four carvone-rich mint species (*Mentha sp.*)**
Živilė Tarasevičienė¹, Anna Kiełtyka-Dadasiewicz², Agnieszka Ludwiczuk³; ¹*Vytautas Magnus University, Agriculture Academy, Lithuania*, ²*University of Life Science in Lublin, Poland*, ³*Medical University of Lublin, Poland*
-
30. **Influence of replacement of wheat flour with sweet potato powder on quality of cupcakes**
Dovilė Motiejauskaitė, Nijolė Vaitkevičienė, *Vytautas Magnus University, Agriculture Academy, Lithuania*
-
31. **Beetroot peel as a sustainable resource of antioxidants for the food industry**
Akvilė Saprionaitė, Nijolė Vaitkevičienė, *Vytautas Magnus University, Agriculture Academy, Lithuania*
-
32. **The effect of field horsetail and stinging nettle extracts in germinated seeds**
Dalė Šumskienė, *Vytautas Magnus University, Agriculture Academy, Lithuania*
-
33. **Chemical composition of the leaves of white mulberry grown in Lithuania**
Dovilė Levickienė, Irina Skirmantienė, *Vytautas Magnus University, Agriculture Academy, Lithuania*
-

34. **The effect of ripening stages on the pomological parameters and total carotenoid content of rosehip species growing under organic system**
Medveckienė Brigita¹, Kulaitienė Jurgita¹, Ewelina Hallmann²; ¹Vytautas Magnus University, Agriculture Academy, Lithuania; ²Warsaw University of Life Sciences, Poland
-
35. **Quality of sea buckthorn (*Hippophae rhamnoides* L.) oil extracted from berries press cake**
Aurelija Paulauskienė, Živilė Tarasevičienė, Vytautas Magnus University, Agriculture Academy, Lithuania
-
36. **Evaluation of bioactive compounds in the different cultivars of beetroots**
Judita Černiauskienė¹, Živilė Tarasevičienė¹, Anna Kiełtyka-Dadasiewicz², Jovita Šimčikė¹, ¹Vytautas Magnus University, Agriculture Academy, Lithuania, ²University of Life Sciences in Lublin, Poland
-
37. **Effect of *Ustilago maydis* on the nutritive value and aerobic deterioration of maize silage**
Lauksmė Merkevičiūtė-Venslovė, Eimantas Venslovas, Audronė Mankevičienė, Alvyra Šlepetienė, Jurgita Cesevičienė, Lithuanian Research Centre for Agriculture and Forestry, Lithuania
-
38. **Risk of mycotoxin formation in barley grain during delayed harvesting**
Eimantas Venslovas, Sigita Janavičienė, Lithuanian Research Centre for Agriculture and Forestry, Lithuania
-
39. **Drying research of *Cannabis sativa* L seed in a stationary layer**
Živilė Černiauskienė, Egidijus Zvicevičius, Kęstutis Žiūra, Germantas Zajančkauskas, Vytautas Magnus University, Agriculture Academy, Lithuania

Climate change mitigation

40. **Research on conservative agriculture and the manifestation of climate change in the north of the Republic of Moldova**
Cojocar Olesia, Panfil Gheorghe, Technical University of Moldova, Moldova
-
41. **The influence of controlled drainage on the water regime of the soil**
Inga Adamonytė, Algis Kvaraciejus, Vytautas Magnus University, Agriculture Academy, Lithuania
-

ABSTRACTS

ORAL PRESENTATIONS

SOIL ORGANIC MATTER AND ITS ROLE IN THE ENVIRONMENT

Jerzy Weber

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Wroclaw University of Environmental and Life Sciences, Poland
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Soil organic matter (SOM) is a complex mixture of plants, animals, and microorganisms residues of different composition, degrees of transformation, availability, and environmental activity. Decades of research have shown that to recognize its role in the environment, it is necessary to separate it into components with different properties and behaviour. Lately, the method of separation of SOM into particulate (POM) and mineral-associated organic matter (MAOM) has been often used. Another approach is determination of carbon stabilization by different soil components, including biochemically protected C pool, a silt- and clay-protected C pool, a microaggregate-protected C pool, and an unprotected C pool. The classic alkali extraction method allows the separation of humic substances (HS), including humic acids, fulvic acids, and the humin fraction. The latter is the most resistant to decay SOM fraction.

SOM affect the physical, chemical and biological properties of soils to a much greater extent than other soil mass constituents, thus they are vital to maintaining soil fertility. The sorption capacity of SOM significantly exceeds this property of soil minerals, therefore it plays a key role in providing plants with nutrients, as well as inactivating pesticides, heavy metals and other contaminants. SOM also have a decisive impact on the pH buffering capacity of soils and cause the formation of stable aggregates, which in turn positively affects field water capacity, air capacity, porosity, and permeability. Additionally, the dark color of SOM causes an enhancement of sunlight absorption and an improvement of the thermal properties of soils, which is crucial for plant development, especially at the beginning of the growing season. HS are known to stimulate the growth of plants thus commercial HS products are commonly used as organic amendments for agricultural soils.

Soils contain more organic carbon than the atmosphere and vegetation combined together; therefore, mineralization of soil organic matter and release of carbon versus humification processes could greatly affect carbon capture and stabilization and consequently mitigation of climate change. For this reason, proper soil management should ensure that the SOM fractions most resistant to decomposition are created and stored in the soil.

HS are known to have a biostimulating effect on plants and animals, thus commercial humic products are used in agriculture, pharmacy and medicine.

Key words: *soil organic matter, humic substances, soil fertility, soil services.*

INFLUENCE OF GRANULAR ORGANIC FERTILIZERS FROM MEAT BONE MEAL WITH BIO-PREPARATIONS ON THE GROWTH PARAMETERS OF PAK CHOY

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Fertilisation of agricultural plants with organic fertilisers improves microbiological and biochemical processes in the soil. Meat bone meal (MBM) contains considerable amount of nutrients (~8% N, ~5–14% P and ~10–14% Ca) and other elements important for plant nutrition. Therefore, it can be used as an organic fertiliser for various crops. However, when fertilising with MBM, there is a quite long process of transformation to a form available to plants. To solve these problems, innovative bio-preparations were applied with granulated MBM to promote their faster decomposition to improve nutrients availability for plants.

The effect of granulated organic fertiliser MBM with bio-preparations on pak choy (*Brassica rapa* var. *Chinensis*) productivity has been evaluated in greenhouse pot experiments in Vytautas Magnus University, Agriculture Academy in 2021. Plants were grown in substrate – soil taken from Experimental Station fields. Substrate properties: neutral (pH 6.70), high phosphorus content (213–318 mg kg⁻¹ P₂O₅), moderate potassium content (103–125 mg kg⁻¹ K₂O), moderate humus content (1.57–1.86%). Experimental treatments were: 1) granulated MBM (control), 2) Bio1 (granulated MBM with bio-preparation 1 used for soil improvement), 3) Bio2 (granulated MBM with bio-preparation 2 for composting improvement). Observations were carried out in three stages: 1, 2.5, and 3 months after sowing.

It was found, that bio-preparations used with MBM had no significant influence on leaf area, root length and biomass, and dry matter in aboveground parts of plants in later stages. Granulated MBM with Bio2 significantly ($P < 0.05$) by 19% increased the chlorophyll index in the leaves of pak choy in the 2nd stage of the study.

Key words: bio-preparations, *Brassica rapa* var. *Chinensis*, granulated meat bone meal, organic fertilisers.

STABILIZING SOIL ORGANIC CARBON IN AGRICULTURAL SOILS FOR INCREASE OF SOIL MICROBIAL ACTIVITY AS THE MEASURE PROMOTING THE REDUCTION OF MINERAL FERTILIZATION

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The European Commission presented the measures within the Biodiversity Strategy 2030, the Farm to Fork and the European Climate Law regulations with including actions to protect soils. It addresses to soil pollution with 50% reduction in use of chemical pesticides and aims 20% reduction in fertilizer use to decrease by at least 50% of soil nutrient losses. Organic matter is a key component of soil that affects physical, chemical, and biological properties, contributing to proper functioning on which human societies depends. Benefits of soil organic matter include improvement of soil quality through increased retention of water and nutrients, resulting in greater productivity. Soil microbial communities are improving carbon use efficiency, since soil microorganisms are the main decomposers and drives biogeochemical nutrient cycling, either alters the plant-microbe interactions and affect plant health. Therefore, microorganisms may function as an excellent indicator of soil health change, thereby providing an early sign of soil quality improvement or an early warning of soil degradation.

In our study we hypothesized that soil organic carbon (SOC) input, SOC assimilation and organic carbon sequestration could differ due to implementation of organic and biological substances. We also hypothesized, that crop nutrient management, especially with nitrogen, could impact changes in soil carbon and nitrogen dynamic, in SOC content, in microbial abundance and in soil fungi/bacteria ratio. We also could indicate the biological, organic and mineral fertilization interactions in agricultural soils.

Short term field experiment with reduced tillage system along with straw treatments was carried out in 2020–2021 at intensively managed farming field in Boniškiai, Kaunas district, Lithuania (55°04'41", 24°01'41"), with following crop rotation: winter rapeseed (*Brassica rapa* L.), winter wheat (*Triticum aestivum* L.), winter wheat (*Triticum aestivum* L.), winter rapeseed (*Brassica rapa* L.), summer peas (*Pisum sativum* L.). The soil is *Endocalcaric Endogleyic Luvisol* (WRB, 2015). Soil samples were collected at 0–30 soil depth: in summer two times – 30 days and 60 days after application of fertilizers, and in autumn – 60 days after harvest. Experiment was designed with

following treatments: *factor A* – N – nitrogen fertilization (N_{100} , N_{150} , N_{180} and N_{230}); *factor B* – B – biological substances (*Bacillus megaterium* and *Bacillus subtilis* bacteria + *Trichoderma reesei* fungi; B- is not used, B+ is used 0.2 l ha⁻¹); *factor C* – O – organic substances (organic matter in granulating chicken manure pellets; O – is not used, O+ is used 200 kg ha⁻¹ dry matter). Our experiment had totally 16 treatments with 3 replications.

Experiment results shows higher decrease of soil mineral nitrogen and higher increase of soil organic carbon in treatments there biological substance was applied in higher fertilization rate. Therefore, greatest increase of soil C/N ratio was influenced by application of biological substances along with fertilization rate N_{180} and N_{230} . It was found that microbial abundance significantly increased in treatments, there organic substances was applied in lower fertilization rate N_{100} and N_{150} . Soil fungi/bacteria (F/B) ratio increase also was influenced by application of organic substances and showed greatest increase in treatments with fertilization rate N_{100} and N_{150} .

However, organic and biological substances were inducing more by biological SOC stability. It was evident that SOC accumulation was driven by microbial communities and microbial-derived SOC with higher soil fungal abundances and more efficient microbial biomass production.

Key words: *organic and biological substances, nitrogen fertilization, soil organic carbon, microbial abundance.*

GROWING AND PROTECTING CROPS DIFFERENTLY: ZERO-PESTICIDE AS A NEW PARADIGM

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Crop protection is compulsory to ensure safe and affordable food to all. In the last decades, in Europe, this has been mainly achieved with massive amounts of pesticides, with detrimental impacts on air, soil and water quality and on biodiversity.

The European Commission, through the Green Deal, set ambitious objectives of a 50% reduction of pesticides and hazardous pesticides. While considering that the crop protection is today in a lock-in situation where incremental innovations preserve the existing agri-food systems but fail in achieving drastic reduction of pesticide use.

In research, setting such an ambitious but non-prescriptive scenario of a crop protection without pesticide creates a paradigm shift. This shift is possible thanks to emerging fronts of science, such as advances in the understanding of the microbiota, of the odorscapes or plant immunity.

This paradigm shift includes three key principles that are prophylaxy to reduce the pressure of weeds, diseases and pests on crops, agroecology to increase biological regulations and value chains approaches.

The levers that have to be explored and used are: i) crop diversification, ii) plant genetics, iii) biocontrol and especially new options offered by microorganism strains and communities and organic volatile compounds, iv) advances in digital technologies and machineries, and v) organizational innovations, including new relationships in the supply chains and new mechanisms such as insurance to support farmers in the transition towards a pesticide-free agriculture.

Key words: *crop protection, sustainability, agroecology, innovation, adoption, public policies.*

RESULTS OF RESEARCH ON PESTICIDE FREE WEED MANAGEMENT USING INTER-ROW HOEING IN CEREALS

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The weed management system always affects the yield of field crops, especially in organic farming. There are various weed control strategies and methods, in addition it is important to understand which of them is suitable in specific agroecological conditions. In the cultivation of field crops, sowing in spaced rows with following inter-row hoeing are recommended as one of the approaches.

The study was conducted in the organically managed field of the Priekuļi Science Center of the Institute of Agricultural Resources and Economics, 2020–2022. Our aim was to find out whether the innovative method – inter-row hoeing – is more effective than the standard method – harrowing of the sowings. In the variant in which the sowing plot was harrowed, cereals (winter rye and spring oats) were sown in regular rows (12.5 cm) and in distant rows (25 cm) in variants where the camera steered inter-row hoeing was provided: in one variant – once and in the other – twice. Operation time for both methods was, when the small-seeded broad-leaved weeds having 2–4 true leaves up to 90%. The effectiveness of weed control was expressed as a percentage respective to reduction in the number of weeds compared to the control.

On average, 15–22 weed species were registered in both experimental fields. In two out of three seasons, the variant with the innovative weed management method showed relatively higher yield of cultivated crop. There were no statistically significant ($\alpha=0.05$) differences between the variants either in terms of variation (F test) or average weed dry mass (t test).

The results show that both methods are effective in controlling weeds. However, for effective control of weeds, timing of weed harrowing needs to be very precise, whereas the employment of inter-row hoeing is more flexible.

Key words: *weed control method and effectiveness, organic farming.*

The research was carried out within the framework of the EAFRD (European agricultural fund for rural development) project “Investigation of innovative cereal and legumes sowings care technology for application in weed control without the use of pesticides” (Nr.19-00-A01620-000054).

