

**VYTAUTAS MAGNUS UNIVERSITY  
AGRICULTURE ACADEMY**



**3<sup>rd</sup> International Scientific Virtual Conference  
AGROECOSYSTEM SUSTAINABILITY**

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

**Vytautas Magnus University Agriculture Academy, Lithuania, 2-3 December, 2020**

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

**INTERNATIONAL SCIENTIFIC VIRTUAL CONFERENCE**

**AgroEco2020  
PROGRAMME AND ABSTRACTS**



**2020**

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**Scientific reviewers:** Vaclovas Bogužas, Kęstutis Romaneckas, Elvyra Jarienė, Zinta Gaile, Aušra Marcinkevičienė, Aurelija Paulauskienė, Rimantas Vaisvalavičius, Vilija Aleknevičienė

*The conference addresses main issues related to Horizon Europe Mission Area  
'Soil Health and Food'*

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## PROGRAMME

<b>2 December (Wednesday)</b>	
<b>CE Time</b> <b>(for local</b> <b>EE Time</b> <b>add +1<sup>00</sup>)</b>	<b>Plenary Session</b> <b>Moderators: Zita Kriaučiūnienė, Vaclovas Bogužas</b>
9 <sup>00</sup> –9 <sup>10</sup>	<b>Opening of the Conference AgroEco2020</b> Aušra Blinstrubienė, <i>Vytautas Magnus University Agriculture Academy, Lithuania</i> ; Zenonas Dabkevičius, <i>Lithuanian Academy of Sciences</i>
9 <sup>10</sup> –9 <sup>30</sup>	<b>A mission for European soils – The Horizon Europe mission area ‘Soil health and food’</b> Cees Veerman, <i>Chair of the EC Mission Board for Soil Health and Food, Netherlands</i> ; Zita Kriaučiūnienė, <i>member of the EC Mission Board for Soil Health and Food</i> ; Vytautas Magnus University, <i>Agriculture Academy, Lithuania</i>
9 <sup>30</sup> –9 <sup>50</sup>	<b>European Infrastructure for Analysis and Experimentation on Ecosystems – AnaEE</b> Michel Boër, <i>AnaEE Director General, France</i>
9 <sup>50</sup> –10 <sup>10</sup>	<b>Agroecology and sustainable yields – the position of the BIOEAST initiative</b> Dora Drexler, <i>Hungarian Research Institute of Organic Agriculture, Hungary</i>
10 <sup>10</sup> –10 <sup>25</sup>	<b>Coffee, tea break</b>
10 <sup>25</sup> –10 <sup>45</sup>	<b>Economics and environmental potential of data fusion-based variable rate applications in precision agriculture</b> Abdul M. Mouazen, <i>Ghent University, Belgium</i>
10 <sup>45</sup> –11 <sup>05</sup>	<b>Weeds in the agroecosystem</b> Inderjit Singh, <i>University of Delhi, India</i>
11 <sup>05</sup> –11 <sup>25</sup>	<b>The influence of organic and conventional production on the bioactive compounds content in food products</b> Ewelina Hallmann, <i>Warsaw University of Life Sciences, Poland</i>
11 <sup>25</sup> –11 <sup>45</sup>	<b>Circular bioeconomy in the context of food chain management</b> Renata Marks-Bielska, <i>University of Warmia and Mazury in Olsztyn, Poland</i>
11 <sup>45</sup> –12 <sup>00</sup>	<b>Remarks and discussions</b> Moderators: Aušra Blinstrubienė, Vaclovas Bogužas, Zita Kriaučiūnienė, Cees Veerman, Michel Boër, Dora Drexler, Abdul M. Mouazen, Inderjit Singh, Ewelina Hallmann, Renata Marks-Bielska
12 <sup>00</sup> –13 <sup>00</sup>	<b>Lunch</b>

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**Parallel Session I**
**Moderators: Rimantas Vaisvalavičius, Elvyra Jarienė**


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**Soil health and C sequestration for sustainability**


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| 13 <sup>00</sup> –13 <sup>15</sup>   | <b>The effects of sapropel humic substances application on soddy podzolic soil chemical properties</b><br>Livija Zarina, <i>Institute of Agricultural Resources and Economics, Latvia</i> ;<br>Olegs Kukainis, Simona Larsson, <i>Latvian Institute of Humic Substances</i> ; Liga Zarina, <i>University of Latvia</i>   |
| 13 <sup>15</sup> –13 <sup>30</sup>   | <b>Methane fluxes from forest soils under trees of different ages and species</b><br>Anna Walkiewicz, Piotr Bulak, <i>Institute of Agrophysics, Polish Academy of Science, Lublin, Poland</i> ; Mohammad I. Khalil, <i>University College Dublin</i> ; Prudence College Dublin, <i>Ireland</i> ; Bruce Osborne, <i>University College Dublin, Ireland</i>  |
| 13 <sup>30</sup> –13 <sup>45</sup>   | <b>Land use change response on an allocation of organic carbon in the uppermost mineral soil layers</b><br>Jūratė Aleinikovienė, Vytautas Magnus University Agriculture Academy, <i>Lithuania</i> ; Kęstutis Armolaitis, Jelena Ankuda, <i>Lithuanian Research Centre for Agriculture and Forestry</i> ; Audrius Jakutis, Vytautas Magnus University Agriculture Academy, <i>Lithuania</i> ; Diana Sivojienė, Valeriia Mishcherikova, <i>Lithuanian Research Centre for Agriculture and Forestry</i> |
| 13 <sup>45</sup> –14 <sup>00</sup>   | <b>Carbon balances of annual versus perennial cropping systems</b><br>Ji Chen, Johannes Wilhelmus Maria Pullens, Poul Erik Lærke, <i>Aarhus University, Denmark</i>  |
| 14 <sup>00</sup> –14 <sup>15</sup>   | <b>Carbon stocks in the soil under different combination of tillage and organic fertilization</b><br>Monika Vilkenė, Ieva Mockevičienė, Dalia Ambrazaitienė, Danute Karčauskienė, <i>Lithuanian Research Centre for Agriculture and Forestry</i>   |
| 14 <sup>15</sup> –14 <sup>30</sup>   | <b>Depth-related changes in soil enzyme activities and physicochemical properties in the soil profiles</b><br>Anna Piotrowska-Długosz, Jacek Długosz, <i>UTP University of Science and Technology in Bydgoszcz, Poland</i>   |
| <b>Food quality and safety</b> <hr/> |  |
| 14 <sup>30</sup> –14 <sup>45</sup>   | <b>Studies of the variability of polyphenols and carotenoids in different methods fermented organic leaves of willowherb (<i>Chamerion angustifolium</i> (L.) Holub)</b><br>Marius Lasinskas, Elvyra Jarienė, Nijolė Vaitkevičienė, Jurgita Kulaitienė, Vytautas Magnus University Agriculture Academy, <i>Lithuania</i> ; Katarzyna Najman, Ewelina Hallmann, <i>Warsaw University of Life Sciences, Poland</i>   |
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14 <sup>45</sup> –15 <sup>00</sup>	<b>Impact of foliar application of amino acids on essential oil content, total phenols and antioxidant activity of <i>M. piperita</i></b> Aloyzas Velička, Živilė Tarasevičienė, Aurelija Paulauskienė, <i>Vytautas Magnus University Agriculture Academy, Lithuania</i>
15 <sup>00</sup> –15 <sup>15</sup>	<b>Quality changes of the sea buckthorn juice during storage</b> Judita Černiauskienė, Nijolė Vaitkevičienė, Jurgita Kulaitienė, Laura Makūnaitė, <i>Vytautas Magnus University Agriculture Academy, Lithuania</i>
15 <sup>15</sup> –15 <sup>30</sup>	<b>Lutein, zeaxanthin, <math>\alpha</math>, <math>\beta</math>-carotenes and lycopene in rosehip fruit flesh during ripening</b> Jurgita Kulaitienė, Brigita Medveckienė, Dovilė Levickienė <i>Vytautas Magnus University Agriculture Academy, Lithuania</i>
<b>Parallel Session II</b> <i>Moderators: Vaclovas Bogužas, Vilija Aleknevičienė</i>	
<b>Soil and crop management towards a chemical pesticide-free agriculture</b>	
13 <sup>00</sup> –13 <sup>15</sup>	<b>Nitrous oxide dynamics in agricultural soils in response to nitrification inhibitor and N-fertilizer amount</b> Azeem Tariq, Klaus Steenberg Larsen, Line Vinther Hansen, Lars Stoumann Jensen, Sander Bruun, <i>University of Copenhagen, Denmark</i>
13 <sup>15</sup> –13 <sup>30</sup>	<b>Septoria leaf blotch development depending on winter wheat variety</b> Gunita Bimšteine, Kristaps Ieviņš, Jānis Kaņeps, <i>Latvia University of Life Sciences and Technologies</i>
13 <sup>30</sup> –13 <sup>45</sup>	<b>Leaf spot diseases as an emerging problem in <i>Chaenomeles japonica</i> plantations</b> Inta Jakobija, Alise Klūga, <i>Latvia University of Life Sciences and Technologies; Institute for Plant Protection Research "Agrihorts", Latvia; Biruta Bankina, Latvia University of Life Sciences and Technologies</i>
13 <sup>45</sup> –14 <sup>00</sup>	<b>Effects of bio-preparations on soil and carbon footprint</b> Zita Kriaučiūnienė, Darius Juknevičius, Aida Adamavičienė, Sidona Buragienė, Egidijus Šarauskis, <i>Vytautas Magnus University Agriculture Academy, Lithuania</i>
14 <sup>00</sup> –14 <sup>15</sup>	<b>Impact of biochar on heavy metals and crop yield under different moisture regimes</b> Muhammad Ayaz, Urtė Stulpinaitė, Dalia Feizienė, Vita Tilvikienė, <i>Lithuanian Research Center for Agriculture and Forestry</i>
14 <sup>15</sup> –14 <sup>30</sup>	<b>Application of microbiological products in beans under organic farming conditions</b> Sonata Kazlauskaite, Povilas Mulercikas, Aurimas Krasauskas, <i>Vytautas Magnus University Agriculture Academy, Lithuania</i>

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- 14<sup>30</sup>–14<sup>45</sup> **Development of tan spot depending on fungicide treatment schemes and nitrogen rates**  
 Agrita Švarta, Gunita Bimšteine, Jānis Kaņeps, *Latvia University of Life Sciences and Technologies*
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### **The role of circular bioeconomy in climate change mitigation**

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- 14<sup>45</sup>–15<sup>00</sup> **Bioeconomy development in Lithuania: cases for sustainable change**  
 Vilija Aleknevičienė, *Vytautas Magnus University Agriculture Academy, Lithuania*
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- 15<sup>00</sup>–15<sup>15</sup> **The impact of the use of mineral nitrogen fertilizers on GHG emissions and mitigation using economic instruments**  
 Aušra Nausėdienė, Astrida Miceikienė, *Vytautas Magnus University Agriculture Academy, Lithuania*
- 
- 15<sup>15</sup>–15<sup>30</sup> **Comparative assessment of the sustainability performance of glue laminated timber and non-renewable material-based value chains**  
 Edgaras Linkevičius, *Vytautas Magnus University Agriculture Academy, Lithuania*; Marius Aleinikovas, Povilas Žemaitis, *Lithuanian Research Centre for Agriculture and Forestry*
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### **Parallel Session III**