EFFECT OF ENDOPHYTIC BACTERIA ASSOCIATED WITH *ARTEMISIA* PLANT ON BIOLOGICAL CONTROL PEA ROT ROOT PATHOGEN

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Pea root rot is one of the major constraints to pea cultivation worldwide. Over-using conventional chemical fertilizers and pesticides, resulting in pollution of the environment and a decline in soil and human health. Medicinal plant-microbe interactions are one of the most widely studied phenomena, with the potential for customizing microbe formulations as a substitute for chemical inputs in enhancing plant growth and development. The genus *Artemisia* is a valuable resource for medicine and agriculture, industry. The aim of this study is to survey the population structure and diversity of endophytic bacteria of *Artemisia* sp. and their effect on pea root rot pathogen in sustainable agriculture.

Bacterial endophytes were isolated from roots, stems, and leaves of four different *Artemisia* species, *A. vulgaris*, *A. absintium*, *A. dubia*, *A. campestris* from Kaunas botanical garden, Vailainiai Kedainiai distr. and Šiauliai botanical garden in Lithuania. Two fungal pathogens isolated from the root of pea plants with signs of rot root, from Kedainiai distr., Akademia of Lithuania. In vivo screening of selected endophytic bacteria for antagonistic activity against the plant, pathogens have been done.

Finally, 151 strains were isolated based on unique colony morphologies on different isolation media. The diversity of the isolates varied based on the plant tissue, the highest number of distinct bacterial species was recovered from *A. campestris* root tissue (n = 18), compared to stems (n = 14) and leaves (n = 11). According to microscopic morphology, *Fusarium* sp. and *Aphanomyces* sp. were peas' isolated root rot pathogens. The antagonistic activity of all isolated bacteria showed 65 isolates had antagonistic activity on both fungi and displayed an enhanced inhibitory activity against the pathogen mycelial growth, but they had different inhibition percentages effect on *Fusarium* and *Aphanomyces*.

Identification of *Artemisia* endophytic bacteria possess a vital role to plant protection, improve plant growth, and could be used as inoculants to establish a sustainable crop production system.

Key words: *Aphanomyces* sp., *Artemisia* sp., Endophytic bacteria, *Fusarium* sp., Pea root rot.

TOWARDS A CHEMICAL PESTICIDE-FREE AGRICULTURE: OPPORTUNITIES FOR IMPROVING SOIL MICROBIOLOGICAL ACTIVITY AND PLANT NUTRIENT AVAILABILITY

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Agriculture is one of the most significant and important sectors globally. Soil fertility and agricultural production are highly dependent on which plant protection and growth promotion substance is used. Although applying mineral fertilizers can promote rapid crop growth, extensive mineral fertilizer use has reduced soil quality worldwide. Nowadays, special attention is focused globally on organic farming. Agricultural bio-stimulants are bioproducts that contain substances of natural origin along with beneficial microorganisms. They can be used to activate seeds, plants, and soil. Bio-stimulants are used in plants to improve nutritional efficiency, cause changes in vital and structural processes to affect plant growth, enhance abiotic and biotic stress tolerance and increase the yield and quality of products.

Bioenergy LT has come a long way since 2003 when it started out with the sales of biological fertilizers in Latvia. From the very beginning, the company aimed to change agriculture for the better and bring growers closer to the products and services they are lacking. This knowledge led the way to expand and open the new plant in Lithuania in 2013. Now Bioenergy LT is the largest innovative biotechnology company in Northern Europe in terms of production capacity. With the help of advanced production technologies, it develops and manufactures microbiological products for the enhancement of plant nutrition, restoration of natural soil fertility, fat digestion, water treatment, oil decomposition and other biotechnological processes. Bioenergy LT is a future-oriented manufacturing company that uses the most advanced technologies to implement intelligent and sustainable processes, to create and register new products that have a high added value, and respond flexibly to increasingly specific customer needs.

Bioenergy LT vision – to become a trustworthy and innovative global leader in developing biotechnologies, producing biological products, and providing sustainable biotech solutions and Bioenergy LT mission – with the help of constant strategical investments to develop scientific discoveries, upgrade the existing biotechnologies, and produce biological products that change community behavior.

Key words: *agriculture, organic farming, bio-stimulants, fertilizers.*

PRODUCTIVITY OF DIVERSE PLANT SPECIES IN RELATION TO EFFECTIVE PHOTOCHEMICAL YIELD

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Introduction of diverse, underutilized green vegetable species of different origins for cultivation in closed environment agriculture (CEA) systems (vertical farming, plant factories) promote its competitiveness and economic efficiency both regionally and globally. Nutritionally sensitive precise agriculture traits and proposed miscellaneous, rich in different phytochemicals and minerals green vegetable species, would promote the value of vegetable foods. The aim of this topic is biodiversification of underutilized leafy vegetable species in CEA and experimental explication of the impact of different artificial light intensity seeking to evaluate the relations between effective photochemical yield and plant productivity, thus developing efficient lighting strategies. *Amaranthus tricolor* cv. Amaranth Red Aztec, *Portulaca olearacea* Purslane Green, and *Mesembryanthemum crystallinum* Iceplant grew in controlled environment chamber in hydroponic system under photosynthetically active photon flux densities (PPFDs) maintained at 150, 200, 250 and 300 $\mu\text{mol m}^{-2} \text{s}^{-1}$ at 16 h photoperiod and 21/17° C day/night temperature. The results suggest that optimal plant yield productivity is not directly associated with the optimal electron transport rate. Species, tolerating higher light levels with higher electron transport rates, still have higher yield productivity in sufficient lighting intensity conditions compared to excess light intensity.

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Key words: underutilized leafy vegetables, productivity, controlled environment agriculture, artificial lighting, hydroponics.

THE PRODUCTIVITY OF MAIZE, HEMP AND FABA BEAN MULTI-CROPPED CULTIVATIONS

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The thematics of our research are currently carrying out contribute to the realization of the national strategy “Adaptation to climate change and protection of natural resources” and priority “Sustainable agricultural and food production systems and protection and sustainable use of natural capital”. They meet the mandatory objectives of the Common Agricultural Policy (CAP): to help mitigate climate change and develop sustainable energy; to promote sustainable development and effective management of natural resources. Investigations addresses strategic areas raised by the EU Green Deal, such as: independent energy from renewable resources and related climate change issues. It also allows to save the soil, to make agricultural production more efficient with the lowest energy and environmental costs. Therefore, contributes to the update of the policy priorities, policies and work areas of the European Bioeconomy Strategy (EBS (2018) 673); strengthening European competitiveness and job creation through the development of new high-value products from biomass (for example, biofuels/feed pellets).

For this reason, the stationary field research was initiated in 2020 at Vytautas Magnus University, Agriculture Academy, Experimental Station. The aim of the study was to ascertain the effect of crop diversity level on the crop productivity of biomass for energy purposes. Crops with different biodiversity levels were studied:

1. Maize single-crop;
2. Hemp single-crop;
3. Faba bean single-crop;
4. Maize and hemp binary-crop;
5. Maize and faba bean binary-crop;
6. Hemp and faba bean binary-crop;
7. Maize, hemp and faba bean ternary-crop.

The highest total fresh biomass of crops was established in single and multi-cropped maize; however, as expected, the highest total dry biomass was found in the ternary crop. The highest dried biomass of separate species (maize, hemp or beans) was observed of singly grown cultivations, except faba bean in ternary-crop.

In this crop, the dried biomass of faba bean was the highest, and it replace ternary-rop to the first place according to the dried biomass.

Key words: *Zea mays*, *Cannabis sativa*, *Vicia faba*, *multi-functional energy cultivation*, *biomass productivity*.

INFLUENCE OF DIFFERENT FERTILIZERS ON THE WATER QUALITY OF AQUACULTURE PONDS

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The aim of fertilizing of aquaculture ponds is not to enrich the soil, but to form a feed base for the fish, especially – fish larvae, later introduced into the ponds. The purpose of this study is to evaluate an effect of different natural organic fertilizers and different fertilization rates on the water quality of aquaculture ponds and the increase of the natural nutritional base for fish larvae and fish.

The study involved aquaculture farms that used chicken manure, cattle manure, straw, and bioenergy substrate for fertilization. The ponds were fertilized using different fertilizer rates. Samples were taken to determine water quality and biomass of phytoplankton and zooplankton. The obtained results were compared with the technological water quality standards for fish farming.

An analysis of the results of the main parameters of water quality showed that in all aquaculture ponds where fertilizers were used, the water quality met the established technological water quality standards for fish farming all time.

In the ponds where straw was used as fertilizer (rate – 570 kg ha⁻¹ of straw), the amount of phytoplankton reached 0.18 mg l⁻¹ and then decreased till 0.07 mg l⁻¹ in 4 weeks (fish larvae used phytoplankton as feed). The use of substrate (10 t ha⁻¹) influenced the increase of phytoplankton biomass from 0.27 mg l⁻¹ to 9.37 mg l⁻¹ in 4 weeks after fertilizing. Use of cattle manure increase phytoplankton biomass, but not so significant. Applying full fertilizer rate at once gave little increase of phytoplankton biomass 4 weeks after fertilization. Applying chicken manure twice in 4 week (half of fertilizer rate each time) increased phytoplankton biomass from 0.063 mg l⁻¹ to 19.3 mg l⁻¹ (fertilizer rate – 2500 kg ha⁻¹ of chicken manure).

An analysis of zooplankton biomass showed that biomass, determined at the beginning of summer, increased almost double in 4 weeks in all ponds. At the same time fish larvae used zooplankton as feed. Higher growth of zooplankton biomass was observed in ponds, where chicken manure was used, especially with a higher fertilizer rate: zooplankton biomass increased from 0.14 mg l⁻¹ to 5.51 mg l⁻¹ (fertilizer rate – 1,400 kg ha⁻¹) and from 3.05 to 36.92 mg l⁻¹ (fertilizer rate – 2,500 kg ha⁻¹). In the ponds where straw was used as fertilizer, the amount of zooplankton reached 11.7 mg l⁻¹ and decreased in 4 weeks till 1.57 mg l⁻¹ (fertilizer rate 570 kg ha⁻¹ of straw).

The obtained results show that the use of natural organic fertilizers does not deteriorate the water quality of the ponds and is an excellent measure for increasing the natural nutritional base of the fish, especially fish larvae.

Key words: *aquaculture pond, fertilizer, water quality, fish.*

CHALLENGES OF PREDICTING REGIONAL CROP YIELDS AND WATER BALANCE USING AGROECOSYSTEM MODELS AT HIGH RESOLUTION

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Mechanistic models have been developed to simulate the growth of plants, their yield formation and related processes in soil and atmosphere in order to inform about potential developments of agricultural production under climate change and other potential scenarios of changing boundary conditions. Output variables include agricultural yields and biomass production, the sequestration of carbon, losses of nitrate and greenhouse gases, the fate of water and many more. Such models have mostly been designed to operate at the point scale, and experimental data obtained from small-scale plant monitorings under different growing conditions and treatments is commonly used to parameterise, calibrate and validate the models. Using this type of models for predictions of regional crop yields and water balance requires a scaling approach, of which a gridded simulation is one option. Such simulation, however, requires suitable data products to drive the model, and a simulation infrastructure that enables efficient use of High Performance Computing facilities.

The data component includes all information that the model demands for its calculations, including weather, soil, and agricultural management. Weather data products are increasingly available in high resolution, as a higher degree of digitalisation at the level of the meteorological stations allows real-time data retrieval and also a very quick postprocessing and delivery. Digital soil maps and the underlying soil profile information is under development in many areas of the world, although the resolution may differ. Machine Learning algorithms help to fill spatial gaps towards uniform global data products, but the topical detail is often still to improve. Agricultural management, however, is extremely difficult to obtain across larger areas. First remote sensing applications give rise to the expectation that crop types (Blickensdörfer et al., 2022), sowing dates (REF) and irrigation applications (Zappa et al., 2021) can be determined from space, and mowing events or grazing patterns in grasslands seem also to be detectable (Schwieder et al., 2022). The determination of nitrogen application levels appears more of a challenge, and first attempts to quantify crop biomass at harvest still report high uncertainties. Soil tillage determination requires short revisit times of the observation platform, and the depth of the tillage event then remains

still at question. Unsolvable at the moment seems any qualification of crop protection measures. Only the failure of such measures, which results in pest and disease outbreaks with visible damages in crops is a matter of satellite observation. Here, more and more examples add to the list of successful determinations of pest- and disease related yield reductions (Ibrahim et al., 2021).

Simulation infrastructures serve multiple purposes. Beside the provisioning of tools and methods to interlink different models to use the output of one model to drive another model (e.g. economic models using crop yields obtained from crop models), or the ability to interchange parts of models (modules, algorithms) to test for performance impact, the operability of models for specific, repeatedly demanded applications without bothering about the required input data is the most important reason for which simulation infrastructures are being constructed. With the increasing need for powerful computers and the increasing availability of big data sources, the demand for high-performance simulations emerges. Such infrastructure is often only available in some institutions, where large amounts of institutional money is used to equip, maintain and operate such facilities. Smaller, decentralised infrastructures often find their limits in data security issues. However, the revival of object capabilities to control ownership in decentralised infrastructures promises organically growing, grassroot type simulation projects and the inclusion of smaller and less well-resourced institutions and individuals.

Key words: *large-area simulations, mechanistic models, agro-ecosystem models, big data, simulation infrastructure, object capabilities.*

CARAWAY (*CARUM CARVI* L.) IN MULTIFUNCTIONAL CROPS AND INTEGRATED ASSESSMENT OF ITS IMPACT ON THE AGROECOSYSTEM

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The multifunctional crops could be an effective agricultural practice that includes soil improvement, balancing nutrient cycling, while increasing the yield of caraway seeds by growing them as a intercrop. Multifunctional crops is the cultivation of two or more agricultural crops with different biological and agrotechnical characteristics in the same field.

The research is carried out from 2017–2019. Vytautas Magnus University Agricultural Academy Experimental Station. The soil of the experimental site was Endocalcaric Amphistagnic Luvisol, according to the World Reference Base. Soil agrochemical properties: pH – 6.70, humus – 1.57–1.86%, mobile nutrients in soil: P₂O₅ – 213–318 mg kg⁻¹, K₂O – 103–125 mg kg⁻¹. Thus, the above-listed soil characteristics show that the topsoil richness in organic carbon is low, but the available phosphorus corresponds to group V (very high content) and potassium to group III (average concentration) according to the evaluation of agrochemical properties of Lithuanian soil. The aim of the study was determined the agrochemical, agrophysical and biological properties of soils under multifunctional crops. Also was assessed the weediness and yield of caraway using multifunctional crops and finally was conducted an integrated assessment of the impact of multifunctional crops on the agroecosystem. In the 2017–2019 multifunctional crops, the soil agrochemical, agrophysical and biological properties of the soil showed that trinary and, in some cases, binary crops were superior to sole crops. The calculated indicators of the integrated assessment and the areas limited by the assessment scores showed that the positive impact on the agroecosystem of the binary spring barley and the trinary spring barley, spring wheat crops was higher than that of the other comparative sole, binary and trinary crops.

Key words: *Caraway, multifunctional crops, integrated assessment, agroecosystem.*

INCENTIVISING THE UPTAKE OF PRECISION AGRICULTURAL TECHNOLOGIES IN GRAIN FARMING: EMPIRICAL EVIDENCE FROM CHOICE EXPERIMENTAL SURVEY IN SPAIN

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In recent years, the use of Information and communications technology (ICT) and precision agricultural techniques has evolved to support farmers' decision-making at different stages of the production cycle, including seeding, fertilization, disease detection, spraying, irrigation and harvesting. The uptake of precision farming technologies, especially newly developed ones, in Europe is low. One of the new technologies combines Preventive Site Specific Spraying (PSSS) and selective harvesting (SH) to reduce the risk of mycotoxin contamination in food products originated from barley and wheat grains by adopting smart farming technologies. Generally, an eventual decision by farmers to adopt this new technology is complex as it includes different trade-offs between the possible farming, economic and environmental changes to be achieved. Therefore, aim of this study was to investigate factors that influence Spanish wheat farmers' decision to adopt PSSS and SH technology, and to examine farmers' preferences and willingness to pay for using the technology. We conducted choice experimental survey with Spanish wheat farmers. The results of conditional and mixed logit models revealed that Spanish wheat farmers are heterogeneous in their choice of precision agricultural technology and that farmers' choice of a given smart farming solution depends on both financial and non-financial utilities obtained from the choice. Specifically, farmers have higher preferences for 20% and 15% improvement in greenhouse gas (GHG) balance, respectively. A potential increase in grain yield of about 0.6 tons per hectare would significantly influence farmers' decision to adopt the technology. Farmers are willing to adopt the PAT if selective SH can lead to a 20% increase in profit due to quantitative prediction of mycotoxin. In addition, Spanish farmers were willing to offer €106 and €135 for 15% and 20% improvement in GHG yearly balance, respectively. Farmers were willing to offer €49 for 20% increase in

profit due to quantitative prediction of mycotoxin. The general conclusion is that Spanish wheat farmers are interested in adopting precision agricultural technologies that combine SH and PSSS. Another important conclusion is that farmer's interest in precision agricultural technologies does not only hinge on the technology's economic return; but also, on the environmental aspect of reducing GHG emission.

Key words: *choice experiment, selective harvesting, preventive site-specific spraying, willingness to pay.*

APPLICATIONS OF SMART TECHNOLOGIES FOR MONITORING FOOD QUALITY AND SAFETY TO IMPROVE TRACEABILITY AND CUSTOMERS TRUST

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Concern about food safety has become a hot topic, and numerous researchers have come up with various effective solutions. To ensure the safety of food and avoid financial loss, it is important to improve the safety of food information in addition to the quality of food. In the context of epidemic prevention and control, food safety monitoring, data analysis and food safety traceability have become more important. At the same time, the most important reason for food safety issues is incomplete, opaque, and asymmetric information. The most fundamental way to solve these problems is to do a good job of traceability, and establish a reasonable and reliable food safety traceability system. The traceability system is currently an important means to ensure food quality and safety and solve the crisis of trust between consumers and the market. Technology solutions, such as the Internet of Things (IoT), Artificial Intelligence (AI), Privacy Preservation (PP), and Blockchain (BC), are proposed for food monitoring, traceability, and analysis of collected data, as well as intelligent decision-making to support the selection and the data storage function in big data to obtain information in the food production process. The whole process of food production information can be traced through the design of dynamic query platform and mobile terminal. The food safety traceability system based on big data and the Internet of Things guarantees the integrity, reliability and safety of traceability information from a technical level. This is an effective solution for enhancing the credibility of traceability information, ensuring the integrity of information, and optimizing the data storage structure.

Key words: *food safety, artificial intelligence, internet of things.*

ANTHOCYANINS AND CHLOROPHYLLS CHANGES IN *SOLANUM* SPP. FRUITS DURING RIPENING

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The genus *Solanum* belongs to the Solanaceae family which is otherwise known as wonder-berry or sun – berry and is used in pharmacy with health benefits. This work presents the research of anthocyanins and chlorophylls composition in different ripening stages of *Solanum melanoscerasum* and *Solanum nigrum* fruit. The aim of the experiment is to study the change in anthocyanins and chlorophylls of *Solanum* spp. fruits during ripening.

Two genotypes of *S. melanoscerasum* and *S. nigrum* fruit were cultivated at Kaunas, Noreikiškės, Marius Staveckas farm in 2021–2022. Fruits were harvested three times in season according to ripening stages. Stage I – fruit color green, stage II – 30–60% color purplish-violet, the inside is incompletely ripe, stage III – 100% color velvety black blue, inside fully ripe. After harvesting the fruit samples were lyophilized 24 hours using Sublimator 3x4x5 (ZIRBUS Technology GmbH, Bad Grund, Germany). After lyophilization fruits were milled (Grindomix GM 200, Retsch GmbH, Haan, Germany) and stored in airtight containers at 5 °C in the dark until chemical analysis. Analysis of anthocyanins was determined by the pH-differential method. The chlorophylls – spectrophotometrically using the values of absorption coefficients in methanol, acetone.

The results demonstrated that the significantly highest contents of total anthocyanins were identified in the *S. melanoscerasum* species in fully ripe fruit. The significantly highest contents of total chlorophylls were identified in the *S. nigrum* fruits in the first ripening stage.

Key words: ripening stage, fruit, anthocyanins, chlorophylls.

STUDIES OF THE VARIABILITY OF BIOLOGICALLY ACTIVE AND ANTICANCER COMPOUNDS IN ORGANICALLY GROWN FERMENTED FIREWEED (*CHAMERION ANGUSTIFOLIUM* (L.) HOLUB) LEAVES

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The demand for organic production is increasing worldwide everyday. The fireweeds, grown in an organic way, contributes greatly to the idea of a healthier society. Fireweeds are widespread in the world and has high polyphenols and antioxidant properties, and they can be used for cancer treatment.

The aim of this work was to investigate flavonoids, phenolic acids, tannin oenothin B (which has the highest anticancer properties in fireweeds) and antioxidant activity in fireweeds leaves fermented for 24, 48 and 72 h in solid-phase fermentation (SPF) under aerobic and anaerobic conditions. High-performance liquid chromatography (HPLC) for polyphenols and the spectrophotometric method for antioxidant activity determinations were used. Principal component analysis (PCA) was used to describe differences in biologically active compounds between fireweeds samples. The experiment showed that the highest quantity of total phenolic acids was determined after 48 h anaerobic SPF, but the amounts of total flavonoids and tannin oenothin B were higher after 72 h anaerobic SPF, compared to control. Fireweeds leaves after 72 h aerobic SPF had a higher antioxidant activity, compared to not-fermented leaves.

In conclusion, the obtained results provide new knowledge about the influence of technological parameters of solid-phase fermentation on the quantitative composition of flavonoids, phenolic acids, tannins and antioxidant activity in fireweeds leaves. According to the results of this experiment, solid-phase fermentation with various technological parameters can be used to prepare high-quality organic products (foods and food supplements) from organic fireweeds leaves.

Key words: *antioxidant activity, fermentation, fireweed, organic.*

Acknowledgement. *The study was funded by the Ekshagastiftelsen for application "Studies of the variability of biologically active and anticancer compounds in organically and biodynamically grown and fermented fireweed leaves" (No. 2021-67).*

RETHINKING RESILIENT AGRICULTURE: FROM CLIMATE-SMART AGRICULTURE TO VULNERABLE-SMART AGRICULTURE

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Climate-Smart Agriculture (CSA) is seeking to overcome the food security problem and develop rural livelihoods while minimizing negative impacts on the environment. However, when such synergies exist, the situation of small-scale farmers is often overlooked, and they are unable to implement new practices and technologies. Therefore, the main aim of this study is to improve CSA by adding the neglected but very important element “small-scale farmer”, and introduce Vulnerable-Smart Agriculture (VSA) as a complete version of CSA. VSA indicates, based on the results of this study, that none of the decisions made by policymakers can be realistic and functional as long as the voice of the farmers influenced by their decisions is not heard. Therefore, to identify different levels for possible interventions and develop VSA monitoring indicators, a new conceptual framework needs to be developed. This study proposed such a framework consisting of five elements: prediction of critical incidents by farmers, measuring the consequences of incidents, identifying farmers’ coping strategies, assessing farmers’ livelihood capital when facing an incident, and adapting to climate incidents.

Key words: *vulnerability, sustainable livelihood, food security, climate change, small-scale farming.*

ABSTRACTS

POSTER PRESENTATIONS

LONG-TERM IMPACT OF REDUCED INTENSITY TILLAGE SYSTEMS COMBINATIONS ON SOIL PROPERTIES

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In Experimental station of Vytautas Magnus University, Kaunas district, Lithuania, a long-term field experiment has been established since 1999. The field experiment was conducted at 54°52'50" N latitude and 23°49'41" E longitude on Planosol. Humus layer thickness – 25 cm, slightly alkaline with pH of 7.6, average humus content – 2.86 mg kg⁻¹, average potassium content – 134 mg kg⁻¹ and high phosphorus content – 266 mg kg⁻¹.

A short crop rotation was introduced: spring oilseed rape (*Brassica napus* L.), winter wheat (*Triticum aestivum* L.), and spring barley (*Hordeum vulgare* L.). The aim of our investigation was to find out long-term impact of reduced intensity tillage systems with straw and green manure combinations on soil aggregation and stability, soil temperature, productivity.

It was found that straw incorporation to compare without straw have no significant effect on soil water content and temperature. Shallow tillage systems, compared with a deep ploughing, significantly reduced soil water content and temperature.

Straw incorporation improved soil aggregation at 10–25 cm depth. Amount of macro aggregates increased by 12.5% and micro aggregates decreased by 20%. Shallow rotovating at 5–6 cm depth improved soil structure by 20.3% due to the increased macro aggregates and decreased amount mega aggregates by 30.7%, compared with a deep ploughing.

Straw incorporation had no significant influence on aggregate stability, but effect of soil tillage intensity was significant. Shallow rotovating, catch cropping for green manure and rotovating and no-tillage direct drilling increased stability of aggregates from 74.4 to 90.4% in upper soil layer (0–10 cm), and from 32.8 to 38.3% in lower soil layer (10–25 cm), compared with a deep ploughing.

Key words: long term, tillage systems, productivity, agroecosystems stability.

EFFECT OF BIOLOGICAL PREPARATIONS ON THE BIOMETRIC PROPERTIES OF 'FUTURA 75' HEMP STEMS

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In Lithuania, the area under cannabis cultivation is increasing every year and the market is seeing an increasing supply of cannabis products.

However, there is a major problem with cannabis cultivation – the stems. The latter contain a lot of cellulose, which makes it more difficult for the stems to decompose in the soil. If hemp is grown for inflorescences, the stems that remain in the field are tough and it is not an easy job to get them into the soil. The bark of the stems themselves is strong and difficult to break due to the fibre content. As a result, when working the land, unbroken stems will drag around implements, impairing the quality of sowing or other work. To tackle this problem, farmers have been using higher rates of nitrogen fertiliser since the collective farms, which encourages mineralisation of the hemp stems by activating micro-organisms. However, this is not the most effective measure. Nor will this solution to the stem problem have to be abandoned in the near future. The reason for this is the European Union's Green Deal objective. This objective calls for a reduction in mineral fertiliser rates and more sustainable farming. The problem of stems may lead to a decline in cannabis cultivation again, but it is not the first decade that biological agents have been tested which could solve the problem of decomposition of cannabis stems and enrich the soil with nutrients.

This study was carried out in the laboratory using cannabis stems and two different biological preparations on them. The aim of the study was to determine the effect of the tested bio-agents for the activation of mineralisation of plant residues on the change in the mass of the stems of hemp and on the change in the diameter of the stems of different diameters.

In summary, the results show that the use of biological products is recommended to accelerate the decomposition of cannabis stems, with thinner cannabis stems not being affected by the chosen product, and thicker stems being affected by the biological product Ruinex 2 l ha⁻¹.

Key words: *fibrous sowing hemp, biological preparations, stems, biometric properties.*

SOIL PROPERTIES AFTER LONG-TERM REDUCED TILLAGE, NO-TILL AND RESIDUE MANAGEMENT

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Long-term fixed experiment, set up in 1999, at the Experimental Station of Vytautas Magnus University. The soil of the experimental site is Epieutric Endocalcaric Endogleyic Planosol (Endoclayic, Aric, Drainic, Humic, Episiltic) according to WRB 2014 classification. The long-term experiment was laid out in a split-plot design with 4 replications and a total of 48 plots. The following crop rotation sequence was employed: spring oilseed rape, winter wheat, spring barley. In one part of the experiment, the straw was removed (R), and in the other part the straw was chopped and spread (S). The aim of our investigation was to find out long-term impact of reduced intensity tillage systems with straw and green manure combinations on soil shear strength.

All tillage systems in 2022 were studied in both parts of the experiment, i.e. with straw removed and straw chopped and spread. Long-term application of reduced tillage results in a significant increase in soil penetration and soil shear resistance. The lesser the tillage depth, the higher the soil penetration and soil shear resistance. The effect of plant residue spreading is lower.