*Moderators: Kęstutis Romaneckas, Aida Adamavičienė, Aušra Marcinkevičienė*

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### **Biodiversity, crop and production diversification**

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- 13<sup>00</sup>–13<sup>15</sup> **Agronomic and grain quality responses to fertilizer management in hulled and hullless barley**  
 Mara Bleidere, Margita Damskalne, Veneranda Stramkale, Sanita Zute, *Institute of Agricultural Resources and Economics, Latvia*
- 
- 13<sup>15</sup>–13<sup>30</sup> **Response of plants to seed processing with cold plasma, vacuum and electromagnetic field**  
 Vida Mildažienė, Anatolii Ivankov, Rasa Žukienė, Zita Naučienė, Asta Malakauskienė, *Vytautas Magnus University Agriculture Academy, Lithuania*, Irina Filatova, Veronika Lyuskevich, *B. I. Stepanov Institute of Physics, National Academy of Sciences of Belarus*, Kazunori Koga, Masaharu Shiratani, *Kyushu University, Japan*
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- 13<sup>30</sup>–13<sup>45</sup> **Influence of the symbiotic bacteria *Paenibacillus* sp. on the viability of European larch (*Larix decidua* Mill.) explants in vitro**  
 Evelina Zavtrikovienė, Jonas Žiauka, *Lithuanian Research Centre for Agriculture and Forestry*
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- 13<sup>45</sup>–14<sup>00</sup> **Conservation tillage in faba bean cultivation: weed flora**  
 Rasa Kimbirauskienė, Kęstutis Romaneckas, Aušra Sinkevičienė, Aida Adamavičienė, Sidona Buragienė, *Vytautas Magnus University Agriculture Academy, Lithuania*
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14 <sup>00</sup> –14 <sup>10</sup>	<b>Economical evaluation of reduced intensity tillage systems, straw and green manure combinations</b> Asta Bendoraitytė, Vaida Steponavičienė, Vaclovas Bogužas, Lina Skinulienė, Aušra Sinkevičienė, Vytautas Magnus University Agriculture Academy, Lithuania
14 <sup>10</sup> –14 <sup>20</sup>	<b>Influence of urease inhibitor and biopreparations on maize productivity</b> Povilas Drulis, Zita Kriaučiūnienė, Vytautas Magnus University Agriculture Academy, Lithuania
14 <sup>20</sup> –14 <sup>30</sup>	<b>Complex of soil tillage, organic and biological fertilization for improving soil microbial activity and nitrogen transformation efficiency in intensive cropping on Calcaric Luvisols</b> Jūratė Aleinikovienė, Lina Marija Butkevičienė, Audrius Jakutis, Vaclovas Bogužas, Vytautas Magnus University Agriculture Academy, Lithuania
14 <sup>30</sup> –14 <sup>45</sup>	<b>Less known <i>Botrytis</i> species as causal agent of legume diseases</b> Elina Brauna-Morževska, Janis Kaņeps, Biruna Bankina, Gunita Bimšteine, Latvia University of Life Sciences and Technologies; Ance Roga, Ingrida Neusa-Luca, Davids Fridmanis, Latvian Biomedical Research and Study Centre, Latvia
<b>Precision farming and digital technologies</b>	
14 <sup>45</sup> –15 <sup>00</sup>	<b>Efficiency of detection of particles by high-speed cameras in splash erosion studies</b> Agata Sochan, Magdalena Ryżak, Michał Beczek, Rafał Mazur, Cezary Polakowski, Institute of Agrophysics PAS, Poland; Zbigniew Łagodowski, Ernest Nieznaj, Adam Bobrowski, Lublin University of Technology, Poland; Andrzej Bieganski, Institute of Agrophysics PAS, Lublin, Poland
15 <sup>00</sup> –15 <sup>15</sup>	<b>Telemetry – for remote monitoring of the agricultural processes and the environment</b> Antanas Juostas, Eglė Jotautienė, Vytautas Magnus University Agriculture Academy, Lithuania
15 <sup>15</sup> –15 <sup>30</sup>	<b>Investigation of granular organic fertilizer distribution in soil using computer simulation</b> Raimonda Zinkevičienė, Eglė Jotautienė, Vytautas Magnus University Agriculture Academy, Lithuania
15 <sup>30</sup> –16 <sup>00</sup>	<b>Concluding remarks and discussions</b> Moderators: Zita Kriaučiūnienė, Rimantas Vaisvalavičius, Elvyra Jarienė, Vaclovas Bogužas, Vilija Aleknevičienė, Kęstutis Romaneckas, Aušra Marcinkevičienė, Aida Adamavičienė

<b>3 December (Wednesday)</b>	
<b>CE Time</b> <b>(for local</b> <b>EE Time</b> <b>add +1<sup>00</sup>)</b>	Webinar AnaEE (Analysis and Experimentation on Ecosystems, <a href="https://www.anaee.eu/">https://www.anaee.eu/</a> ) on data, modelling and access to the platform. AnaEE will also present the services offered by the Research Infrastructure and how it enables to develop multidisciplinary approaches at the frontiers of life sciences, agronomy and environmental sciences, combining experimentation, analysis and modelling services. <i>Moderators: Michel Boër, Sarah Mahe</i>
9 <sup>00</sup> –9 <sup>25</sup>	<b>Welcome address and introduction to AnaEE, its services and the Central Hub – AnaEE as facilitator of integrated experimental research in Europe</b> <i>Michel Boër, AnaEE Director General, France</i>
9 <sup>25</sup> –10 <sup>25</sup>	<b>AnaEE web services – fund raising, a rich platform catalogue of services and how the access portal works (showcase)</b> <i>Sarah Mahé, AnaEE, Chloé Martin, CNRS, Florent Massol, CNRS, France</i>
10 <sup>25</sup> –10 <sup>40</sup>	<b>Coffee, tea break</b>
10 <sup>40</sup> –11 <sup>15</sup>	<b>The AnaEE Data &amp; Modelling Centre – sharing FAIR data and integrating modelling in AnaEE</b> <i>Dario De Nart, CREA, Italy</i>
11 <sup>15</sup> –11 <sup>30</sup>	<b>AnaEE in ENVRIFAIR</b> <b>Christian Pichot, INRAE, France</b>
11 <sup>30</sup> –11 <sup>45</sup>	<b>Example of FAIRification of data from AnaEE Denmark</b> <i>Klaus Steenberg Larsen, UCPH, Denmark</i>
11 <sup>45</sup> –12 <sup>00</sup>	<b>The AnaEE Technology Centre – doing experiments together</b> <i>Klaus Steenberg Larsen, UCPH, Denmark</i>
12 <sup>00</sup> –12 <sup>30</sup>	<b>The AnaEE Interface &amp; Synthesis Centre – doing syntheses together</b> <i>Karel Klem, Global Change Research Institute CAS, Czech Republic</i>
12 <sup>30</sup> –13 <sup>30</sup>	<b>Lunch</b>
13 <sup>30</sup> –14 <sup>00</sup>	<b>Added value of ecotrons in AnaEE</b> <i>Alexandru Milcu, CNRS, France</i>
14 <sup>00</sup> –14 <sup>06</sup>	<b>Analytical and enclosed platforms at VMU AA</b> <i>Zita Kriaučiūnienė, Vytautas Magnus University Agriculture Academy, Lithuania</i>
14 <sup>06</sup> –14 <sup>12</sup>	<b>Long-term forest ecosystem monitoring and modeling platform</b> <i>Algirdas Augustaitis, Vytautas Magnus University Agriculture Academy, Lithuania</i>
14 <sup>12</sup> –14 <sup>18</sup>	<b>An aquacosc platform targeting controlled drainage system and constructed wetland manipulations</b> <i>Arvydas Povilaitis, Vytautas Magnus University Agriculture Academy, Lithuania</i>
14 <sup>18</sup> –14 <sup>24</sup>	<b>Agroecosystem manipulation platform at VMU AA</b>



	Vaclovas Bogužas, <i>Vytautas Magnus University Agriculture Academy, Lithuania</i>
14 <sup>24</sup> –14 <sup>30</sup>	<b>Plant phenotyping platforms at LAMMC</b> Gintaras Brazauskas, <i>Director of Lithuanian Research Centre for Agriculture and Forestry</i>
14 <sup>30</sup> –14 <sup>50</sup>	<b>Presentation on FATI-Platform</b> Simon Reynaert, A. Hans De Boeck, Ivan Nijs, <i>University of Antwerpen, Belgium</i>
14 <sup>50</sup> –15 <sup>05</sup>	<b>Coffee, tea break</b>
15 <sup>05</sup> –15 <sup>25</sup>	<b>Presentation about co-location sites</b> Taneli Kolström, <i>Natural Resources Institute, Finland</i>
15 <sup>25</sup> –16 <sup>00</sup>	<b>Concluding remarks and discussions</b>

## POSTER PRESENTATIONS

### *Soil health and C sequestration for sustainability*

- The influence of different nitrogen forms of fertilizers and meteorological conditions on nitrogen transformation and evaporation**  
Irena Pranckietienė, Rūta Dromantienė, *Vytautas Magnus University Agriculture Academy, Lithuania*
- Dynamics of changes in selected soil traits in the profiles of arable soils anthropogenically alkalised with in the Kielecko-Łagowski Vale (Poland)**  
Anna Swiercz, Agnieszka Gandzel, Ilona Tomczyk-Wydrych, *Institute of Geography and Environmental Science Jan Kochanowski University in Kielce, Doctoral Scholl of the Jan Kochanowski University, Poland*
- Influence of biological preparation on soil properties**  
Darija Jodaugienė, Rita Čepulienė, Irena Pranckietienė, Rūta Dromantienė, *Vytautas Magnus University Agriculture Academy, Lithuania*
- Biochar systems as carbon storage technique in agriculture: dealing with a new pharmacop**  
Samuel Abiven, *CNRS, Montpellier European Ecotron, CEREEP-Ecotron IleDe, Université Paris, France*
- Diurnal soil CO<sub>2</sub> efflux variations in mature Scot Pine (*Pinus sylvestris*) stands**  
Osvaldas Kučinskas, *Vytautas Magnus University Agriculture Academy, Lithuania*
- The physical-mechanical properties evaluation of experimental granulated poultry manure and biofuel ash fertilizer**  
Ramūnas Mieldažys, Eglė Jotautienė, Algirdas Jasinskas, *Vytautas Magnus University Agriculture Academy, Lithuania*
- Specific soil microorganisms effect on soil organic matter stabilization and quality parameters under drought conditions**  
Arnoldas Jurys, Dalia Feizienė, *Lithuanian Research Centre for Agriculture and Forestry*