Key words: *no-till, shear resistance, crop rotation, long-term.*

CHANGES OF SOIL ORGANIC CARBON AND MOBILE HUMIC ACIDS CARBON CONTENT UNDER LONG-TERM RED FESCUE (*FESTUCA RUBRA* L.)

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The cultivation of perennial grasses increases the amount of organic matter in the soil, which at the same time leads to the accumulation of soil organic carbon (SOC). This process is influenced by the abundant root systems of these plants, which accumulate more carbon in their biomass.

Red fescue (*Festuca rubra* L.) is a long-lived grass that forms a strong turf and is undemanding to climatic conditions and soil. It is one of the most used grasses for decorative, sports and other lawns, and also a common component of many grass mixtures due to its resistance to frequent mowing and grazing.

This study aimed to investigate and compare the carbon accumulation and storage capacity of the soil on which these plants were grown for 5, 10, and 15 years and an arable field at the same site.

The experiment was established at Institute of Agriculture, Lithuanian Research Centre for Agriculture and Forestry, Akademija, Kedainiai district, in perennial grasslands on a *Cambisol*. Soil samples were taken with a steel auger from three replications of the topsoil (0–10, 10–20, and 20–30 cm depth). The SOC content was determined by a spectrophotometric measurement after dichromatic oxidation (Nikitin modified Tyurin method), mobile humic acids carbon (C-MHA) – according to Ponomareva and Plotnikova modified Tyurin method. The data were analysed using the software SAS Enterprise, version 7.1 (SAS Institute Inc., USA). The analysis of variance (ANOVA) was performed, and the data were compared using Fisher's least significant difference (LSD) test at the probability level of $P < 0.05$.

Red fescue, cultivated for a long time, did not lose its vitality and significantly increased the amount of SOC and C-MHA in the soil. The amount of SOC, depending on the soil depth and the age of the red fescue grass, increased by 1.3–2.8 times compared to the arable field. The highest content of C-MHA was determined in the upper 0–10 cm soil layer, where the most intensive carbon transformation process occurs.

This study confirms that more extended grassland maintenance is an important agricultural and environmental welfare management practice to improve SOC sequestration in the soil.

Key words: red fescue, soil organic carbon, land use, long-term grassland.

THE CHANGE OF SOIL PHYSICAL PROPERTIES IN DIFFERENT SOIL SUBSTRATES AFTER THE USE OF BIOLOGICAL PREPARATION

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In order to provide soil with food, it must be fertilised. In the light of the environmental requirements and the implementation of the European Green Deal, the use of bio-based products is encouraged. Biological preparations or their combinations affect soil properties. Long-term use of biological preparations leads to changes in the physical properties of the soil: its soil structure and stability, density, electrical conductivity, temperature, porosity.

The aim of this experiment was to determine the effect of biological preparation on soil physical properties in soil substrates of different properties in strawberry cultivation under laboratory conditions. The laboratory tests were conducted in a special greenhouse at the Vytautas Magnus University, Agriculture Academy, which is equipped to maintain natural climatic conditions. The experiment was carried out in May–August of 2019. Five substrates of different properties were selected: loamy, clay, sandy, compost and coconut coir soils. Dessert strawberries were grown in special “Asia” containers. In all cases the plants were watered with a molasses and magnesium sulphate based biological preparation. In the control variant, all plants received only water.

When biopreparation was used, the soil temperature was slightly higher than in the variant without biological preparation, but the effect was insignificant. During the experiment, an increase in electrical conductivity in loamy soil from 0.09 to 13.20% was recorded, compared to soil where no biological preparation was used. In contrast, the electrical conductivity in coconut coir was higher by 6.4 to 58.14% in soil where no biopreparation was used. Significant differences in electrical conductivity were observed between sandy and loamy soil variants on May 29, June 6, 13 and 21 in both variants. Analysis of air-filled porosity data has revealed that coconut coir substrate significantly improves soil air-filled porosity.

Key words: *biological preparation, strawberry, soil physical properties.*

INFLUENCE OF BIO-CARBONISATE ON THE SOIL ORGANIC MATTER QUALITY

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The content of organic matter in soil is an important factor of its fertility and thus efficiency of agricultural production. In degraded soils or soils with a low content of organic matter, soil amendments with a diversified composition depending on their origin are used. In recent years, much attention has been focused on biocarbonizates as effective products that improve soil properties, and thus the content of soil organic matter.

The aim of the research was to assess the effect of the addition of biochar, obtained in the processes of high-temperature combustion (630 °C), on the fractional composition of soil organic matter expressed by the content of humic substances. The analyzes were carried out on five soils with different C_{org} content (7.0–12.7 g kg⁻¹), N_{total} (0.76–1.17 g kg⁻¹), clay fraction (0–4%) and pH ($\text{pH}_{\text{KCL}} = 4.4\text{--}5.3$), which were enriched with a 5% dose of biochar. Fractional composition of soil organic matter (FU: low molecular weight fulvic fraction, FA: fulvic acids, HA: humic acids, HUM: humins) was determined in soils (without the addition of biochar and with the addition of biochar) after nine months of incubation (humidity: 60% ppw, temperature: 20 ± 1°C) using the method recommended by IHSS.

Studies have shown that the addition of biocarbonizate will significantly change the fractional composition of organic matter by increasing the content of labile fractions, i.e. FU (9–43%), FA (2–45%), HA (4–51%) and a decrease in the stable HUM fraction (7–37%). This resulted in a decrease in the degree of humification of organic matter from 1 to 21%. Nevertheless, the total content of humic substances did not change significantly under the influence of biochar addition, which means that biochar will mainly change the proportion between fractions, inducing the processes of their transformation towards decomposition / mineralization of resistant forms.

Key words: soil organic matter, humic substances, biochar, soil amendments.

Acknowledgments: The studies were supported from the National Science Centre project No. UMO-2018/29/N/ST10/01320 “Analysis of the fractional composition and sorption properties of humic substances in relation to various groups of organic contaminants”.

EFFECT OF SOIL CRUST BREAKER ON THE EMERGENCE OF SOME VEGETABLE SEEDS

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The soil crust is the boundary layer between the atmosphere and the soil, where the mass and energy transfer take place. It affects the evaporation rate, the infiltration rate, and emergence rate of seedlings. The effect of soil crust is more important in vegetable cultivation, because in general, vegetable seeds are small and emergence force are low. Therefore, even small soil crust resistance negatively affects emergence of vegetable seeds. If uniform seedling emergence is achieved in vegetable production, the crop will have a greater proportion of yield at high value size grades at harvest than a non-uniform emerged crop. In this case, uniform emergence means optimal final plant stand and more importantly, a narrower time window for final plant stand in the field.

Soil crusting is a serious problem especially in southern part of Turkey; it restricts the emergence of vegetable crop seedlings such as onion, carrot and watermelon. The period between the sowing and seedling emergence is critical in relation to soil crust. If the dry and hot weather follows the rain in this period, soil crust will probably be formed and emergence of the seeds will be critical. The farmers use the tillage equipment such as harrows (disc or tine) to break soil crust in Turkey and developing countries. Because of the uncontrolled cultivation depths, these equipment can damage the germinated seeds in soil.

Mechanical, rolling type soil crust breaker was designed and tested in the field for onion, carrot and watermelon cultivation. The soil crust breaker is of simple construction, and it breaks the soil crust over the rows of germinated seeds effectively, improving emergence significantly. Application of the crust breaker increased the percentage of emergence of tested seeds at least 28.5%. Crust breaker can be manufactured as a single-row unit or a multiple row and can be operated manually or pulled by a tractor.

Key words: *soil crust breaker, onion, carrot, watermelon, seed emergence, germination.*

IMPACT OF SOIL BIOSTIMULANTS ON SOIL CARBON AND NITROGEN DYNAMICS UNDER WHEAT CROP

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The field experiment was performed at the Experimental Station of Vytautas Magnus University, Agriculture Academy. The soil of the experimental site was Endocalcaric Endogleyic Luvisol (WRB, 2022). A two-factor field experiment was performed on the crops of spring wheat "Wicki" in 2020. Factor A – soil tillage technology: (1) no-till (2) reduced tillage; factor B – biostimulants and their mixtures: (1) N8 – compensatory nitrogen 8 kg per tonne of straw, without biostimulants; (2) Ruinex 1 L ha⁻¹; (3) Pernergetic k 0.2 L ha⁻¹; (4) Azofix L ha⁻¹; (5) Ruinex 1 L ha⁻¹ + Pernergetic k 0.2 L ha⁻¹; (6) Ruinex 1 L ha⁻¹ + Azofix 0.5 L ha⁻¹; (7) Pernergetic k 0.2 L ha⁻¹ + Azofix 1 L ha⁻¹; (8) Ruinex 1 L ha⁻¹ + Pernergetic k 0.2 L ha⁻¹ + Azofix 0.5 L ha⁻¹. The hypothesis: biostimulants and their mixtures will improve soil agrochemical properties and their effects under no-till and reduced soil tillage can be different. The objective of the work was to assess the decomposition of the wheat straw using two different soil tillage management and the use of different biostimulants as facilitators for soil microbial activity. Tillage technologies had a significant impact on the content of water-soluble carbon. Under no-till, its content increased by an average of 9.0%, and under reduced tillage, its content increased by only 2.3%. The combination of no-till with catch crops increased the stocks of soluble C in the soil. Compared to the use of compensatory nitrogen, this indicator was increased by all biostimulants, especially when using all three preparations in the mixture. The results of three years show that biostilants promote the release of mobile humic substances and humic acids better than compensatory nitrogen for straw decomposition. The effect was the same on the humus content.

Key words: *soil properties, no-till, reduced tillage, wheat crop.*

THE INFLUENCE OF DIFFERENT LONG-TERM CROP ROTATIONS ON SOIL HYDROPHYSICAL PROPERTIES IN SPRING BARLEY CROPS

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Soil water content is one of the most important factors affecting soil ecosystem health. It influences plant growth, crop yield, and is also vital for organisms in the soil (Ankenbauer et al., 2017). The soil water capacity describes the maximum amount of water moisture that the soil can retain (Zhang et al., 2021).

Research aim was to investigate the effect of different pre-crops of long-term crop rotations on soil hydrophysical properties.

Objectives: to determine soil moisture content, water retention capacity, temperature, bulk density, total porosity and CO₂ emissions in various crop rotations after different preceding crops.

The long-term stationary field experiment (crop rotation collection) was established in 1966 at Vytautas Magnus University Experimental Station in Kaunas, Lithuania (54°53' N, 23°50' E) and has been continued until now. The investigation was performed in 2021 on spring barley 'Orphelija'. Research methods: soil moisture, temperature and soil-CO₂ emissions were determined by IRGA method. Water retention capacity was determined by sorption (pF) method. Results obtained by this analysis were used to calculate soil bulk density and total porosity.

Research results: In spring barley – after fodder beetroot in the fodder rotation and after potatoes in green manure and Norfolk rotations. Preceding crops, which left a higher amount of plant residues, resulted in higher soil moisture content, lower soil temperature and higher soil-CO₂ emission. Preceding crops had no significant effect on soil bulk density and total porosity.

Key words: *crop rotations, pre-crops, water capacity, porosity, soil-CO₂ emissions.*

EFFECTS OF BIOPESTICIDES AND UNDERSOWN COVER CROPS ON SOIL BIOLOGICAL PROPERTIES IN THE ORGANIC FARMING SYSTEM

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Around the world, there is a growing emphasis on maintaining soil fertility and vitality. Undersown cover crops can improve soil properties and organic matter content which can reduce soil loss and improve land productivity. Biopesticides are an alternative of agrochemicals to improve soil fertility and control various insects, pests and diseases in almost all agricultural crops

The field experiment was carried out in 2021 at the Experimental Station of Vytautas Magnus University, Agriculture Academy. Soil – *Endocalcaric Amphistagnic Luvisol*. The aim of the research was to determine the influence of biopesticides and undersown cover crops on soil biological properties under the conditions of organic farming system.

Experimental applications: Factor A: biopesticides: 1) not used; 2) used. Factor B: undersown cover crops: 1) no cover crop; 2) crimson (incarnate) clover (*Trifolium incarnatum* Broth.) 'Kardinal' (10 kg ha⁻¹); 3) hairy (winter) vetch (*Vicia villosa* Roth.) 'Rea' (50 kg ha⁻¹); (4) perennial ryegrass (*Lolium perenne* L.) 'Merkem' (10 kg ha⁻¹); and 5) winter rye (*Secale cereale* L.) 'Elias' (50 kg ha⁻¹). Spring oilseed rape (*Brassica napus* L. spp. *oleifera biennis* Metzg.) 'Fenja' (7 kg ha⁻¹) was sown at 48 cm row spacing. At the 2–3 leaf stage (BBCH 12–13), the inter-rows of oilseed rape were loosened with a soil loosener and two rows of cover crops were undersown in the oilseed rape inter-rows.

The results of our research showed that the plots with cover crops undersown in spring oilseed rape and with both non-used and used of biopesticides demonstrated significantly higher plant root biomass, compared to the plots without cover crops. Undersown cover crops and biopesticides had no significant influence on soil enzyme saccharase activity. The highest number of earthworms was found in the plots without undersown cover crops and biopesticides application. The highest biomass of earthworms was established in the plots with undersown winter rye and biopesticides application. The highest soil-CO₂ emission was established in the plots with undersown crimson clover and with the used of biopesticides.

Key words: biopesticides, undersown cover crop, soil properties, spring oilseed rape, organic farming system.

EFFECT OF HUMIC ACID AND SILICON ON WINTER WHEAT

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In agriculture, soil health is the most important foundation for a healthy farm ecosystem. However, most intensive crop production technologies, such as the application of synthetic fertilizers and intensive agriculture, can only degrade the soil over time. Farms, in order to obtain a better harvest, intensively use mineral fertilizers and chemical plant protection measures, which can accelerate the appearance of various negative factors: soil degradation, reduction of biological diversity, pollution of the entire environment and agricultural food production with excessive amounts of chemical residues. One of the main indicators of soil fertility is the amount of humus in the soil. Soil properties and plant productivity are closely related to the amount of humus and its qualitative composition. One of the simplest and most effective ways to increase the amount of humus in the soil is to add preparations containing humic acids.

Silicon balances the entry and circulation of nutrients in the plant, participates in the formation, transport and distribution of manganese, which is important in chlorophyll, removes excess amounts of micro and macro elements, strengthens the immunity of a weakened plant, thickens cell walls, strengthens stems.

The investigations were carried out at the Experimental Station of Vytautas Magnus University, Agriculture Academy, Lithuania, in 2021–2022, in *Calc(ar)i-Endohypogleyic Luvisol*, a semi-neutral (pH_{KCl} 6.9), high phosphorus ($232.6 \text{ mg kg}^{-1} \text{ P}_2\text{O}_5$), mid-potassium-level ($111.0 \text{ mg kg}^{-1} \text{ K}_2\text{O}$), mid-humus-level (2.39%) soil, in order to evaluate the effect of humic acid and silicon on winter wheat crop. Treatments of the experiment: 1) fertilizer $\text{N}_5\text{P}_{15}\text{K}_{30}\text{S}_5$ with microelements B and Zn, 2) fertilizer $\text{N}_5\text{P}_{15}\text{K}_{30}\text{S}_5$ with microelements B, Zn, humic acid and silicon. Local fertilization (300 kg ha^{-1}) was used during sowing. Fertilizers with humic acids and silicon increased the area of plant leaves and the amount of chlorophyll pigments, compared to fertilizers without humic acid and silicon. Using fertilizers with humic acid and silicon improved the soil properties and increased the mass of the plants and their roots, and at the same time the productivity of the winter wheat yield.

Key words: *winter wheat, area of leaves, chlorophyll pigments, winter wheat productivity.*

INFLUENCE OF SOWING TIME AND SEED RATE ON PRODUCTIVITY OF WINTER WHEAT (*TRITICUM AESTIVUM* L.)

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In the era of climate change, considerable improvement in cereal production is inevitable to feed the ever increasing and burgeoning population and to maintain global food security. Sowing date is one of the most important agronomic factors which need great emphasis for maximum yield of crops. Optimum sowing date positively affect grain yield and quality of wheat and causing better adjustment to the physiology, phenology and environmental conditions.

The field research was performed at Vytautas Magnus University Agricultural Academy Experimental Station in years 2018–2019. A two-factor experiment investigated the effect of seed rate on the productivity of winter wheat sown at four different sowing dates.

Factor A – sowing dates: 4 September; 14 September; 21 September; 1 October.

Factor B – seed rate: 2.0 million seeds ha⁻¹; 3.0 million seeds ha⁻¹; 4.0 million seeds ha⁻¹; 5.0 million seeds ha⁻¹.

Before the experiment, topsoil pH_{KCl} was from 7.0 to 7.1, the concentration of available P₂O₅ varied from 234 to 260 mg kg⁻¹, available K₂O varied from 126 to 152 mg kg⁻¹, humus content varied from 2.05 to 2.19%.

Winter wheat sown on 21 September, matured grains of the best quality, in which, depending on the seed rate, the following were found: protein – 14.4–14.8%, wet gluten – 30.0–31.0%, sedimentation values – 52–55 ml. Inferior grains matured in the early sowing (4 September) wheat crop, and in the late sowing (1 October) the best grain quality was found in the rarest (2.0 million ha⁻¹ seed rate) crop. Winter wheat sown on 4, 14 and 21 September yield, depending on the seed rate, ranged from 6.2 t ha⁻¹ to 7.5 t ha⁻¹, and sown on 1 October was significantly lower and ranged from 2.8 t ha⁻¹ to 5.4 t ha⁻¹. In the winter wheat crop sown on 1 October, the yield of winter wheat decreased significantly with the reduction of the seed rate. The optimum seed rate for the September sowing is 3,0 million ha⁻¹.

Key words: winter wheat, time of sowing, seed rate, productivity, grain quality.

INFLUENCE OF SOWING METHOD AND RATE ON MILK THISTLE GERMINATION AND WEED FLORA

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Milk thistle (*Silybum marianum* L.) is grown in many countries as a raw material for the production of medicines but in Lithuania it poorly established. For this reason in 2022, a field experiment was carried out at the Vytautas Magnus University, Agriculture Academy, Experimental station. The soil of experimental field is *Endocalcaric Endogleyic Luvisol* (WRB, 2015). The purpose of the study is to evaluate the influence of sowing method and seed rate on crop germination and weediness. Treatments of the experiment: factor A – sowing method: 1. Narrow-row sowing (12 cm row spacing); 2. Wide-row sowing (48 cm row spacing); 3. Scattered sowing. Factor B – seed rate: 1. 12 kg ha⁻¹; 2. 24 kg ha⁻¹; 3. 36 kg ha⁻¹. The size of the experiment plot – 30 m². The experiment was performed in 4 replications. Crop density and number of weed seedlings were assessed at 4 spots in each plot using a 0.5 x 0.5 m (0.25 m²) frame. The number of plants was converted to units m⁻².

It was found, that both the method and rate of sowing influenced the density of the crop. Comparing the sowing method, plants germinated least often in plots where scattered sowing was used – the crop density reached 40 units m⁻² and was significantly lower compared to other sowing methods. As expected, seed rate had a significant effect on crop density: the least number of plants have been germinated at the lowest seeding rate (28.3 units m⁻²), 1.8 times more (51.8 units m⁻²) at the medium seeding rate and 3.0 times more (84.5 units m⁻²) in those plots where the highest seeding rate was applied.

Milk thistle sprouts for a long time – up to 21 days, grows slowly, especially in unfavorable growing conditions, so it does not suppress weeds in the initial stages of growth. It was investigated, that only the method of sowing had a significant influence on weed density. Significantly the fewest weed number, compared to the plots where other sowing methods were used, were found in the fields where scattered sowing was applied (70.8 pcs. m⁻²). No statistically significant correlation was found between crop density and the number of weed seedlings. The annual summer weeds – *Sinapis arvensis* L., *Persicaria lapathifolia* (L.) Gray, *Chenopodium album* L. dominated in the crop.

Key words: *Silybum marianum* L., sowing method, seed rate, germination, weed density.

MONILINIA SPP. PREVALENCE IN BERRIES OF EUROPEAN CRANBERRY (*VACCINIUM OXYCOCCOS*)

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European cranberry (*Vaccinium oxycoccos* L.) fruit rot is an important problem after cranberry harvest and occurs wherever cranberries are grown or stored. The disease is caused by a group of fungi that requires identification. The *Monilinia* genus includes economically important pathogens, which are responsible for berry rot. *Monilinia oxycocci* is the most important field and stored rot agent in cranberries. Infected fruit are filled with cotton-like fungal masses and are unfit for processing.

The investigations were carried out at Botanical Garden of Vytautas Magnus University, Lithuania in 2021. The aim of the study was to identify *M.oxycocci* prevalence in different clones of cranberry.

In this study, four clones of cranberry berries were evaluated in the field collection. The samples of berries were harvested after full maturity. Only damaged berries with rot symptoms were selected for the study. The standard plate diluting method was applied for culturing the *M. oxycocci* from berries. The Potato Dextrose Agar (PDA) was used to identify fungi.

During the study period, *M. oxycocci* fungi in berries ranged from 3.36 to 10.53%. Clones 95-A-03 and 97-J-04 were found to be the most sensitive to *M. oxycocci* infection. *M. oxycocci* damaged 10.41 and 10.53% berries, respectively. The lowest *M. oxycocci* infection (3.36%) was found in the berries of clone 96-K-02. 8% prevalence of *Monilinia* was determined in the berries of clone 96-K-05.

Obtained research results will allow to select cranberry clones which characteristics will be the most suitable for growers.

Key words: *cranberry, berries, fungi, Monilinia spp.*

MORPHOLOGICAL CHARACTERIZATION OF ALMOND ACCESSIONS (NATIONAL COLLECTION) IN AFGHANISTAN

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Almond (*Amygdalus communis*) is the most important nut tree in Afghanistan, in 2009 listed at the ninth almond producing countries globally, its domestic production accounted about 2% of the world production. Almond known as a high valuable exporting crop in Afghanistan but considering to limited number of high yielding and climate resilience varieties in the country, total production is negligible. However, this study was aimed to characterize the Afghanistan's almond national collection, which encompass 56 accessions, under two different agroclimatic regions (Kundaz and Balkh) for two consecutive years (2019 to 2020). Therefore, the investigation traits were trees, leaves, flowers and fruits. Characterization was measured based on DUS-UPOV and IPGRI guidelines. Tree traits data were collected in field; while measurement of other organs were performed in the pomology laboratory. Descriptive traits described based on rating and coding of the adopted almond descriptor standard. However, results showed that the national collection of varieties of almonds showed a significant variability in terms of morphological characteristic. Therefore, about over 70% of the accessions were susceptible in different degrees to the risk of early frost damage during the flowering time with a dominant trait of early flowering. Among the 56 accessions, Sattarbai type, with higher kernel / dry fruit weight ratio (>0.65), characterized soft and thin endocarp along crescent shape, has selected a superior and marketable varieties in respect to other accession. While, the Qambari type accession showed less exaggerated length and crescent shape nuts, but clearly have "paper shell". Likewise, Qaharbai type accession were less elongated and tend to have more thickening of the semi "paper shells". Whereas, together Qambari and Qaharbai varieties were closer to reference cultivare such as Lauranne, Carmel, Ferraduel and Ferragnes.

Key words: genetic resources, germplasm, kernel, *Prunus dulcis*, DUS-UPOV, IPGRI guideline and Badam.

CONTENT OF ARABINOXYLAN IN BARLEY AND WHEAT GRAINS DEPENDING ON N RATE USED AND YEAR

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Cereal yields in agricultural sector can be very variable depending largely on weather conditions. This means that also crop producers' incomes are vulnerable. Although it is impossible to predict crop yields for every year it is possible to ensure a more stable income via added value. This could be achieved by finding opportunities to sell more valuable components of cereals instead of grains themselves. Cereal grains are rich in dietary fibres that are known to have immense effect on the properties of food and human health. Extraction of those valuable substances from grains could offer more opportunities for agricultural sector economic development. One of the most important dietary fibre components in cereal grains is arabinoxylan (AX), which can be extracted from the grains of wheat and barley. Its concentration in cereal grains depends on genetic, environmental and agronomic factors.

The goal of our study was to investigate the effect of plant nitrogen supply and source on AX accumulation in the grain and to observe the effect of growing conditions on grains AX content. More specifically, the objective was to compare the effect of organic (cattle manure, off-season cover crop) and mineral N (NH_4NO_3 ; 0, 50, 100, 150 kg N ha⁻¹) fertilizers on AX content in barley and wheat wholegrain flours and to observe the impact of different weather conditions on AX content in the grains. The grain samples were collected from the long-term field crop rotation experiment located at the Estonian University of Life Sciences in 2019–2021. The amount of AX in the barley (N=84) and wheat samples (N=83) was determined by using D-xylose assay with enzymatic kit from Megazyme (Megazyme International Ireland, Ltd) in triplicate.

The results revealed that barley and wheat AX content was stable and did not depend on N fertilization. The average content of AX in compared cereal grains was similar 4.5 and 4.9 g 100 g⁻¹ in barley and wheat respectively, showing that both grains can be considered as a good source of AX. Barley and wheat grains AX content was affected by the growing year. For barley it was significantly lower in 2020 (3.3 g 100 g⁻¹) compared to 2019 (5.5 g 100 g⁻¹) and 2021 (4.7 g 100 g⁻¹) and for wheat it was the lowest also in 2020 (3.4 g 100 g⁻¹) compared to 2019 and 2021 (5.1 and 6.1 g 100 g⁻¹). Lower AX content in 2020 could be associated with higher amount of precipitation at the stages of grain development and ripening.

Our results are supporting the idea that AX from wheat and barley grains can be a valuable resource for cereal valorization and though it is not affected by N fertilization its content in grains could vary depending on weather conditions.

Take-home message: Cereal grains are rich in dietary fibres that are known to have immense effect on the properties of food and human health. Knowing the factors affecting their content in grains could offer better opportunities for cereal grain valorization. Our research supports the idea that AX from wheat and barley grains can be a valuable resource and though it is not affected by N fertilization its content in grains could vary depending on weather conditions.

Key words: *arabinoxylan, nitrogen, fertilization, weather conditions.*

PRECISION FARMING AS ELEMENT OF PLANT PRODUCTION OPTIMIZATION

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Since the 1990s, in the USA and in Western European countries – in the field of agricultural science specialists, politicians, economists, and farmers – the concept and practice of improving the current and introducing new farming technologies is spreading. They are referred to as precision agriculture, precision farming, prescription agriculture or computer aided farming system. Precision agriculture – this is agriculture that processes data, among others, from observation and meteorological satellites. It provides farmers with detailed information on the diversity of local habitat conditions, which allows the optimization of sowing rate and rational dosing of plant protection products and fertilizers.

Accurate maps of fields and buffer zones installed in devices with satellite navigation facilitate the performance of agrotechnical treatments.

The dissemination of precision agriculture has enabled the extremely dynamic development of navigation and information techniques, and more specifically: GPS – (Global Positioning System) and methods of acquiring and processing spatial data GIS – (Geographic Information System).

The introduction of this system on a larger scale is determined by three groups of factors: economic (the farmer's desire to reduce production costs), ecological (respect for the environment, protection of natural resources, especially soil and water, reduction of the concentration of nitrates and pesticides in the environment), social (care for safe working conditions, obtaining good-quality food and feed).