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8. **Water stable soil aggregates under the different fertilizer treatments**  
 Rimantas Vaisvalavičius, Vytautas Magnus University Agriculture Academy,  
 Lithuania; Romutė Mikučionienė, Lithuanian Agricultural Advisory Service
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***Soil and crop management towards a chemical pesticide-free agriculture***

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9. **The influence of organic mulches on beetroot (*Beta vulgaris* L.) agrocnosis**  
 Alfredas Sinkevičius, Nida Palubinckaitė, Vaclovas Bogužas, Vaida Steponavičienė, Lina Skinulienė, Aušra Sinkevičienė, Vytautas Magnus University Agriculture Academy, Lithuania
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10. **Effect of different tillage on soil properties in winter rape crop**  
 Darija Jodaugienė, Aušra Sinkevičienė, Vaida Steponavičienė, Lina Skinulienė, Tautvydas Žemaitis, Vytautas Magnus University Agriculture Academy, Lithuania
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11. **Organic mulches in vegetable crops**  
 Irena Zemblienė, Rita Pupalienė, Vytautas Magnus University Agriculture Academy, Lithuania
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12. **Long-term crop rotation and fertilisation effect on soil organic matter dynamics in sustainable agriculture management systems**  
 Laura Masilionytė, Lithuanian Research Centre for Agriculture and Forestry, Zita Kriaučiūnienė, Egidijus Šarauskis, Vytautas Magnus University Agriculture Academy, Lithuania; Aušra Arlauskienė, Danutė Jablonskytė Raščė, Lithuanian Research Centre for Agriculture and Forestry
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13. **The influence of non-chemical weed control on the productivity of spring oilseed rape**  
 Rita Mockevičienė, Rimantas Velička, Aušra Marcinkevičienė, Vytautas Magnus University Agriculture Academy, Lithuania
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14. **Multifunctional agrocnoses biodiversity, sustainability and functionality in short vegetation conditions**  
 Jovita Balandaitė, Kęstutis Romanekas, Rasa Kimbirauskienė, Aušra Sinkevičienė, Algirdas Jasinskas, Kęstutis Stravinskas, Matas Skruzdis, Vytautas Magnus University Agriculture Academy, Lithuania
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15. **The influence of biological preparations and their mixtures on soil properties in winter wheat**  
 Lina Marija Butkevičienė, Vaclovas Bogužas, Vaida Steponavičienė, Tadas Kerdokas, Vytautas Magnus University Agriculture Academy, Lithuania
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16. **Impact of tillage intensity with vertical soil stratification on soil physical quality indexes**  
 Inga Andruškaitė, Vaclovas Bogužas, Vytautas Magnus University Agriculture Academy, Lithuania
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17. **Susceptibility of different varieties of tulips to viral diseases**  
 Sonata Kazlauskaite, Arūnas Balsevičius, Indre Lukšytė, Rita Maršelienė, Ričardas Narijauskas, Vytautas Magnus University Agriculture Academy, Lithuania
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18. **Evaluation of potato varieties and clones of breeding material in the integrated farming and management system in the North Kurzeme region of Latvia**

Lidija Vojevoda, Ilze Skrabule, *Institute of Agricultural Resources and Economics, Centre Crop Research Department, Latvia*

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***Biodiversity, crop and production diversification***

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19. **Effects of subsequent drought events and abilities to recover of alfalfa and ryegrass forage crops**

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## **ABSTRACTS**

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## **ORAL PRESENTATIONS**

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## A MISSION FOR EUROPEAN SOILS – THE HORIZON EUROPE MISSION AREA ‘SOIL HEALTH AND FOOD’

**Cees Veerman<sup>1</sup>, Zita Kriauciūnienė<sup>2</sup>**

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Healthy living soils keep us, and the world around, alive. The soil under our feet is a living system. It is home to many fascinating plants and animals, whose invisible interactions ensure our and planet well-being. Soils provide us with nutritious food and other products as well as with clean water and habitats for biodiversity. Soils can help slow climate change and make us more resilient to extreme climate events.

The increasing demand for land for urban development is consuming many of our most fertile soils. Unsustainable use of soil is affecting soil health, which, disrupts the capacity of soils to carry out the vital services. Soils are fragile and they can take thousands of years to form but can be destroyed in hours! Therefore, we need to take care of soils now so that they can be safeguarded for future generations.

Soil condition is at the heart of the new EU Green Deal and the United Nations Sustainable Development Goals, both of which aim to reduce biodiversity loss and pollution, reverse climate change while striving for a healthy environment and sustainable land use. The Mission will have a major role in responding to risks from the coronavirus, as some of the microbes in the soil are one of our most promising sources of new therapeutic drugs.

The Mission “Caring for Soils is Caring for Life” will raise society’s awareness of soils and put Europe on a path towards sustainable land and soil management. The Mission will bring people from all areas. Together, all of us will help to design and apply solutions to achieve the main goal of the Mission: By 2030, at least 75% of soils in each EU Member State are healthy, or show a significant improvement towards meeting accepted thresholds of indicators, to support ecosystem services. Mission activities will bring communities together to work with land managers to co-create new knowledge and innovation, training and advice in “Lighthouses” and “Living labs”, enabling validation and demonstration of good practices and widespread uptake of solutions.

**Key words:** *healthy soil, nutritious food, key indicators, monitoring, lighthouses, living labs*

## THE EFFECTS OF SAPROPEL HUMIC SUBSTANCES APPLICATION ON SODDY PODZOLIC SOIL CHEMICAL PROPERTIES

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Humic substances are the most common organic substances in nature and their concentration in the soil affects its fertility. In soil, humic substances act as a sorbent for minerals and trace elements, preventing their leaching from the soil during rainy periods, as well as they are nutrients for soil microorganisms, without which fertile soil and strong plants are impossible.

In order to investigate the efficacy of the powerful probiotic soil fertilizer – sapropel concentrate with biologically active humic substances and natural soil microorganisms in improving sod podzolic soils, a study was conducted at the Priekuli Research Centre of Institute of Agricultural Resources and Economics. The study was carried out in a field where biological crop management methods were used. The soil characteristics before the experiment were as follows: pH<sub>KCl</sub> – 5.9–6.17, organic matter – 20.02 g kg<sup>-1</sup>, available phosphorus and potassium – accordingly 164 and 232.6 mg kg<sup>-1</sup> of soil. The sapropel humic substance preparation was sprayed on the field before sowing applying three doses: 5, 10, and 20 l ha<sup>-1</sup>.

The data showed that the use of the sapropel humic substance preparation contributed to the increase in crop yields, but not always significant changes in soil agrochemical parameters were observed. More detailed results needed with some numbers, percent, etc.

**Key words:** *humic substances, sapropel, field crops, organic farming, soil agrochemical parameters.*



# METHANE FLUXES FROM FOREST SOILS UNDER TREES OF DIFFERENT AGES AND SPECIES

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In addition to their well-known role in sequestering carbon, forest soils have a high ability to take up atmospheric methane (CH<sub>4</sub>), and this could have important implications for the cycling of carbon (C). This is due in part to the enhanced activity of methanotrophs in forest soils which reduce the amount of CH<sub>4</sub> emitted to the atmosphere.

Based on the importance of forest soils in the CH<sub>4</sub> cycle, the aim of the research was to determine how the consumption of CH<sub>4</sub> by soils varied with different types of forests, referring to various tree species and stand ages. Soil properties and climatic parameters were also determined as these are also factors that can affect CH<sub>4</sub> uptake.

To examine this, a two-year (2018–2020) field study of CH<sub>4</sub> fluxes was conducted in ten contrasting forests in Lublin Upland, Poland using static chambers. For each month, CH<sub>4</sub> fluxes were measured in forests differing in tree species (three deciduous, two coniferous, and five mixed sites), and stand age (from 11 to 100 years).

The results showed that the mean annual negative CH<sub>4</sub> fluxes were in the range from 0.525 to 4.83 kg CH<sub>4</sub> ha<sup>-1</sup> in the youngest and mature forests, respectively. The oxidation of CH<sub>4</sub> varied seasonally, and was positively correlated with temperature, and negatively correlated with soil moisture. More CH<sub>4</sub> was uptaken by sandy soils.

The oxidation of CH<sub>4</sub> by forest soils was found to be controlled by complex interactions among soil parameters, stand age, tree species identity, and climate. This indicates that further work is required in order that these drivers can be further quantified and the absorption of CH<sub>4</sub> by forest soils fully exploited for mitigating the impacts of climate change.

**Acknowledgements:** The research was partially financed by the Polish National Centre for Research and Development within of ERA-NET CO-FUND ERA-GAS (ERA-GAS/I/GHG-MANAGE/01/2018).

**Key words:** forest soil, CH<sub>4</sub> uptake, deciduous forests, coniferous forests.

## LAND USE CHANGE RESPONSE ON AN ALLOCATION OF ORGANIC CARBON IN MINERAL TOPSOIL

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Land-use change drives both the turnover of soil organic matter (SOM) and the changes in soil organic carbon (SOC) storage. Meanwhile, the objective of this study was to determine SOM allocation into the SOC and into the soil microbial biomass (SMB) along the land use change. Composite soil samples were collected from the mineral topsoil (in 0-10 cm of the depth) of cropland, abandoned agricultural land, managed and unmanaged grassland and adjacent middle-aged and premature forest stands of different tree species, mainly Scots pine (*Pinus sylvestris* L.) and silver birch (*Betula pendula* Roth). It was estimated, that mean allocation of decomposed SOM into the SOC was higher in the silver birch stands (22.0–4.2 mg C g<sup>-1</sup> of dry soil) and were significantly decreasing in Scots pine stands (10.1–14.4 mg C g<sup>-1</sup> DS) and cropland (9.8–13.7 mg C g<sup>-1</sup> DS). However, the SOC in abandoned agricultural land and in grassland was varying in relatively high extent, respectively, from 15.6 to 20.5 mg C g<sup>-1</sup> DS and from 15.0 to 23.5 mg C g<sup>-1</sup> DS and was higher than in cropland. There were estimated the significant link between the SOM allocation into the SMB and the vegetation composition in the land use change experimental sites. Thus, SMB carbon was significantly increasing mainly in the mineral topsoil of managed and unmanaged grassland (449–496 µg C g<sup>-1</sup> DS) and were by 1.6-2.3 folds higher than in cropland (217–280 µg C g<sup>-1</sup> DS) and 1.4–1.7 times higher than in the Scots pine stands (289–314 µg C g<sup>-1</sup> DS) This research work was carried out to obtain the results funded by the EEA Financial Mechanism Baltic Research Programme in Estonia.

**Key words:** *soil, land-use change, organic matter, organic carbon, soil microbial biomass.*

## CARBON BALANCES OF ANNUAL VERSUS PERENNIAL CROPPING SYSTEMS

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To meet the growing challenges of food security, sufficient biomass for biorefineries and mitigation of climate change, perennial grass is recommended as an alternative for annual grain crop to increase biomass production while protecting soil C stock. However, the long-term biomass yield production, soil C stock, and ecosystem CO<sub>2</sub> flux are rarely simultaneously evaluated in the same study site, limiting the understanding of C flows in different cropping systems. We compared the annual grain crop triticale (*Triticosecale*) grown every year since 2012 with the productive perennial grass festulolium (*Festulolium braunii*) established in 2012. Annual yield production, five-year changes in soil C stock, and ecosystem CO<sub>2</sub> fluxes in 2020 are documented. The first five-year field observations showed that festulolium produced 76% more biomass as compared to triticale (grain and straw). Meanwhile, there was an increasing trend of soil C stock in festulolium but a declining trend of soil C stock in triticale across the first five years, despite both changes were statistically non-significant. At the conference we will present carbon fluxes measured in triticale and festulolium during the growth season of 2020 with automatic ECO2Flux chambers ([www.prenart.dk](http://www.prenart.dk)). The results are derived from the experimental research platform Biobase as part of the European research infrastructure AnaEE ([www.anaee.dk](http://www.anaee.dk)).

**Key words:** *continuous monoculture, perennial grass, biomass production, soil carbon content, ecosystem CO<sub>2</sub> flux.*

## CARBON STOCKS IN THE SOIL UNDER DIFFERENT COMBINATION OF TILLAGE AND ORGANIC FERTILIZATION

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Soil organic carbon (SOC) plays a key role in sustaining soil productivity and health. The aim of this research was to evaluate the regularities of SOC accumulation in the effect of long-term application of agrotechniques. The field experiments were carried out at the Vežaičiai Branch of LAMMC during the period between 2013 and 2017. The research treatments consisted of three tillage methods – deep ploughing (22–25 cm), ploughless tillage (7–10 cm) and ploughless tillage (7–10 cm) with additional deep loosening (up to 40 cm) and four types of additional organic fertilizers: stubble, chopped straw, chopped grass and farmyard manure 40 t ha<sup>-1</sup>.

Different intensity of tillage affects SOC accumulation. It was determined that accumulation processes happened in the deep ploughed soil lower arable layer (10–20 cm), C<sub>org.</sub> seeks 1.59%, it's 3.7% more then in upper layer. Meanwhile, in the shallow ploughless tillage, these processes were noticed in the upper soil layer (0–10 cm), there C<sub>org.</sub> seeks 1.74%, and it's 12.6% more compared with deeper layer (10–20 cm). The highest relative annual positive change (rate was 0.008) of dissolved organic carbon (DOC) was established in the shallow ploughless soil. Application of additional deep loosening 11% reduced the DOC content (0.173 g kg<sup>-1</sup>) compared to shallow ploughless tillage (0.194 g kg<sup>-1</sup>). Organic fertilizer had no statistically significant effects on SOC and DOC accumulation. However, carbon emitted as CO<sub>2</sub> in deep ploughed soil was significantly lower (0.017 g (kg.a.d.s.d)<sup>-1</sup> day<sup>-1</sup>) compared to shallow ploughless tillage (0.026 g (kg.a.d.s.d)<sup>-1</sup> day<sup>-1</sup>) and treatment with deep loosening (0.023 g (kg.a.d.s.d)<sup>-1</sup> day<sup>-1</sup>). That indicates that the mineralization processes are not very active in deeply ploughed soil.

In the conditions of western Lithuanian climate, shallow ploughless tillage is the most suitable tillage technology, as it creates favorable conditions for the accumulation of SOC. Additional loosening promotes the loss of SOC and increases the amount of unsaturated compounds, which leads to soil degradation.

**Key words:** *tillage system, soil organic carbon, deep loosening, organic fertilization, acid soil.*

## DEPTH-RELATED CHANGES IN SOIL ENZYME ACTIVITIES AND PHYSICOCHEMICAL PROPERTIES IN THE SOIL PROFILES

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Enzymes play an essential role in the functioning of the soil environment because they participate in the pedogenic processes by transforming soil organic matter, thereby making nutrients available for plants. However, most studies of enzymes in agricultural soil have been restricted to the upper soil layer, mostly affected by repeated agricultural treatments and natural factors, although soil microbes and related enzymes influence the biogeochemical processes throughout the entire soil profile. Therefore, the objective of the study was to determine the depth-related changes in soil enzymatic activity to understand organic matter transformation in the soil profile.

A study was conducted on four soil profiles localized in two mesoregions of the South Baltic Lake District, central Poland, namely Haplic Luvisols, Albic Eutric Stagnosols, Mollic Stagnic Gleysols and Cutanic Luvisols. Studied soil profiles were formed on the same parent material (glacial till) but differed with soil pedogenic processes. Soil samples were collected from fields with alfalfa (*Medicago sativa* L.) in the fourth year of its cultivation. Soil oxidoreductases activity (dehydrogenase, peroxidase, phenoloxidase), FDA hydrolysis, microbial biomass carbon and nitrogen (MBC, MBN) and some physicochemical properties were determined.

Differences in the enzyme activity between the soil horizons were both profile and enzyme specific. The enzymatic activity expressed per soil unit was the highest in the surface horizons of the profiles (counted as 100% of activity); however, it was lower in sub-surface layers (between 1 and 50% of surface activity) and had a different pattern in response to depth of a profile. In turn, specific enzymatic activity (activity per unit of  $C_{ORG}$  and MBC content) either decreased with soil depth (dehydrogenase and FDA hydrolysis) or increased (phenoloxidase and peroxidase). The highest concentration of MBC and MBN was in the surface layers (mean 190 and 34 mg kg<sup>-1</sup>) and decreased down the soil profiles, up to 24 and 4 mg kg<sup>-1</sup>, respectively.

**Key words:** soil profile, depth pattern, enzymes, physicochemical properties.

**STUDIES OF THE VARIABILITY OF POLYPHENOLS AND  
CAROTENOIDS IN DIFFERENT METHODS FERMENTED  
ORGANIC LEAVES OF WILLOWHERB (*CHAMERION  
ANGUSTIFOLIUM* (L.) HOLUB)**

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The demand for organic production is increasing worldwide. The willowherb, grown in an organic way, contributes greatly to the idea of a healthier society and clean land. Willowherb is widespread in the world and has high polyphenols, carotenoids, and antioxidant properties. The purpose of this work was to investigate the influence of solid-phase fermentation (SPF) under different conditions on the variation of polyphenols and carotenoids in the organic leaves of willowherb. The leaves were fermented for different periods of time: 24, 48, and 72 h; and in aerobic and anaerobic conditions. The evaluation of polyphenols and carotenoids was completed using high-performance liquid chromatography (HPLC), and antioxidant activity was measured by spectrophotometric method. Hierarchical cluster analysis was used to describe differences in biologically active compounds between willowherb samples. The experiment showed that the highest quantities of total phenolic acids and flavonoids were determined after 24 h under aerobic SPF, but the number of total carotenoids was higher after 72 h anaerobic SPF, compared to control. Not-fermented willowherb leaves had a lower antioxidant activity compared to fermented leaves. In conclusion, SPF can be used to change polyphenol and carotenoid quantities in organic leaves of willowherb.

**Key words:** *organic willowherb, solid-phase fermentation, polyphenols, carotenoids; antioxidant activity.*

## IMPACT OF FOLIAR APPLICATION OF AMINO ACIDS ON ESSENTIAL OIL CONTENT, TOTAL PHENOLS AND ANTIOXIDANT ACTIVITY OF *M. PIPERITA*

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Plants of *Mentha* family are one of the most important sources of essential oils and extracts with high antioxidant activity. The aromatic amino acids are not only components of protein synthesis in plants, but can be used as precursors for secondary metabolites synthesis stimulation in plants.

Research was conducted at Research station of Aleksandras Stulginskis University (since 2019 – Vytautas Magnus University Agriculture Academy), Lithuania, 2017–2018. The aim of this study was to investigate the influence of aromatic amino acids on phenols, essential oil content and antioxidant activity of *M. piperita* cvs. 'Swiss' and *M. piperita* 'Multimentha'.

Mints were sprayed with aromatic amino acids phenylalanine, tryptophan and tyrosine at two concentrations ( $100 \text{ mg l}^{-1}$  and  $200 \text{ mg l}^{-1}$ ) three times with 15 days interval. Plants harvested on the 65 BBCH stage of mints development. The essential oil was extracted by hydro distillation method, phenols content was determined by (HPLC) and antioxidant activity by spectrophotometric method. Statistical analysis was performed using two-way analysis of variance (ANOVA) (Statistica 12, StatSoft, USA). Tukey's (HSD) test was applied to assess significant differences between the samples at  $p < 0.05$ .

The results showed that *M. piperita* 'Swiss' accumulated more secondary metabolites compared with *M. piperita* 'Multimentha', but *M. piperita* 'Multimentha' extract showed strongest antioxidant activity. The highest essential oil content was determined in *M. piperita* 'Swiss' plants sprayed with phenylalanine at concentration of  $100 \text{ mg l}^{-1}$ , while total phenols content in *M. piperita* 'Swiss' mint sprayed with tryptophan at concentration of  $100 \text{ mg l}^{-1}$ .

Research results showed that foliar application of amino acids stimulate synthesis of secondary metabolites, especially phenols in mint plants under field conditions.

**Key words:** aromatic amino acids, DPPH, foliar application, mints.

## QUALITY CHANGES OF THE SEA BUCKTHORN JUICE DURING STORAGE

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Sea buckthorn berries healthy properties are based on the rich nutritional value of berries, which meets the needs of the human body for the necessary substances such as carotenoids, phenolic compounds, mineral composition, also for their antioxidant properties. Due to the chemical composition of sea buckthorn berries, it is important to study different ways of pressed the juice in order to preserve as many biologically active components as possible, which would help consumers to enrich their daily diet.

The aim of this work was to evaluate the influence of various pressing methods to the chemical composition of juice from different cultivars sea buckthorn berry during storage.

Three cultivars of sea buckthorn ('Avgustinka', 'Botaničeskaja', 'Mary C3') juice were obtained by slow-speed and fast-speed pressing.

The chemical composition of the juice from different cultivars of sea buckthorn pressed in various ways were evaluated by standard method: the soluble dry matter, the total carotenoids and phenolic compounds, pH value.

The studies have shown that the highest amount of soluble dry matter were evaluated in the fresh sea buckthorn juice made from the 'Avgustinka' variety. During storage was observed the significant decrease of the soluble dry matter amount and the increase of pH acidity in all samples of juice, especially after 4 months storage comparing with the fresh juices. The highest content of phenolic compounds was found in fresh sea buckthorn juice of the variety 'Botaničeskaja', which was pressed in a high-speed manner, and the lowest - in the juice obtained in a high-speed manner of the same variety after 4 months of storage. For the assessment of total carotenoids, the substantial maximum levels were found in sea buckthorn juice of the variety 'Mary C3', pressed in a slow-speed juicer.