Key words: *precision agriculture, precision farming, global positioning system, geographic information system.*

SHORT-TERM EFFECTS OF AUTONOMOUS ROBOTIC AND CONVENTIONAL WEED CONTROL SYSTEMS ON SOIL PHYSICAL PROPERTIES

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Mechanical weed control is one of the most important technological operations to ensure crop yield and quality, especially in organic farming. However, this method of weed control, like other technological operations, has a considerable impact on the physical properties of the soil. Soil bulk density and penetration resistance are among the most important physical properties influencing soil and plant productivity factors. In this context, the aim of this study was to investigate the impact of conventional (CWC1 – first cultivation, CWC2 – second cultivation) and robotic (RWC) mechanical weed control systems on soil properties. The results showed that both CWC1 and RWC increased soil penetration resistance. However, conventional weed control had an effect on penetration resistance mainly in the surface layer of the soil (20%), while the robot had almost no effect in all soil layers (1%). The evaluation of the effect of the weed control operation on soil bulk density showed that in the conventional technology (CWC2) with a soil moisture content of 21%, soil bulk density was not significantly affected in any of the soil layers. In contrast, the robotic technology (RWC), with a soil moisture content of 23%, resulted in a significant increase of 10.4% in soil bulk density in the topsoil, while there was no difference in the deeper soil layers. The studies showed that the weed control process also had a significant effect on soil temperature, which decreased by 5% in CWC1 and 2.2% in RWC after the technological operation.

Key words: *weed control, soil bulk density, penetration resistance, solar-powered robot, sugar beet, organic farming.*

SAR IMAGES FOR CROP EVALUATION

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Poppy (*Papaver somniferum* L.) is oil plant and also one of an important export commodity of the Czech Republic. This crop is demanding to grow, especially in terms of agro-ecological conditions of the field and agricultural management. For this reason, remote sensing technology appears to be a suitable method for monitoring whole growth for proper treatment timing. As optical remote sensing has its limitations in the form of frequent cloud coverage, synthetic aperture radar images are becoming an alternative source of information about the crop state. The results showed that synthetic aperture radar satellite images can be helpful in case of time evaluation of poppy growth when optical images are not available. The Radar Vegetation Index could explain the yield spatial distribution from 32% only when the crops were in elongation growing stage. The poppy was monitored with optical and synthetic aperture radar sensors during whole vegetation season in year 2020. The results showed that development of calculated RVI values in time, can be very helpful in assessing the condition of the poppy stand, especially in cases where optical satellite images are missing, and the stand cannot often be scanned using UAVs. It has been also confirmed that if a common RGB camera is available on the UAV, it is sufficient to calculate the TGI index as an alternative to NDVI or GNDVI. RVI index was also evaluated in terms of use for yield estimation. The spatial distribution of final yield was explained from 32% by RVI index when the crops were in elongation phenological phase and from 21% in growing phase at the end of flowering. Future research should focus not only on the use of RVI in poppy stands, but also on other crops commonly grown in the Czech Republic, including the implementation of the RVI index into common agricultural practice.

Key words: *crop production, satellite images, spectral indices, radar vegetation index.*

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INFLUENCE OF REPLACEMENT OF WHEAT FLOUR WITH SWEET POTATO POWDER ON QUALITY OF CUPCAKES

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Cupcakes are snack cakes, which are largely consumed by many people every day. These bakery products are normally made from wheat flour, which are nutritionally poor. Therefore, the goal of this study was to evaluate the influence of the replacing of wheat flour with purple sweet potato powder at various proportions (0.5, 10, and 15%) on the quality of the cupcakes.

The following raw materials were used for making the cupcakes: wheat flour, eggs, sugar, vanilla sugar, cream (36% fat), baking powder, and salt. Also, cupcakes enriched with freeze-dried purple sweet potato powder. The experiment consisted of four treatments as follows: T₁ – Control (100% wheat flour); T₂ – 95% wheat flour + 5% sweet potato powder; T₃ – 90% wheat flour + 10% sweet potato powder; T₄ – 85% wheat flour + 15% sweet potato powder. The cupcakes were analysed for moisture, ash and fibre using standard methods. The amounts of calcium, potassium, phosphorus of the cupcakes were established by inductively coupled plasma atomic emission spectrometry. Total phenolic was determined by the Folin-Ciocalteu spectrophotometric method. The firmness and springiness of cupcakes was estimated using a texture analyser TA.XT plus.

The results revealed that cupcakes with 15% sweet potato powder had significantly higher amount of calcium (61.36 mg 100 g⁻¹), potassium (251.19 mg 100 g⁻¹) and phosphorus (207.03 mg 100 g⁻¹), compared to cupcakes without sweet potato powder. Significantly the greatest amounts of ash and total phenolic were found in cupcakes enriched with 15 and 10% sweet potato powder. However, the replacement of wheat flour with the sweet potato powder had no a significant effect on moisture. The cupcakes made from 85% wheat flour and 15% sweet potato powder were significantly softer and more elastic compared to control sample.

In conclusion, that freeze-dried purple sweet potato powder can easily be applied into cupcakes to replace wheat flour by up to 15%.

Key words: *cupcakes, fiber, phenolic compounds, potassium, sweet potato powder.*

QUALITY OF SEA BUCKTHORN (*HIPPOPHAE RHAMNOIDES* L.) OIL EXTRACTED FROM BERRIES PRESS CAKE

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Sea buckthorn oil is a source of natural glycerides, the chemical composition and unique properties of which have been known for a long time. Traditional technology for sea buckthorn oil production is extraction with another vegetable oil, usually sunflower.

The aim of this study was to compare the quality of sea buckthorn oil extracted with refined and unrefined sunflower oil and the changes of both samples during two months of storage.

The research was done in 2021 at the Agriculture Academy of Vytautas Magnus University. Sea buckthorn berry press cake was dried and filled with sunflower refined and unrefined oil in a ratio of 2:3. The extraction was performed in the dark at 5 °C for two weeks. The oil was then separated from the press cake and stored for two months in the refrigerator at 5 °C.

The total content of carotenoids and β -carotene was established by spectrophotometer, the number of peroxides and of fatty acids was determined by titrating the samples. The induction period in the oil was determined by a conductometer, and the oil's colour was determined by a colour analyser. The results were analysed using the factorial analysis of variance (ANOVA).

The obtained research results showed that the fresh sea buckthorn oil had a higher content of β -carotene (1.3-fold), a higher number of peroxides (2.4-fold) and fatty acids (4.7-fold) when unrefined sunflower oil was used for extraction. The total amount of carotenoids in the sea buckthorn oil was not significantly affected by the type of oil used for extraction. During storage, the total content of carotenoids and β -carotene in both samples of sea buckthorn oil decreased, and the number of peroxides and fatty acids increased. The induction period of sea buckthorn oil was prolonged during storage. Fresh sea buckthorn oil extracted with unrefined sunflower oil had a higher content of carotenoids, but the oxidative processes of this oil were more intense during storage.

Key words: β -carotene, carotenoids, fatty acids, number of peroxides, oil.

BEETROOT PEEL AS A SUSTAINABLE RESOURCE OF ANTIOXIDANTS FOR THE FOOD INDUSTRY

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Red beetroot (*Beta vulgaris* L.) is regarded one of the most relevant vegetable due to their valuable nutritional characteristics. However, the industrial processing of beetroot makes high contents of waste such as peel, which could be important source of antioxidant compounds. Therefore, the aim of this study was to establish and compare the amounts of some antioxidants and colour parameters of peel in tested beetroot.

The following red beetroot varieties and hybrids were chosen for the research: 'Kosak', 'Alto F1', 'Pablo F1' and 'Traunus F1'. Beetroots were grown in 2021 at a farm in the Širvintų district under traditional conditions. Freeze-dried beetroot peel was used for chemical analyses. Beetroot peel was analysed for total phenolics using Folin-Ciocalteu spectrophotometric method. The total anthocyanins amount of beetroot peel samples were established by the pH differential method. Individual betalains (betacyanins and betaxanthins) were measured by spectrophotometric method. The colour of raw beetroot peel was determined with a spectrophotometer ColorFlex using the CIE Lab system.

This study showed that total phenolics amount in investigated beetroot peel ranged from 24.87 to 36.12 mg g⁻¹ in dry matter. The highest amount of this component was found in peels of 'Kosak' and 'Pablo F1'. Significantly the highest amounts of total anthocyanins and total betalains were observed in peel of 'Kosak'. The predominant betalain in beetroot peel was betacyanins. The highest amounts of betacyanins and betaxanthins were quantified in the peel of 'Kosak'. The highest L* values were found for peels of 'Alto F1', 'Kosak' and 'Traunus F1', without differences between them. The values of a* in investigated beetroot peel samples significantly no differed. The lowest b* values were found for 'Alto F1' peel.

Summarizing the results of this study it can be concluded that red beetroot peels (especially 'Kosak') are sustainable resource of natural antioxidants. Therefore, special attention should be paid to peel potential uses as an additive for the development of new functional products or to improve the quality of food products.

Key words: *anthocyanins, betalains, beetroot peel powder, colour, phenolics.*

CROP POTENTIAL AND THE ESSENTIAL OILS YIELD OF FOUR CARVONE-RICH MINT SPECIES (*MENTHA* SP.)

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Mints are perennial herbal plants of the *Lamiaceae* L. family cultivated mainly for their essential oils, which are used for medicinal, cosmetic, and aromatic purposes. Next to peppermint (*Mentha × piperita* L.) – the most popular species of *Mentha*, with essential oil rich in menthol – interesting organoleptic and usability properties are mints producing (R)-carvone popular in England and the Arab countries. The aim of the present study was to assess the crop potential and efficiency of the essential oils of four carvone mint species, i.e. (1) *M. spicata* L. ‘Moroccan’; (2) *M. crispata* L.; (3) *M. rotundifolia* (L.) Huds.; and (4) *Mentha × ‘Berries & Cream’*, cultivated under Polish conditions. The field experiment was carried out 2015–2017 in the Garden of Cosmetic Plants and Raw Materials, located in central-eastern Poland (51° 44′ 49″ N 21° 50′ 38″ E). Two harvests were harvested each year. Were determined: the herb yield [t·ha⁻¹], the proportion of leaves in the herb [g·100g⁻¹], the content of the essential oil using steam distillation in the Deryng apparatus [ml·kg⁻¹], and theoretical essential oil yield per hectare [l·ha⁻¹]. The chemical composition of essential oils was determined with the GC/MS; moreover, the theoretical yield of carvone was estimated [l·ha⁻¹]. The highest herb yield was determined in round-leaf mint (*M. rotundifolia*), i.e., 4.95 t·ha⁻¹ during the first harvest and 4.46 t·ha⁻¹ during the second harvest; however, the proportion of leaves in this species was found to be the lowest one (42.6–44.6 g·100g⁻¹). The highest amount of essential oil was demonstrated in Moroccan mint leaves, irrespective of the harvest (20.9–21.2 ml·kg⁻¹) while the lowest amount was found in the leaves of ‘Berries & Cream’ (9.1–9.2 ml·kg⁻¹). The highest yield of the essential oil per area unit (sum of two crops) was calculated for *M. spicata* L. ‘Moroccan’ (almost 80 l·ha⁻¹). Each of the essential oils examined contained substantial amounts of carvone (15.2–55.4%). Spearmint and round-leaf mint were characterized by comparable theoretical yields of carvone, i.e., 35.2 and 37.5 l·ha⁻¹ – which were the highest values in the entire experiment.

Key words: Spearmint, *M. rotundifolia*, *M. crispata*, cultivation.

THE EFFECT OF FIELD HORSETAIL AND STINGING NETTLE EXTRACTS IN GERMINATED SEEDS

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Seed sprouts have long been used in the diet as healthy food and recent research shows that, in addition of being a good source of basic nutrients, they also contain important phytochemicals with disease preventive and health promoting properties.

The aim of this study was to evaluate the impact of aqueous extracts of field horsetail (*Equisetum arvens* L.) and stinging nettle (*Urtica dioica* L.) plants in germinating seeds. The seeds of adzuki bean (*Vigna angularis*), alfalfa (*Medicago sativa* L.), and white clover (*Trifolium repens* L.) were germinated for 72 hours in dark, 23–25 °C ventilated room. Seeds used for germination has been carefully selected. After that the seeds were soaked for 12 hours in four times larger quantity of water used for research than the volume of seeds (ratio 1:4). Germinating seeds were imbibed and daily soaked in aqueous field horsetail and stinging nettle plant extracts.

The influence of elicitation on the amount of dry matter (LST ISO 751:2000) and total polyphenols (by HPLC (Hallmann, 2012)) in germinated seeds were studied.

When for seeds irrigation plants extracts were used, the amount of total polyphenols was more in adzuki beans, white clover, except alfalfa seeds, when for irrigation stinging nettle extracts were used. During germination, more intense synthesis of polyphenols occurred in all seeds treated with field horsetail 1% extract solutions compared with those treated with water only. The highest content of total polyphenols was found in the alfalfa seeds (91.16 mg 100g⁻¹) treated with the field horsetail extracts. When plant extracts were used, there was a tendency for biologically active substances to increase in all variants of the experiment.

Key words: *antioxidant compounds, plant extracts, germination.*

EVALUATION OF BIOACTIVE COMPOUNDS IN THE DIFFERENT CULTIVARS OF BEETROOTS

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Red beetroot (*Beta vulgaris*) root vegetables contain folic acid, betaine and other compounds, which together reduce blood cholesterol levels, blood pressure, and strengthen blood vessel walls. Beetroot accumulates about 11–16% of soluble dry matter, 8–12% of sugars and vitamin C 9–25 mg 100 g⁻¹, as well as trace elements of iron, potassium, sodium salts and manganese. Beets are classified as one of the ten plants with the highest antioxidant activity. It is believed to be the main commercial source of betalains as concentrated forms, powders or natural colors in gelatins, confectionery, dairy, meat and poultry products. Roots contain a lot of betaine glycine, betalain, saponin, betacyanin, folates and polyphenols (Singh, Hathan, 2014; Panghal et. al., 2017; Nirmal et al., 2021). According J. Wruss et al. (2015) the composition of biologically active compounds in roots vary depending on the beetroot variety.

The aim of this research is to evaluate and compare the bioactive compounds amount of different cultivars of beetroots.