The research showed that the highest amount of the total carotenoids and soluble dry matter amounts were in juice produced by slow-speed pressing. But the juice pressing method didn't significantly affect to the total phenolic compounds. The chemical composition significantly decreases during storage in juice from all sea buckthorn berry cultivars.

**Key words:** *storage, juice, sea buckthorn berries.*



## LUTEIN, ZEAXANTHIN, A, B -CAROTENES AND LYCOPENE IN ROSEHIP FRUIT FLESH DURING RIPENING

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Rosehips flesh is a source of the vitamins, minerals, carotenoids such as lycopene, zeaxanthin, lutein,  $\alpha$ ,  $\beta$  -carotene and other biological active compounds.

A two-factor field experiment with two rosehip species *R. Rugosa* and *R. Canina* was conducted in 2017–2018 on an organic farm in Pakruojis district Lithuania. The fruits were harvested five times in season and the carotenoids amount were compared at different stages of rosehip development.

The aim of this research was to determine the effect of ripening stage on some carotenoids composition of two different rosehip flesh species *R. Rugosa* and *R. Canina*. Content of lutein, zeaxanthin,  $\alpha$ ,  $\beta$ -carotenes and cis-lycopene, trans-lycopene in the fruits of rosehip were determined by the method described by Hallmann (2012) with some modifications.

The results revealed very large variations in amount of carotenoids in the rosehips, both in terms of total amount and in composition of specific carotenoid compounds.  $\beta$ -carotene was the predominant carotenoid in rosehip fruit. The flesh of the *R. canina* and *R. rugosa* had the highest amount of  $\beta$ -carotene at ripening stage V (14.10 and 18.55 mg 100 g<sup>-1</sup> DW, respectively), with significant differences between them. The *R. canina* flesh had significantly highest amounts of lutein at ripening stage V (9.19 mg 100 g<sup>-1</sup> DW). Significantly highest zeaxanthin concentrations were established at ripening stages III, IV and V of *R. canina*, compared with *R. rugosa*. The highest amounts of the lycopene were found in the flesh of *R. canina* at ripening stage V.

**Key words:** flesh, lutein, zeaxanthin,  $\alpha$ ,  $\beta$ -carotenes, lycopene, ripening stage.

## NITROUS OXIDE DYNAMICS IN AGRICULTURAL SOILS IN RESPONSE TO NITRIFICATION INHIBITOR AND N-FERTILIZER AMOUNT

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Nitrogen (N) fertilization in agricultural soils significantly contributes to the atmospheric increase of nitrous oxide (N<sub>2</sub>O). Application of nitrification inhibitors (NIs) is a promising strategy to mitigate N<sub>2</sub>O emissions and improve N use efficiency in agriculture systems.

We studied the effect of 3,4-dimethylpyrazol phosphate (DMPP) as a NI on N<sub>2</sub>O mitigation from soils planted with spring barley and spring rape. We used both manual and automatic chamber technologies to capture the high spatial and temporal variability in N<sub>2</sub>O emissions. A small plot experiment with different levels (0, 50, 100, 150, and 200%) of N fertilizer and the standard amount of N with NI was also conducted for two months in soil planted with spring barley.

Higher emissions were observed in treatments with high N levels and without NI. The effect of NI in reducing N<sub>2</sub>O emissions from spring barley planted soils was significant in the small chamber experiments. Where NI reduced N<sub>2</sub>O emissions by 47% in the first two months after fertilization. However, the effect of NI on N<sub>2</sub>O reduction was non-significant in the big chamber experiment for the whole season. Whereas, NI significantly reduced (56%) the seasonal N<sub>2</sub>O emissions from the soils planted with spring rape. After the initial peaks, high N<sub>2</sub>O fluxes were observed following the rain events. The continuous flux measurements showed the dynamic of N<sub>2</sub>O changes during the whole season, which often unobservable with manual chambers. The concentration of nitrate was higher in the soils treated with mineral N without NI compared to soils treated with NI, which clearly showed the inhibition of the nitrification process with the application of NI. The grain and biomass yield were not affected by the use of NI. Application of NI is an efficient mitigation technology without influencing crop yield.

**Key words:** nitrification inhibitor, DMPP, N<sub>2</sub>O, mitigation, agriculture soils.

## SEPTORIA LEAF BLOTCH DEVELOPMENT DEPENDING ON WINTER WHEAT VARIETY

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Septoria leaf blotch, caused by *Zymoseptoria tritici* is one of the most devastating wheat foliar diseases over the world, including Baltic region. The aim of present study is to evaluate development of disease depending on the variety and meteorological conditions. Field experiment was carried out in two different regions of Latvia for 3 years (2018–2020). Fifteen winter wheat varieties ('Skagen', 'Edvins', 'Ceylon', 'Zeppelin', 'Bronš', 'Rotax', 'Creator', 'Fenomen', 'Mariboss', 'KWS Malibu', 'Famulus', 'Patras', 'Talsis', 'Fredis', and 'SW Magnifik') by three replications were included. Development of disease was evaluated by calculation of area under disease progress curve (AUDPC). Three-way analysis of variance was performed by using R free software. Development of *Septoria* leaf blotch significantly differed depending on the year and variety ( $p < 0.05$ ), but site of experiment was not essential. In the year 2018 severity of *Septoria* leaf blotch was low (below 0.1%) and symptoms were observed in some varieties ('KWS Malibu', 'Famulus', 'Talsis' and 'SW Magnifik'). In the year 2019 disease symptoms were observed only in variety 'Fredis'. In 2020, the development of the disease was significantly higher. The highest severity of *Septoria* leaf blotch was observed in varieties 'Edvins' – 25%, 'Talsis' – 19% and 'Fredis' – 20%. In other trial varieties severity did not exceed 0.9–5.0%. It is known that development of *Septoria* leaf blotch mainly depends on amount of precipitations and number of rainy days. The years 2018 and 2019 were relatively dry with low amount of precipitation and the low number of rainy days. While in the year 2020 precipitation was sufficient and evenly distributed through all the vegetation season.

**Acknowledgments:** The study was carried out in EIP-AGRI project no. 18-00-A01612-000003 "Development of a decision support system for the control of winter wheat leaf and ear diseases".

**Key words:** *Z. tritici*, foliar diseases, varieties.

## LEAF SPOT DISEASES AS AN EMERGING PROBLEM IN *CHAENOMELES JAPONICA* PLANTATIONS

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Japanese quince (*Chaenomeles japonica*; hereinafter quince) is cultivated as a fruit crop in Latvia and in several North European countries. The area of commercially grown quince in Latvia is continuously increasing; therefore, leaf spots can become an important reason for the decrease of yield.

Investigations were carried out in Latvia in 2017–2019. The aim of the present study was to clarify the dynamics of leaf spot development and the diversity of fungi on quince leaves.

The assessment of quince leaf diseases was carried out in eight plantations. A total of 300 fully developed leaf rosettes were evaluated, and the incidence of leaf spot complex was calculated. Pure cultures of fungi from quince leaves were obtained and identified by mycological and molecular genetic analyses.

Different symptoms of leaf diseases were observed: small black spots with a red halo; brown circular spots or spots with concentric rings, 2–5 mm in diameter; and irregularly shaped spots. Fungi of eight genera were found: *Monilinia*, *Botrytis*, *Fusarium*, *Alternaria*, *Boeremia*, *Didymella*, *Arthrrium*, and *Discosia*.

The first symptoms of leaf spots in quince were detected from the end of May to the beginning of June. An agronomically significant incidence of leaf spot complex (about 20% and higher) was observed at the end of June and at the beginning of July in the 2017 and 2019 vegetation seasons. Infected leaves turned yellow and fell prematurely. Rapid progress of leaf diseases occurred simultaneously with fruit development and could have had a negative impact on the quality and quantity of yield. At the end of vegetation period, the incidence of leaf spots reached high levels – 30 to 63% in 2017, 20 to 100% in 2018, and 20 to 60% in 2019 – depending on the site of observation.

Identification of fungal species and the performance of pathogenicity tests are further tasks of investigations.

**Key words:** diversity, japanese quince, incidence, monilinia, botrytis.

## EFFECTS OF BIO-PREPARATIONS ON SOIL AND CARBON FOOTPRINT

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Crops cultivated, chemical and organic substances, agro-technologies used, as well as meteorological conditions have a significant impact on soil organic carbon (SOC) and footprint. A carbon footprint is the total amount of greenhouse gases (GHG) that are generated by our actions, expressed as carbon dioxide equivalent. Carbon footprint is mostly used for assessment of ecologically sustainable production systems.

The aim of this research was to analyse the effect of different bio-preparations on the changes of SOC content and winter wheat and oilseed rape yields by assessing the energy consumption efficiency and the environmental impacts. The experimental research was conducted in 2017–2019 in three different scenarios. In two scenarios were used bio-preparations – a molasses and magnesium sulphate based bio-preparation (SC1) and bacteria based bio-preparation (SC2), while scenario SC3 was as a control where no bio-preparations were used. The changes of SOC content were analysed at two depths: 0–10 and 10–20 cm. For the analysis of energy efficiency indicators and environmental impacts, the GHG and energy consumption conversion equivalents were used. Results showed that both types of bio-preparations had a positive effect on the changes of SOC content, which was especially evident in the deeper layers at 10–20 cm depth, where, irrespective of the crop type, a more significant increase of the SOC content was observed every year of the experiment compared to the control scenario (SC3). Bio-preparations had a significant effect in increasing the winter wheat and oilseed rape yields. The optimal energy efficiency ratio was observed in scenario SC1: in winter wheat – 4.84 and winter oilseed rape – 5.11. The results of the environmental impact assessment showed that the lowest GHG emissions were recorded in the winter wheat production in SC1 at 108.7–149.1 kg CO<sub>2</sub>eq Mg<sup>-1</sup>, while the highest were observed in winter oilseed rape production in control (SC3) at 343.4 kg CO<sub>2</sub>eq Mg<sup>-1</sup>.

**Acknowledgments:** to Vytautas Magnus University Agriculture Academy and World Federation of Scientists for support and scholarship.

**Key words:** SOC, agricultural inputs and outputs, winter wheat yield, winter oilseed rape yield, footprint

## IMPACT OF BIOCHAR ON HEAVY METALS AND CROP YIELD UNDER DIFFERENT MOISTURE REGIMES

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Soil ability to retain water under drought and other severe hydrothermal conditions is crucial to the sustainability of agrofarming systems and conserving soil ecological services. We investigated the impact of biochar under different moisture conditions on soil elements and wheat crop in pots. Moisture conditions applied were Drought ( $<5\%$  moisture), optimal ( $\leq 15$ ) and flooded ( $35\% >$ ) with and without Swine manure biochar ( $450^{\circ}\text{C}$ ) applied at the rate of  $15 \text{ ton ha}^{-1}$ . Nitrogen fertilizer was applied to all treatments at the rate of  $180 \text{ kg ha}^{-1}$ , (total of 6 treatments with 4 replications each). Results show that the highest wheat crop yield was determined in the presence of optimal moisture with biochar e.g.  $3.25 \text{ t ha}^{-1}$ , while the lowest in the case of drought condition without biochar e.g.  $0.96 \text{ t ha}^{-1}$ . Chlorophyll index and fluorescence measurements showed that the highest content was at 62nd and 34<sup>th</sup> days respectively of sowing under biochar treated soil at optimal moisture respectively. The highest dry matter content was determined in the treatment with biochar at the optimal moisture content e.g.  $2.53\%$ . Comparing the micronutrient composition of soil and biochar, it was observed that the highest amount of major elements were observed in biochar treated pots. M2B1 treatment shows significantly higher Mg  $37.31\%$  and  $22.34\%$ , P  $70\%$  and  $55.53\%$ , K  $37.86\%$  and  $31.03\%$  and Ca  $34.17\%$  and  $34.31\%$  in soil and plants respectively compared to Non-biochar treatments, which may be due to the richness content of the biochar mixed with the soil. The analysis of heavy metals (Cr, Ni, Cu, Zn, Cd, Pb) showed that more zinc was found in all biochar treated pots ranging from  $0.048\%$  to  $0.068\%$  as well as in plants under all moisture regimes. It can be concluded that the intensity of chlorophyll and fluorescence was positively affected by biochar thus enhanced wheat crop yield under optimal moisture condition. Biochar enriches soil and plants with trace elements such as phosphorus, calcium, potassium, magnesium. However, along with biochar, heavy metals such as zinc and copper also enter the soil and plants. It is very important to determine the chemical properties of soil and biochar before mixing biochar with soil.

**Key words:** *biochar, soil moisture retention, crop yield, heavy metals.*

## APPLICATION OF MICROBIOLOGICAL PRODUCTS IN BEANS UNDER ORGANIC FARMING CONDITIONS

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The area of beans has increased significantly as a result of the greening program. However, to obtain production with high quality has become a challenge as the application of chemicals has been severely restricted. Therefore, various alternatives of biological origin products are constantly being sought.

The objective of the study was to test the effect of five different microbiological preparations on the growth and development of beans grown under organic farming conditions.

The experiment was performed in 2018 in the fields of agricultural association Auga, Raseiniai district municipality, Kalnųjai village surroundings. The effect of five different microbiological products on bean growth and plant biometric parameters was investigated. Bean seed was coated with microbiological products. The growth of plants was observed once a week.

Compared to the control, all five microbiological preparations had a positive effect on bean growth and development. However, the best results were defined in beans treated with a product contained complex of zinc-releasing bacteria (*Bacillus coagulans*, *Bacillus subtilis*, *Bacillus polymyxa*).

**Key words:** *seed treatment, microbiological products, bacterial products.*

## DEVELOPMENT OF TAN SPOT DEPENDING ON FUNGICIDE TREATMENT SCHEMES AND NITROGEN RATES

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Tan spot caused by *Pyrenophora tritici-repentis* is the most widespread winter wheat leaf disease in Latvia. The losses of winter wheat yield can range from 10 to 74% and depend on development stage at which the infection occurs. The aim of the present research was to clarify the development of tan spot in winter wheat under four nitrogen rates and five fungicide schemes. A two-factorial trial was conducted at the Research and Study farm "Pēterlauki" (Latvia) of the Latvia University of Life Sciences and Technologies in 2017–2020. Fungicides with different active ingredients, doses, application times, and nitrogen rates (120–210 kg ha<sup>-1</sup>) were used. The disease impact during the vegetation period was estimated by calculating the area under the disease progress curve (AUDPC). Rapid development of tan spot began at the time of grain ripening (GS 75-79). At this growth stage, the highest severity of tan spot (8.3% on average in 2017–2020) was obtained in control variant (without fungicide application). In contrast, fungicide application decreased tan spot severity to 4.7–2.6%. The development of tan spot was influenced significantly by fungicide application schemes ( $p < 0.001$ ), but not by nitrogen fertilizer rates ( $p = 0.91$ ). The differences in average AUDPC values among the variants of fungicide treatment schemes during investigation years ranged between 20 and 64 units. The effectivity of fungicide application schemes depended on the year. In 2018 un 2020, the severity of tan spot was low and the effectivities of fungicide treatment schemes was similar. In 2019, the severity of disease was higher and the effectivities of fungicide treatment schemes differed significantly.

**Acknowledgements:** The research was supported by the EIP-Agri project "The development of the decision-making support system for restriction of the diseases, affecting leaves and ears of winter wheat".

**Key words:** winter wheat, tan spot, values of AUDPC, control.



## CIRCULAR BIOECONOMY IN THE CONTEXT OF FOOD CHAIN MANAGEMENT

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The aim of the scientific considerations was to determine the relationship between the circular bioeconomy and the food chain. Based on the literature studies, it was found that the current approach to the circular bioeconomy should take into account the maximum elimination of waste generation in the biomass production and processing chain. It is very important to take into account food production processes, prevent food waste and introduce technologies for the management of biological waste and used packaging used in production cycles and biomass processing. Insiders predict that the implementation of actions according to the criteria for a circular bioeconomy will enable significant progress in the area of innovation and competitiveness.

When analyzing the relationship between the circular economy and the food chain, it can be noticed that primary sectors (agriculture supplemented with forestry and fisheries) form the raw material base of biomass (food and non-food raw materials). Biomass flows that start at the primary production stage continue in the processing sectors (mainly feed and food - food chain). By-products and bio-waste can be reused in cascade and organic recycling (this part is the circular bioeconomy).

**Key words:** *bioeconomy, biomass, food chain.*

## BIOECONOMY DEVELOPMENT IN LITHUANIA: CASES FOR SUSTAINABLE CHANGE

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The main global drivers of bioeconomy development are depletion of natural resources, increasing population, increasing environmental pressures and climate change. Bioeconomy offers many opportunities for climate change mitigation by decarbonising the EU and national economy. It is based on four main pillars: replacement, upgrading, circulating and collaboration. Replacement means focusing on opportunities to replace fossil-based materials with bio-based materials. This pathway is most important, but not the only one. For example, climate change can be mitigated by replacing livestock products with fish products. Upgrading is identified as production of higher value-added products from bio-resources and valuable products from previous waste streams. Circularity is related to elimination of waste. Finally, cross-sectoral collaboration involving industry, R&D institutions, politicians and society, is crucial for a successful bioeconomy. Each country has a different pathway of bioeconomy development. The question is how Lithuania's bioeconomy stands on these pillars.

The purpose of the research is to present the cases of good practice in Lithuania's bioeconomy development according to the pillars. Case study and content analysis were applied for reaching this purpose.

Replacement is most important pillar for climate change mitigation. There are some companies standing on the replacement pillar: UAB "Bio Energy LT", UAB "Kurana", "Modus Energy", etc. The good examples for upgrading are agricultural co-operative "Pienas LT", AB "Roquette Amilina". The best example of circulating is AB "Auga Group". This company was the first which issued green bonds. Collaboration is observed through the implementation of research projects, launching and adopting bioeconomy related strategies and policies, foundation of business clusters. In Lithuania, 6 clusters are already operating in bioeconomy sector: Biopower plant development cluster (Adecco), Smart food cluster, National Food Cluster (NaMŪK), Lithuanian prefabricated wooden houses cluster (PrefabLT), Baltic furniture cluster, and Cleantech Cluster of Lithuania.

The main conclusion of the research is that bioeconomy development in Lithuania is standing on all four pillars and it is in the right pathway for sustainable change.

**Key words:** *bioeconomy development, bioeconomy pillars, cases of good practice, sustainable change, climate change.*

## THE IMPACT OF THE USE OF MINERAL NITROGEN FERTILIZERS ON GHG EMISSIONS AND MITIGATION USING ECONOMIC INSTRUMENTS

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The problem of excessive use of mineral nitrogen fertilizers requires increasing attention. Intensifying agricultural production increase a negative impact on the environment through increasing urbanization and human needs. Increasing rates of nitrogen fertilizers are being used to grow crops, in which case the focus is on yields. The environmental pollution, which is inevitably caused by agricultural production, calls for a more responsible approach not only from farmers but from the authorities as well. It is emphasized that the use of mineral fertilizers is one of the main sources of GHG emissions in agriculture and therefore a disciplinary focus is needed to address this issue.

This study presents the economic response use of mineral nitrogen fertilizers regarding the impact of the use of mineral nitrogen fertilizers on GHG emissions. Scientific literature, analysis of statistical data, TIER 1 IPCC (2019) methodology. The results show that in 2018, nitrous oxide emissions account for the largest share of GHG emissions in Bulgaria, Latvia and Lithuania, proving the importance of the topic. GHG emissions from agricultural activities (ESU 27) consist of 11% total GHG emissions, however, there has been a drastic increase in GHG emissions from agriculture in Sweden. Nevertheless, Lithuania GHG emissions from agricultural activities seen a decrease in recent years.

Economic instruments such as taxes or subsidies shall be used to reduce environmental pollution in agriculture. Both instruments are difficult to implement, have pros and cons. The subsidy system is being implemented, but the provision of environmentally harmful subsidies needs to be reconsidered. The instrument of taxation of mineral nitrogen fertilizers is described as effective, but a complex system of actions is needed, which is not focused on one country.

**Key words:** *mineral nitrogen, fertilizers, GHG emissions, environmental pollution.*

## **COMPARATIVE ASSESSMENT OF THE SUSTAINABILITY PERFORMANCE OF GLUE LAMINATED TIMBER AND NON-RENEWABLE MATERIAL-BASED VALUE CHAINS**

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Mitigation of climate change, carbon sequestration and low carbon economy are some of the corner stones of the European bioeconomy strategy (European commission 2012). Wood use as environmentally friendly material might contribute to bioeconomy development, climate change mitigation, therefore wood as a house construction element rapidly growing globally.

The aim of the study was to design two and five floors glue laminated timber and reinforced concrete public buildings' frames and then to quantify and to compare sustainability impacts of value chains for non-renewable materials (concrete and reinforced concrete (RC)) and renewable materials (glue laminated and sawn timber) used to construct these buildings.

Following indicators of value chains were analyzed: Gross value added, CO<sub>2</sub> equivalent, Employment, Generation of waste in total, Water use, Production value

Energy use, Occupational accidents, Salary, Biogenetic carbon storage, Non-renewable raw material used.

The results of the study highlighted the environmental advantages of wood-based material use in the construction sector.

**Key words:** *glue laminated timber, reinforced concrete, value chains, indicators, construction sector.*

## AGRONOMIC AND GRAIN QUALITY RESPONSES TO FERTILIZER MANAGEMENT IN HULLED AND HULLESS BARLEY

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Improved productivity, grain physical parameters, and grain protein quantity and quality effect the profitability of feed barley cultivation where fertilization management has a decisive influence on these parameters. It provides the potential benefits for growers and feed processors to facilitate grain handling and to reduce the cost of additives in feed formulation.