The research was carried out in 2019–2020 in the Food Raw Materials Laboratories at Department of Plant Biology and Food Sciences of VMU Agriculture Academy. There were analysed the three cultivars of beetroot: 'Kosak', 'Bona', 'Bikores'. Standard methods were used to determine amounts of the dry matter, the total anthocyanins, the total phenolic compounds by a spectrophotometric method using with Folin-Ciocalteu reagent and the betalains such as betacyanin and betaxanthin. Color was determined by ColorFlex spectrophotometer (Hunter Associates Laboratory Inc., JAV). Statistical analysis of the results was performed using processed by the dispersion analysis method (ANOVA), software STATISTICA 10 computer program. The statistical reliability of differences between means was assessed by Fisher's test (LSD) ($p < 0.05$).

The research have shown that the highest amount of dry matter, betacyanin and betaxanthin were found in beetroot of the 'Kosak' cultivar. The significantly biggest amount of total anthocyanins were indentifay in the beetroot of 'Bona' cultivar. The biggest amount of total fenolic compounds were acumulated the roots of 'Bona' and 'Kosak' cultivar beetroots. The reserch show that the essential intensity of red color (coordinate a*) and yellow color (coordinate b*) were evaluated in the 'Kosak' cultivar beetroots.

Key words: *biactive compounds, beetroot, varieties.*

CHEMICAL COMPOSITION OF THE LEAVES OF WHITE MULBERRY GROWN IN LITHUANIA

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The aim of our investigation was to compare the chemical composition of the leaves of mulberry. A one-factor field experiment with the white mulberry cultivars 'Galicia', 'Plodovaja 3', 'Smuglianka' and 'Turčianka' was conducted on an organic farm in Kaunas district, Lithuania. Leaves of white mulberry were harvested in June in the 2nd ten-day period. The leaves were frozen at -35 °C, then lyophilized and finally ground to a fine powder in a laboratory mill.

Using standard analysis methods of mulberry leaves was determined: vitamin C, total chlorophyll and total phenolic compounds. The data were processed by MS Excel (Microsoft, US) software and STATISTICA 10 (StatSoft, Inc., USA) package. The statistical significance of differences between the means was estimated by the Fisher's LSD test.

Studies have shown that, the amounts of vitamin C and total chlorophyll in leaves depending on the characteristics of the cultivars. In the leaves of cultivar 'Smuglianka' was determined significantly highest content of vitamin C and total chlorophyll. While the significantly highest phenolic content was determined in leaves of cultivars 'Plodovaja 3' and 'Turčianka' 33.99 and 35.76 mg 100 g⁻¹, respectively.

Key words: *mulberry, leaves, cultivar, phenolic compounds.*

EFFECT OF *USTILAGO MAYDIS* ON THE QUALITY AND AEROBIC DETERIORATION OF MAIZE SILAGE

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Common smut of corn, caused by *Ustilago maydis*, reduces the yield and quality of maize forage. This is influenced by adverse weather conditions, such as high temperatures and droughts during the period of pollen scattering and filaments spread. In severe cases of infestations of corn smut, grain yields can be so severely decreased that the most viable economic alternative may be to harvest and ensile the crop. Only a few of studies have attempted to investigate the effect of aerobic exposure on the nutritive value and aerobic stability of silage, prepared from smut-infected maize. In this study individual whole corn plants were harvested by hand. The plants were assigned to three treatments: 0% infected, 50% infected and 100% infected. The fresh forage was ensiled in triplicate for 90 days. Samples were taken on the day of opening and on days 3, 7, 14 and 28. Near infrared spectroscopy (NIRS) calibration equations (ADAS, UK) were used for the determination of crude protein (CP), crude fat (CL), starch, crude fibre (CF), neutral detergent fibre (NDF), acid detergent fibre (ADF), metabolizable energy (ME) and net energy lactation (NEL) data. The temperature was registered using temperature sensors inside the samples.

Silage made from 100% smut-infected maize was relatively poor in quality, with dry matter loss, increased pH and low starch content. It was also distinguished by a large increase in temperature increase from day 15 to 18 of aerobic exposure. Silage made from 50% smut-infected maize did not show significant quality changes over the experimental period, although, it had inferior quality compared to the silage, prepared from smut-free maize.

Key words: maize silage, smut, *Ustilago maydis*, fermentation, aerobic exposure, nutritive value.

THE EFFECT OF RIPENING STAGES ON THE POMOLOGICAL PARAMETERS AND TOTAL CAROTENOIDS CONTENT OF ROSEHIP SPECIES GROWING UNDER ORGANIC SYSTEM

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Rosehips – the fruits of rose plants, well-known for its high phenolic, carotenoids and vitamin C contents.

The field experiment was conducted in two vegetation seasons at an organic rosehip farm, located in northern Lithuanian.

The aim of experiment to study the change pomological parameters and total carotenoids content of two different rosehip species *Rosa canina* and *Rosa rugosa* during ripening.

During the experiment rosehip were harvested at five different ripening stages: I – the initial stage of ripening, at least 10% of the surface color of rosehips has changed from green to yellow, pink, red; II – 10–30% of the green color surface of rosehips became dark yellow, pink and red; III – 30–60% of the green color surface of rosehips transformed to light orange, red or a combination thereof; IV – 60–90% of the surface color of rosehips turned orange or orange-red; V – the surface of the rosehips was red or orange, depending on the species.

The following pomological parameters were determined: fruits length (mm), fruits width (mm) and fruits weight (g). An average of one ripening stage was calculated from 30 values. Total carotenoids were determined using the high-performance liquid chromatography (HPLC) equipment.

Analyses were performed in triplicate. The data analysis was conducted with Microsoft®Excel®2016 MSO. The reliability of the results was evaluated by a two-way analysis of variance, using the ANOVA software package. The statistical significance of differences between the means was estimated by Tukey test ($p < 0.05$).

Our results shown that average of *Rosa canina* and *Rosa rugosa* fruits length, width and weight increased with ripening stage. The rosehip of *Rosa canina* length, width and weight were determined respectively 1.3, 1.4 and 4.7 and *Rosa rugosa* 1.6, 1.4 and 3.7 times higher than at ripening stage I. Also, this study showed a significant increase in the total content of carotenoid during the ripening period. In rosehip of *Rosa Canina* and *Rosa rugosa* was determined 6.7- and 5.8-time higher content at ripening stage V compared with results determined at ripening stage I.

Key words: rosehip, species, pomological parameters, carotenoids, ripening stage.

RISK OF MYCOTOXIN FORMATION IN BARLEY GRAIN DURING DELAYED HARVESTING

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In Lithuania, barley accounts for about one third of the total annual harvest of spring cereals and is one of the main cereals used for food and animal feed. The aim of this experiment was to determine whether the timing of harvesting influenced the variation of mycotoxin concentrations in grains of different barley cultivars.

Two barley cultivars, *Laureate* and *Luokė*, were studied. 24 samples were taken in four replicates at three different times: at hard maturity (BBCH 87), then 12 days and 22 days after the first harvest. The method used for the detection of mycotoxins was the High-Performance Liquid Chromatography – Mass Spectrometry (HPLC-MS) method. Moniliformin, nivalenol, deoxynivalenol, T-2, HT-2, zearalenone and enniatins A, A1, B, and B1 were detected in the samples and their concentrations were determined. Statistical analysis was conducted using SPSS Statistics, version 25 (IBM Inc.). Significant differences between mycotoxin concentrations were calculated using one-way ANOVA (Duncan's post-hoc test).

Deoxynivalenol, HT-2 and zearalenone were detected in all samples and the mean concentrations were 22, 18 and 480 $\mu\text{g kg}^{-1}$, respectively. Nivalenol and enniatins B1 and A were detected in 67, 63 and 42% of the samples and the mean concentrations were 14, 37 and 12 $\mu\text{g kg}^{-1}$, respectively. Only traces of moniliformin, T-2 and enniatins B and A1 were detected in 17, 21, 21 and 29% of samples, respectively. Zearalenone was the most prominent with concentrations from 3 to 7 times (from 362 to 719 $\mu\text{g kg}^{-1}$) exceeding the EU regulated maximum level in unprocessed cereals (100 $\mu\text{g kg}^{-1}$), but no statistically significant differences were observed when comparing concentrations between harvests and barley cultivars. Currently there are no European guidance values or maximum levels for moniliformin, nivalenol and enniatins. For the other mycotoxins, the concentrations were within the EU regulatory limits and did not vary significantly between harvests, however this contamination of the samples with different mycotoxins raises concerns about the possible synergistic effects of these mycotoxins on human and animal health.

Key words: *mycotoxins, HPLC-MS, barley, harvest time.*

DRYING RESEARCH OF *CANNABIS SATIVA* L. SEED IN A STATIONARY LAYER

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Climate conditions prevailing in Lithuania are favorable for growing energy plants. Fiber hemp is a valued plant for its potential wide range of uses. There are over 25 thousand uses of hemp plant material. Farmers in Lithuania mostly grow fiber hemp for food, i.e. produces seeds.

Fiber hemp is harvested in August-September, but sometimes it can be harvested even in October. Harvest time is influenced by weather conditions in July-August, when the seeds are ripening. Seed moisture control is a key tool to preserve seed quality and prevent spoilage.

Based on long-term research results, it can be stated that the moisture content of the harvested fiber hemp seeds varies within wide limits: the initial moisture content of the fresh fibrous hemp seeds used in the laboratory research ranged from 13.51 ± 0.49 to $25.5 \pm 0.17\%$. At that time, the moisture content of seeds for long-term storage and food is recommended to be about 7%. Therefore, in order to keep seeds of high quality, it is important to create favorable conditions and ensure optimal technological processes.

The objective of the research is to determine the dynamics of drying of *Cannabis sativa* L. seeds in a special stand with a dryer preparation system.

A special stand with a dryer preparation system was used for drying tests. Comparative studies of fiber hemp seed drying technologies were carried out in cylinders with a diameter of 200 mm and a height of 1.15 m – ventilated containers with a mesh bottom. Low-temperature drying, when a dryer with a temperature no higher than 40–50 °C is used, has the lowest impact on the quality of the dried products.

The drying dynamics of fibrous hemp seeds were studied using different ventilation intensities: from 200 to 997 m³ (t·h)⁻¹. Accordingly, the duration of seed drying ranged from 74 to 172 hours.

It was determined that after increasing the comparative ventilation intensity from 200 to 997 m³ (t·h)⁻¹, in a stationary layer with a height of 700–800 mm, temperatures of 23.1 ± 0.63 °C and $51.8 \pm 4.3\%$ relative humidity, the drying time of fibrous hemp seeds ventilated with a dryer decreased logarithmically from 172 to 74 hours, i.e. 2.32 times.

Key words: *Cannabis sativa* L., seeds, drying studies, stationary layer, low-temperature drying.

RESEARCH ON CONSERVATIVE AGRICULTURE AND THE MANIFESTATION OF CLIMATE CHANGE IN THE NORTH OF THE REPUBLIC OF MOLDOVA

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If we analyze the specialized and literal sources, we find that, globally, the conservative system was introduced six decades ago. This would mean that the Republic of Moldova is approximately 60 years behind the rest of the world. Based on some results obtained in the territory of the country, conservative agriculture is considered a measure to increase competitiveness by reducing production costs and adapting to climate change. In this context, a current example of research presented by the authors evokes the purpose of this paper, which consists in evaluating the use of conservative agriculture by the peasant household. "Agro-Panfil" farm annually grows cereals and industrial crops on over 1.000 hectares of agricultural fields. The monitoring of agroecosystems was carried out practically from sowing to harvest and post-harvest throughout the agricultural year through the "HOBO-01102025" Station for the years 2018–2021. The scientific study on the key polygon, regarding the implementation of No-till agriculture, has been active for 15 years, and the Mini-till technology has been working for 20 years. The competitiveness of this peasant household is a notorious example for our country – being a classic business model of a successful family from the North of the Republic of Moldova. Price instability, but also climate change taking place on the territory of the Republic of Moldova, using "No-Till" technology, production costs are reduced and crops increase by 1.5 times. This farm records revenues of 400 thousand Euros per year as a result of the rational use of soil resources and the application of efficient technologies in agricultural production. In order to achieve the objectives proposed this year, the following research methods will be monitored on 5 research polygons with agroecosystems – variants. A significant benefit in the respective locality, even in the current conditions, is expressed by the provision of irrigation on some lands, increasing the harvests by 1.5–2 times or more, compared to the harvests obtained on the lands without irrigation.

Key words: *agroecosystem, conservative agriculture, climate change, North of the Republic of Moldova.*

THE INFLUENCE OF CONTROLLED DRAINAGE ON THE WATER REGIME OF THE SOIL

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Lithuania is in the zone of excessive humidity, but the ongoing climate changes rapidly increase the recurrence of droughts. This forces us to look for new measures for the effective cultivation of agricultural crops. In the course of numerous studies, it has been proven that controlled drainage has a positive effect on the yield of agricultural crops and the quality of the environment.

The aim of the study was to evaluate the measures for regulating the soil water regime and the effectiveness of their application in order to implement innovative technologies that ensure the sustainable use of water resources. The experimental sites were selected in different Lithuanian climatic sub-areas. Measurements of soil moisture, groundwater level and drainage runoff were carried out in free conventional and controlled drainage systems.

Due to insufficient humidity conditions at all experimental sites, controlled drainage structures have been maintained in the highest position (0.7 m from the ground surface) since their installation in 2018. Drainage water was accumulated during the wet period and only after reaching the maximum level did the drainage work as free drainage. The end of free drainage runoff is determined by fluctuations in the amount of precipitation and air temperature, the level of groundwater and soil moisture. The greater the difference between the end of outflow in controlled drainage and free drainage systems, the more water is accumulated. The largest difference in the duration of the drainage runoff was found in the spring of 2019 – 153 days.

One of the indicators of the effectiveness of the controlled drainage is the amount of water accumulated. During the period of winter/spring 2019, holding controlled drainage structures in the highest position to reduce the duration of the runoff by an average of 43%. On average, the volume of the runoff managed to be reduced by 60%. For controlled drainage and free drainage systems, the total runoff height differed by an average of 58%. The differences between the experimental sites were determined by the size of the controlled drainage areas and the properties of the soils.

The results obtained show that when growing winter cereals, it makes sense to store raised controlled drainage structures throughout the winter and spring time.