Field trials were conducted at the Institute of Agricultural Resources and Economics (2019–2020) located in two trial sites differed in soil characteristics to examine the potential gains from altering productivity and grain quality with nitrogen (N) and sulfur (S) fertilizer management for two hulled and one hulless spring barley (*Hordeum vulgare* L.) genotypes.

In Stende trial five different fertilization treatments and in Vilani trial three fertilization treatments were established. Two rates of N (80 and 100 kg N ha<sup>-1</sup>) without and with S fertilizer application, with one and two timings of fertilizer application were arranged. Agronomic nitrogen use efficiency (NUEA) and N uptake in grain were calculated.

Two out of four field experiments showed significant grain yield responses to split N application for both types of barley. Only in Vilani responses to S addition were detected where hulless genotype ST-13053K in 2019 and hulled variety 'Austris' in 2020 showed significant yield increase. Average values of NUEA were significantly higher under reduced N fertilizer treatment where hulled varieties showed better results compared to hulless one. Positive response to S addition by increasing the proportion of essential AA and lysine in the protein detected for ST-13053K.

In general, N and S fertilizer management can provide the positive effect on both agronomic and grain quality but extent of response was influenced by both genotype and growing conditions.

**Key words:** barley, N and S fertilizer management, yield, protein, amino acids.

## RESPONSE OF PLANTS TO SEED PROCESSING WITH COLD PLASMA, VACUUM AND ELECTROMAGNETIC FIELD

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The effects of pre-sowing seed treatment with cold plasma (CP) and electromagnetic field (EMF) have been focused on the effects of treatments on seed decontamination, germination and early seedling growth while the research on long term effects was limited by few reports. The aim of our study was to compare the effects of seed treatment with CP, vacuum and EMF on seed germination and seedling growth under laboratory conditions and during long-term field observations in order to determine the sustainability of the observed effects. Seed germination (in vitro and in the field), plant growth, photosynthetic efficiency, production of biomass and secondary metabolites was estimated for Norway spruce; red clover; common buckwheat and industrial hemp.

Secondary metabolites were determined by HPLC analysis. Long-term observations on Norway spruce revealed that the effects persist for at least 5 years. Seedlings grown from vacuum and CP treated seeds had up to 40% larger height, increased branching in comparison to the control seedlings. Biomass production for red clover increased up to 49% and nodulation was stimulated; for buckwheat biomass production increased up to 97%, seed yield – up to 85%. In female plants of industrial hemp EMF treatment induced positive changes in weight of the above ground part (66%) and number of inflorescences (70%). Substantial changes in the production of secondary metabolites was determined in Norway spruce, red clover and industrial hemp. Specifically, changes in isoflavone amounts in root exudates of red clover resulted in stimulated root nodulation.

Thus, long-term observations revealed that effects of seed treatment with CP and EMF on plant growth, production of biomass, seeds and secondary metabolites are more relevant for sustainable agriculture compared to the effects on germination.

**Key words:** cold plasma, biomass production, electromagnetic field, pre-sowing seed treatment, secondary metabolism.

## INFLUENCE OF THE SYMBIOTIC BACTERIA *PAENIBACILLUS* SP. ON THE VIABILITY OF EUROPEAN LARCH (*LARIX DECIDUA* MILL.) EXPLANTS *IN VITRO*

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In the face of various environmental factors in today's forests, it is essential to look for biotechnological methods that will speed up tree reproduction. For this day, very little research has been done on the possibilities to promote tissue culture growth *in vitro* with the help of symbiotic bacteria. Due to its valuable properties European larch (*Larix Decidua* Mill.) is a promising object for *in vitro* micropropagation. The aim of this research was to determine the influence of the symbiotic plant bacteria, first isolated from the hybrid aspen tissue (*Populus tremuloides* × *P. tremula*) and identified as *Paenibacillus* sp., on the European larch (*Larix decidua* Mill.) viability.

The research was conducted in 2018–2020 at Vytautas Magnus University and the Forest Institute, Lithuanian Research Centre for Agriculture and Forestry. The *in vitro* system was used to study the effect of *Paenibacillus* on the growth of European larch explants, depending on the growth conditions (different experimental medium composition, growth duration) of the bacterium before the experiment. Morphological parameters of larch explants, such as shoot and needle length, were assessed every two weeks. European larch explants were grown on different nutrient medium variants: 1) control, bacteria free, Woody Plant Medium (WPM), 2) WPM with bacteria cultivated on LB medium, 4 weeks before research, 3) WPM with bacteria and apical larch explants cultivated on LB medium, 4 weeks before research, 4) WPM, produced and infected with bacteria, 4 weeks before research. The experiment was repeated three times for reliable results. The results had shown that symbiotic bacteria has a positive effect on the growth of European larch explants. The maximum length of the shoots and needles was fixed on medium where bacteria was grown in unsuitable conditions (4th nutrient medium): 137% longer shoots ( $P < 0.001$ ) and 135% longer needles ( $P < 0.001$ ) were recorded. In this context, the bacteria's ability to release certain plant growth-promoting substances might be suggested as a promising object for further research.

**Key words:** explants, *Larix*, *in vitro*, *Paenibacillus*.

## CONSERVATION TILLAGE IN FABA BEAN CULTIVATION: WEED FLORA

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Legumes poorly compete with weeds, especially when their developmental conditions are markedly altered by the soil management practices, including ploughless tillage or direct drilling. Faba bean particularly requires a comprehensive study due to the lack of experimental data. The aim of the study was to determine the influence of tillage systems on the composition, number and dry mass of weeds. Therefore, in 2016–2018 field experiment was conducted at Vytautas Magnus University, Agriculture Academy on the basis of a long-term tillage experiment, carried out since 1988. Systems of conventional deep and shallow ploughing, deep chiselling, shallow disking and no-tillage were investigated. Weed species composition and weed density were evaluated at the beginning (BBCH 25–27) and end (BBCH 75–79) of faba bean vegetative period, biomass – at the end of vegetation.

Investigations showed, that a minimal chemical control of weeds and meteorological conditions influenced weed abundance more than tillage systems. With an increase in the volume of pre-crop residues on the soil surface, the biomass of annual weeds decreased, while that of perennial and total weeds increased. The tested tillage systems generally did not have any significant impact on weed biomass, except for the warmer and wetter end of vegetative season in 2018.

**Keywords:** *conservation tillage, pre-crop residues, weed composition, Vicia faba L.*



# INFLUENCE OF UREASE INHIBITOR AND BIOPREPARATIONS ON MAIZE PRODUCTIVITY

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Nitrogen fertilizers are necessary for optimal plant productivity, but increasing the rates of nitrogen fertilizers may increase nitrogen oxide emissions into the atmosphere and nitrogen leaching into deeper soil layers.

The aim of the study was to evaluate the influence of different nitrogen fertilizer urea ammonium nitrate solution (UAN) rates and their combinations with ammonium thiosulphate and biopreparations on the productivity of maize grown for grain (FAO 170) and the change of nitrogen fluxes in soil and plants during vegetation. The object of research – maize crop (*Zea mays* L.) fertilized with different rates of nitrogen fertilizers and treated with urease inhibitor and biopreparations. The research was carried out in 2019 and 2020 at Vytautas Magnus University Agricultural Academy Experimental Station. Soil: *Calc(ar)i-Endohypogleyic Luvisol*, medium loam on sandy light loam. Different rates of UAN fertilizers applied after maize sowing (factor A: 1) N100; 2) N140; 3) N180) and preparations (factor B: 1) inhibitor ammonium thiosulfate 10% – co-applied with UAN; 2) humic acid – applied together with UAN; 3) phytohormone – sprayed at 6–8 leaf stage).

According to the literature, chemical (ammonium thiosulfate) and biological (humic acids, phytohormones) additives are designed to slow nitrogen transformation in the soil, improve plant productivity and reduce nitrogen loss. The effectiveness of UAN and specialized additives depends on various factors, including meteorological conditions. In general, the highest average two year maize grain yield ( $11.6 \text{ t ha}^{-1}$ ) was obtained using N180 in combination with 10% ammonium thiosulfate. It should be noted that the use of N140 in combination with ammonium thiosulphate 10% gave an average grain yield of  $11.2 \text{ t ha}^{-1}$ . Positive results were obtained with other combinations, but not so significant. The final conclusions could be done after another year of research. This study shows that using different rates of UAN fertilizer in combination with ammonium thiosulphate, lower (N140) nitrogen rates can give a maize grain yield equivalent to fertilization with (N180).

**Key words:** *maize, fertilization, urea ammonium nitrate solution, urease inhibitor, biopreparations, yield.*

# COMPLEX OF SOIL TILLAGE, ORGANIC AND BIOLOGICAL FERTILIZATION FOR IMPROVING SOIL MICROBIAL ACTIVITY AND NITROGEN TRANSFORMATION EFFICIENCY IN INTENSIVE CROPPING ON *CALCARIC LUVISOLS*

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Intensive cropping is, mainly, based on the cultivation of monocultures and highly relying on the use of mineral fertilizers and pesticides. Those can reduce soil microbial activity (SMA) and decrease the nitrogen transformation efficiency (NTE). However, we can expect that the capacity of the SMA and NTE will be recovered when all the reducing soil tillage, the using organic fertilizers or crop residues and the applying of biological stimulants carried out in complex. To evaluate the SMA and NTE response to the complex of soil tillage, organic and biological fertilization, two sites in the vicinity of Kaunas district were selected in the intensive cropping experiments. In both experiment sites continuous winter wheat (*Triticum aestivum* L.) cropping was dominant and wheat straw was returned as organic fertilizer for soil organic matter improvement. Thus, the soils were different tilled in both experiment sites. In first site the deep ploughing was used once per season with straw incorporation by disking. In site two reduced and no-tillage systems in complex with straw retention and different biological preparations was evaluated. The results showed, that applying biological stimulants and nitrogen fertilizers in complex with deep ploughing in experimental site one, the SMA was not significantly increasing but the significantly higher content of N-NH<sub>4</sub> (N-NH<sub>4</sub> – 118 mg kg<sup>-1</sup>) in soil was obtained. Additionally, the transformation to N-NO<sub>3</sub> in soil was consistent and intensified (N-NO<sub>3</sub> were in 32–50 mg kg<sup>-1</sup>). However, in second experimental site with straw different application technology by different intensity soil tillage the SMA was not significantly affected but the content of N-NH<sub>4</sub> was decreasing even the biological stimulants were applied (from 216 N-NH<sub>4</sub> mg kg<sup>-1</sup> to 100 N-NH<sub>4</sub> mg kg<sup>-1</sup>). Despite that, the nitrogen transformation to N-NO<sub>3</sub> in soil (in some cases reached more than 120 N-NO<sub>3</sub> mg kg<sup>-1</sup>) was higher than the N-NH<sub>4</sub> content.