It does not harm the vegetation of plants, accumulates more water and gives greater efficiency of the controlled drainage structures.

Key words: *soil moisture, drainage runoff, free drainage, controlled drainage.*

CONTENTS

PROGRAMME.....	3
POSTER PRESENTATIONS.....	8
ABSTRACTS. ORAL PRESENTATIONS	13
SOIL HEALTH AND CARBON SEQUESTRATION FOR SUSTAINABILITY.....	14
Jerzy Weber SOIL ORGANIC MATTER AND ITS ROLE IN THE ENVIRONMENT	14
Zita Kriaučiūnienė, Rita Čepulienė, Ernestas Zaleckas, Vilma Naujokienė, Quirijn de Jong van Lier, Egidijus Šarauskis INFLUENCE OF GRANULAR ORGANIC FERTILIZERS FROM MEAT BONE MEAL WITH BIO-PREPARATIONS ON THE GROWTH PARAMETERS OF PAK CHOY	15
Audrius Jakutis, Jūratė Aleinikovienė STABILIZING SOIL ORGANIC CARBON IN AGRICULTURAL SOILS FOR INCREASE OF SOIL MICROBIAL ACTIVITY AS THE MEASURE PROMOTING THE REDUCTION OF MINERAL FERTILIZATION	16
SOIL AND CROP MANAGEMENT TOWARDS A CHEMICAL PESTICIDE-FREE AGRICULTURE.....	18
Christian Huyghe GROWING AND PROTECTING CROPS DIFFERENTLY: ZERO-PESTICIDE AS A NEW PARADIGM	18
Livija Zarina, Dace Piliksere, Liga Zarina RESULTS OF RESEARCH ON PESTICIDE FREE WEED MANAGEMENT USING INTER-ROW HOEING IN CEREALS.....	19
Shervin Hadian, Skaidrė Supronienė EFFECT OF ENDOPHYTIC BACTERIA ASSOCIATED WITH <i>ARTEMISIA</i> PLANT ON BIOLOGICAL CONTROL PEA ROT ROOT PATHOGEN.....	20
Raimonda Mažilytė, Audrius Gegeckas TOWARDS A CHEMICAL PESTICIDE-FREE AGRICULTURE: OPPORTUNITIES FOR IMPROVING SOIL MICROBIOLOGICAL ACTIVITY AND PLANT NUTRIENT AVAILABILITY.....	21
BIODIVERSITY, CROP AND PRODUCTION DIVERSIFICATION.....	22
Giedrė Samuolienė, Viktorija Vaštakaitė-Kairienė, Kristina Laužikė, Gediminas Kudirka, Akvilė Viršilė PRODUCTIVITY OF DIVERSE PLANT SPECIES IN RELATION TO EFFECTIVE PHOTOCHEMICAL YIELD	22

Jovita Balandaitė, Kęstutis Romaneckas, Algirdas Jasinskas THE PRODUCTIVITY OF MAIZE, HEMP AND FABA BEAN MULTI-CROPPED CULTIVATIONS.....	23
Gražina Žibienė, Laima Česonienė, Alvydas Žibas, Mantas Brazauskas INFLUENCE OF DIFFERENT FERTILIZERS ON THE WATER QUALITY OF AQUACULTURE PONDS.....	25
Nendel Claas CHALLENGES OF PREDICTING REGIONAL CROP YIELDS AND WATER BALANCE USING AGROECOSYSTEM MODELS AT HIGH RESOLUTION.....	27
Aušra Rudinskienė, Aušra Marcinkevičienė, Zita Kriauciūnienė, Rimantas Velička, Robertas Kosteckas CARAWAY (<i>CARUM CARVI</i> L.) IN MULTIFUNCTIONAL CROPS AND INTEGRATED ASSESSMENT OF ITS IMPACT ON THE AGROECOSYSTEM.....	29
PRECISION FARMING AND DIGITAL TECHNOLOGIES.....	30
Enoch Owusu-Sekyere, Assem Abu Hatab, Carl-Johan Lagerkvist, Egidijus Šarauskis, Zita Kriauciūnienė, Manuel Pérez Ruiz, Manuela Díaz, Enrique Apolo-Apolo, Mhd Baraa Almoujahed, Rebecca L. Whetton, Abdul M. Mouazen INCENTIVISING THE UPTAKE OF PRECISION AGRICULTURAL TECHNOLOGIES IN GRAIN FARMING: EMPIRICAL EVIDENCE FROM CHOICE EXPERIMENTAL SURVEY IN SPAIN.....	30
Imran Aslan APPLICATIONS OF SMART TECHNOLOGIES FOR MONITORING FOOD QUALITY AND SAFETY TO IMPROVE TRACEABILITY AND CUSTOMERS TRUST.....	32
Jūratė Staveckienė, Jurgita Kulaitienė, Agnieszka Tajner-Czopek ANTHOCYANINS AND CHLOROPHYLLS CHANGES IN <i>SOLANUM</i> SPP. FRUITS DURING RIPENING.....	33
FOOD QUALITY AND SAFETY.....	33
Elvyra Jarienė, Jurgita Kulaitienė, Nijolė Vaitkevičienė, Marius Lasinskas STUDIES OF THE VARIABILITY OF BIOLOGICALLY ACTIVE AND ANTICANCER COMPOUNDS IN ORGANICALLY GROWN FERMENTED FIREWEED (<i>CHAMERION ANGUSTIFOLIUM</i> (L.) HOLUB) LEAVES.....	34
CLIMATE CHANGE MITIGATION.....	35
Hossein Azadi RETHINKING RESILIENT AGRICULTURE: FROM CLIMATE-SMART AGRICULTURE TO VULNERABLE-SMART AGRICULTURE.....	35

ABSTRACTS. POSTER PRESENTATIONS

SOIL HEALTH AND CARBON SEQUESTRATION FOR SUSTAINABILITY..... 38

Vaida Steponavičienė, Vaclovas Bogužas, Lina Skinulienė, Marta Wyzinska
LONG-TERM IMPACT OF REDUCED INTENSITY TILLAGE SYSTEMS COMBINATIONS
ON SOIL PROPERTIES..... 38

Arnas Vansevicius, Vytautas Liakas, Zita Kriauciūnienė
EFFECT OF BIOLOGICAL PREPARATIONS ON THE BIOMETRIC PROPERTIES OF
'FUTURA 75' HEMP STEMS 39

**Giedrius Žiūraitis, Vaclovas Bogužas, Vaida Steponavičienė, Lina Skinulienė,
Aneta Perzanowska**
SOIL PROPERTIES AFTER LONG-TERM REDUCED TILLAGE, NO-TILL AND RESIDUE
MANAGEMENT 40

Aida Skersiene, Alvyra Slepeliene, Vaclovas Stukonis
CHANGES OF SOIL ORGANIC CARBON AND MOBILE HUMIC ACIDS CARBON
CONTENT UNDER LONG-TERM RED FESCUE (*FESTUCA RUBRA* L.) 41

Sidona Buragienė, Aida Adamavičienė, Egidijus Šarauskis
THE CHANGE OF SOIL PHYSICAL PROPERTIES IN DIFFERENT SOIL SUBSTRATES
AFTER THE USE OF BIOLOGICAL PREPARATION 42

**Aleksandra Ukalska-Jaruga, Bożena Smreczak, Joanna Ciepiel,
Urszula Pasternak**
INFLUENCE OF BIO-CARBONISATE ON THE SOIL ORGANIC MATTER QUALITY..... 43

Davut Karayel, Zita Kriauciūnienė, Egidijus Šarauskis
EFFECT OF SOIL CRUST BREAKER ON THE EMERGENCE OF SOME VEGETABLE
SEEDS..... 44

**Lina Marija Butkevičienė, Vaida Steponavičienė, Rita Pupalienė,
Lina Skinulienė, Vaclovas Bogužas**
IMPACT OF SOIL BIOSTIMULANTS ON SOIL CARBON AND NITROGEN DYNAMICS
UNDER WHEAT CROP 45

Lina Skinulienė, Edyta Hewelke, Vaida Steponavičienė, Vaclovas Bogužas
THE INFLUENCE OF DIFFERENT LONG-TERM CROP ROTATIONS ON SOIL
HYDROPHYSICAL PROPERTIES IN SPRING BARLEY CROPS 46

**Aušra Marcinkevičienė, Arūnas Čmukas, Rimantas Velička, Robertas
Kosteckas, Lina Skinulienė**
EFFECTS OF BIOPESTICIDES AND UNDERSOWN COVER CROPS ON SOIL
BIOLOGICAL PROPERTIES IN THE ORGANIC FARMING SYSTEM..... 47

SOIL AND CROP MANAGEMENT TOWARDS A CHEMICAL PESTICIDE-FREE AGRICULTURE.....	47
Darija Jodaugienė, Rita Čepulienė, Edita Mažuolytė-Miškinė, Irena Pranckietienė, Ilona Vagusevičienė EFFECT OF HUMIC ACID AND SILICON ON WINTER WHEAT	48
Ilona Vagusevičienė, Darija Jodaugienė, Gintarė Sujetovienė, Arvydas Kanapickas, Irena Pranckietienė INFLUENCE OF SOWING TIME AND SEED RATE ON PRODUCTIVITY OF WINTER WHEAT (<i>TRITICUM AESTIVUM</i> L.).....	49
BIODIVERSITY, CROP AND PRODUCTION DIVERSIFICATION.....	49
Rita Pupalienė, Kęstutis Romaneckas, Aiva Stankaitytė INFLUENCE OF SOWING METHOD AND RATE ON MILK THISTLE GERMINATION AND WEED FLORA.....	50
Jolanta Sinkevičienė, Laima Česonienė, Remigijus Daubaras <i>MONILINIA</i> SPP. PREVALENCE IN BERRIES OF EUROPEAN CRANBERRY (<i>VACCINIUM OXYCOCCOS</i>).....	51
Rahmatullah Atefi, Qudratullah Soofizada MORPHOLOGICAL CHARACTERIZATION OF ALMOND ACCESSIONS (NATIONAL COLLECTION) IN AFGHANISTAN	52
Mailiis Korge, Maarika Alaru, Kaidi Möll, Evelin Loit CONTENT OF ARABINOXYLAN IN BARLEY AND WHEAT GRAINS DEPENDING ON N RATE USED AND YEAR.....	53
Marek Marks, Stanislaw Bielski PRECISION FARMING AS ELEMENT OF PLANT PRODUCTION OPTIMIZATION	55
PRECISION FARMING AND DIGITAL TECHNOLOGIES.....	55
Indrė Bručienė, Egidijus Šarauskis SHORT-TERM EFFECTS OF AUTONOMOUS ROBOTIC AND CONVENTIONAL WEED CONTROL SYSTEMS ON SOIL PHYSICAL PROPERTIES	56
Jakub Dvořák, Kristýna Balážová, Karel Starý, Zdeněk Jelínek, Jan Chyba, Jiří Mašek, Jitka Kumhálová SAR IMAGES FOR CROP EVALUATION.....	57
FOOD QUALITY AND SAFETY	58
Nijolė Vaitkevičienė, Dovilė Motiejauskaitė INFLUENCE OF REPLACEMENT OF WHEAT FLOUR WITH SWEET POTATO POWDER ON QUALITY OF CUPCAKES	58
Aurelija Paulauskienė, Živilė Tarasevičienė QUALITY OF SEA BUCKTHORN (<i>HIPPOPHAE RHAMNOIDES</i> L.) OIL EXTRACTED FROM BERRIES PRESS CAKE.....	59

Nijolė Vaitkevičienė, Akvilė Sapronaitė BEETROOT PEEL AS A SUSTAINABLE RESOURCE OF ANTIOXIDANTS FOR THE FOOD INDUSTRY	60
Anna Kiełtyka-Dadasiewicz, Agnieszka Ludwiczuk, Żyvilė Tarasevičienė CROP POTENTIAL AND THE ESSENTIAL OILS YIELD OF FOUR CARVONE-RICH MINT SPECIES (<i>MENTHA</i> SP.)	61
Dalė Šumskienė THE EFFECT OF FIELD HORSETAIL AND STINGING NETTLE EXTRACTS IN GERMINATED SEEDS	62
Judita Černiauskienė, Žyvilė Tarasevičienė, Anna Kiełtyka-Dadasiewicz, Jovita Šimčikė EVALUATION OF BIOACTIVE COMPOUNDS IN THE DIFFERENT CULTIVARS OF BEETROOTS	63
Dovilė Levickienė, Irina Skirmantienė CHEMICAL COMPOSITION OF THE LEAVES OF WHITE MULBERRY GROWN IN LITHUANIA	64
Lauksmė Merkevičiūtė-Venslovė, Eimantas Venslovas, Audronė Mankevičienė, Alvyra Šlepetienė, Jurgita Cesevičienė EFFECT OF <i>USTILAGO MAYDIS</i> ON THE QUALITY AND AEROBIC DETERIORATION OF MAIZE SILAGE	65
Medveckienė Brigita, Kulaitienė Jurgita, Ewelina Hallmann THE EFFECT OF RIPENING STAGES ON THE POMOLOGICAL PARAMETERS AND TOTAL CAROTENOIDS CONTENT OF ROSEHIP SPECIES GROWING UNDER ORGANIC SYSTEM	66
Eimantas Venslovas, Sigita Janavičienė RISK OF MYCOTOXIN FORMATION IN BARLEY GRAIN DURING DELAYED HARVESTING	67
Egidijus Zvicevičius, Žyvilė Černiauskienė, Kęstutis Žiūra, Germantas Zajančkauskas DRYING RESEARCH OF <i>CANNABIS SATIVA</i> L. SEED IN A STATIONARY LAYER	68
CLIMATE CHANGE MITIGATION	69
Cojocaru Olesea, Panfil Gheorghe RESEARCH ON CONSERVATIVE AGRICULTURE AND THE MANIFESTATION OF CLIMATE CHANGE IN THE NORTH OF THE REPUBLIC OF MOLDOVA	69
Inga Adamonytė, Algis Kvaraciejus THE INFLUENCE OF CONTROLLED DRAINAGE ON THE WATER REGIME OF THE SOIL	70

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