**Key words:** *cropping, monocultures, tillage, straw, biological stimulants, soil, soil microbial activity, nitrogen transformation.*

## LESS KNOWN BOTRYTIS SPECIES AS CAUSAL AGENT OF LEGUME DISEASES

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*Botrytis* spp. are the most important causal agents of legume diseases – grey mould and chocolate spot. Several *Botrytis* spp. cause chocolate spot in faba beans (*Vicia faba*). Recently, in certain regions, new species that could be potential pathogens for faba beans or other legume crops are discovered using molecular methods, but their role in infection of legumes is uncertain. Four species are known in Latvia that cause chocolate spot in faba beans – *B. cinerea*, *B. fabae*, *B. fabiopsis* and *B. pseudocinerea*. The aim of this study was to determine *Botrytis* spp. composition in different legumes, using molecular and morphological methods.

*Botrytis* spp. were isolated from symptomatic faba beans, field peas (*Pisum sativum*), and other legumes – common bean (*Phaseolus vulgaris*), alfalfa (*Medicago sativa* L.), lupine (*Lupinus* spp.), red clover (*Trifolium pratense*), chickpea (*Cicer arietinum*) and common vetch (*Vicia sativa* L.), collected in 2019 in the territory of Latvia. A phylogenetic analysis was made to amplify regions of three nuclear DNA genes combination – RPB2, HSP60 and G3PDH.

*B. cinerea* was isolated from common bean, alfalfa, lupine, red clover and chickpea. The study shows that chocolate spot of faba beans in Latvia can be caused by a wider range of *Botrytis* species than previously thought. Six *Botrytis* spp. – *B. cinerea*, *B. fabae*, *B. fabiopsis*, *B. pseudocinerea*, *B. euroamericana* and *B. prunorum* – were identified in faba beans. *B. fabiopsis* was found in common vetch and chickpea. *B. californica* was isolated from lupine seeds. Two isolates could not be attributed to any of the recognized *Botrytis* species.

The diverse composition of *Botrytis* species and the two unspecified isolates indicate the need for clarification of pathogenicity and the role of isolates in legume crops.

**Acknowledgements:** Latvian Council of Sciences founded project “Pathogenicity and diversity of *Botrytis* spp. – important causal agents of legume diseases”.

**Key words:** legumes, *Botrytis euroamericana*, *Botrytis prunorum*, *Botrytis californica*.

## **ECONOMICS AND ENVIRONMENTAL POTENTIAL OF DATA FUSION-BASED VARIABLE RATE APPLICATIONS IN PRECISION AGRICULTURE**

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Precision management of farm input resources refers to the application the right rate of input in the right place and time using an integrated solution of sensing, modelling and control technologies. However, the first requirement for managing the within field spatio-temporal variability is the accurate measurement and mapping of parameters affecting crop growth and yield. But, the agriculture system even at field or sub-field scales is complex, as crops are affected by multiple limiting factors simultaneously, including soil attributes, crop biotic and abiotic stresses, topography and weather conditions. This necessitates an advanced sensing approach consisting on multiple sensor technologies and data fusion to maximize the quality of data collected and the creation of accurate and science-based variable rate recommendations of different farm input resources, e.g., fertilisers, water for irrigation, seeds, agrochemicals and manure. Data particularly on soil and crop is needed at high sampling density to allow accurate quantification of the spatial variability, which cannot be achieved with the traditional laboratory analysis methods as they are costly, time-consuming, requires expert technical operators and expose hazard chemicals into the environment. Proximal and remote sensing have been immersed in the last few decades as alternative solutions that can overcome the disadvantageous of the traditional laboratory analyses, and fulfil the requirement for variable rate applications. This paper will discuss case studies of variable rate applications based-on the fusion of data on soil, crop normalised difference vegetation index (NDVI), present and historical yield and weather conditions. While this data fusion approach is implemented in map-based variable rate applications, case studies of sensor-based phosphorous fertilisation using a single data input of available P will also be discussed. Results of cost-benefit analysis demonstrating profitability in majority of case studies will be also presented. Since variable rate can also have environmental benefits, results in this regards will also be discussed for fertilisation, manure and agrochemical applications.

**Key words:** *data fusion, variable rate applications, cost-benefit analysis, proximal sensing.*

## EFFICIENCY OF DETECTION OF PARTICLES BY HIGH-SPEED CAMERAS IN SPLASH EROSION STUDIES

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The splash phenomenon is the first stage of soil water erosion. There are many methods for splash investigations, including the use of splash cups, drop force sensors, or high-speed cameras. Moreover, modeling the splash phenomenon is becoming increasingly popular.

The aim of our work was to determine the effectiveness of high-speed cameras in identification of single particles ejected as a result of the drop's impact. Sticky paper was used as a reference method, which guarantees 100% identification of splashed particles.

On the basis of the conducted experiments and analyses, we described the distributions of the total number of ejected particles, the maximum range, and the average distance covered by the particles in a single experiment. We also discussed the effectiveness of detection of particles by the cameras. Such information about the splash phenomenon may be helpful, for example, in understanding the mechanics and scale of the spread of pollutants/pathogens and plant diseases through soil splash caused by rain.

This research was partially financed by the National Science Centre, Poland, in the frame of the project no. 2017/26/D/ST10/01026.

**Key words:** *soil splash, drop's impact, high-speed camera, sticky paper method.*

## TELEMETRY - FOR REMOTE MONITORING OF THE AGRICULTURAL PROCESSES AND THE ENVIRONMENT

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Remote monitoring systems for machines and implements (telemetry systems) increasingly used in agriculture as well. They help farmers to collect, analyse and optimize farm applications and their processes. The settings, automatic steering and automatic machine processing control systems, as well as the software solutions installed in harvesting machines and implements, can be perfectly compatible with each other. This allows you to achieve the best machine performance and the highest agricultural quality and quantitative results. Telemetry systems allow the optimization of specific technological operations. Farmers in the agricultural sector can remotely manage horticultural activities, automated irrigation planning. Also accurately determine local weather conditions, soil moisture monitoring, plant diseases, and more. Such system enables efficient use of the existing fleet of tractors, harvesting machines and agricultural implements. This system allows farmers remotely monitor the location and operational parameters of their agricultural machinery. The fleet manager can track and update information such as engine status, fuel consumption, engine coolant and oil temperature, vehicle location, travel speed, operating hours, and other machine parameters associated with the telemetry system. By using the telemetry system, it is possible more efficiently use the machines and reduce downtime, plan technical service and maintenance.

Studies show that grain harvesters use only about 50% of their maximum productivity. Productivity, between individual drivers, varies by up to 40% under the same working conditions. Using telemetry systems, the right time to harvest increased to 7%, productivity can be increased to 10%, and crop losses can be reduced to 0.5%. Up to 3 working days, required for harvesting, saved during the season, which makes up to 150 ha more harvested cereals per season.

In summary, the use of telemetry facilitates the remote management and control of agricultural processes by reducing costs and crop losses, thereby increasing productivity and simplifying the tasks for the farmer.

**Key words:** *remote monitoring, telemetry, agriculture, automatic control and harvesting machines.*

## INVESTIGATION OF GRANULAR ORGANIC FERTILIZER DISTRIBUTION IN SOIL USING COMPUTER SIMULATION

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Farmers use the manure waste to fertilize the fields to reduce it. An important disadvantage of the use of this waste as a fertilizer is the odor emitted and, in the absence of the possibility to plow the soil immediately after the application of the fertilizer, the reduction of useful substances. As a result, granulation of organic manure waste is becoming increasingly popular. Farmers use centrifugal spreaders of mineral fertilizers to spread these pellets in the soil, and due to the different properties of mineral and organic granular fertilizers, different uniformity of pellet spreading is obtained.

The aim of the research was to investigate the spreading parameters of granular manure compost fertilizers in the soil by centrifugal spreading using computer simulation.

For the simulation was proceeded by using EDEM software, Solid works software. Fertilizer spreader technical and physical and fertilizers physical parameters were set to proceed the simulations of the process.

For the simulation, the operating parameters were selected according to the spread rate of the fertilizer, the working width of the fertilizer spreader, the uniformity of fertilizer spreading for the spreading of granular cylindrical bulk particles. The obtained results showed that it is expedient to apply computer simulation to study the spreading of fertilizers in the soil.

In summary, fertilizer application studies can be very time consuming and expensive, a simulation model is being developed to reduce these costs, simulating the spreading process of organic granular fertilizers and determining the influence of particle rolling speed and spread rate on spreading uniformity.

**Key words:** *fertilizers, simulation, organic, granular, spreading.*



## THE ANAEE RESEARCH INFRASTRUCTURE, UNDERSTANDING THE FUTURE OF ECOSYSTEMS

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Analysis and Experimentation on Ecosystems (AnaEE) is a Research Infrastructures that brings together a series of state-of-the-art experimental and analytical platforms for ecosystem research throughout Europe. By linking these platforms to modelling approaches, AnaEE advances our understanding of the environmental impacts of ongoing global change and fosters adaptation and mitigation strategies for safeguarding ecosystem services and their economic and societal benefits. AnaEE offers capacities to develop multidisciplinary approaches at the frontiers of life sciences, agronomy and environmental sciences, combining experimentation, analysis and modelling services to answer pressing scientific issues. Services from AnaEE in experimental ecology will be open to the community. In this talk we present the main components of AnaEE (the experimental platforms), the state of the project, and how to find and access the resources.

**Key words:** *infrastructure, ecosystems.*



## **ANAEE WEB SERVICES – FUND RAISING, A RICH PLATFORM CATALOGUE OF SERVICES AND HOW THE ACCESS PORTAL WORKS (SHOWCASE)**

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This presentation envisions the path that will be used by an AnaEE user and will present the different AnaEE web services. It will be divided in three parts: 1) presentation of the website and its structure, 2) presentation of the AnaEE services, especially the proposal submission portal and the access procedure, 3) presentation of funding opportunities. The whole presentation will be interactive and subject to questions from attendees.

Firstly, Chloé MARTIN will present the website [anaee.eu](http://anaee.eu) and its features. The different tabs and sub-tabs (home, services, events, outreach, resources) will be outlined. The web portal is also the gateway to two other websites, which will be described in the following session: the API portal and the data portal. A questionnaire will be given to the participants in order to gather their comments regarding the current display and features of the website.

Secondly, the proposal submission portal called SEISM will be presented and showcased to the participants by Florent MASSOL. We will present in details the AnaEE access procedure. For this part, the speaker will divide his presentation into four topics: 1) The proposal submission 2) The evaluation procedure 3) The catalogues of resources 4) The Key Performance Indicators. The features and advantages of the collaborative portal will be presented and it will be highlighted how SEISM allows platforms to fulfill and update the catalogues of resources and KPIs.

Thirdly, Sarah MAHE will end up with the presentation of the funding opportunities. The different kind of funding opportunities will be described followed by a focus on EU funding. Relevant European Structural Funds (such as ERSF) and Thematic Funds (such as Horizon Europe) will be detailed. Finally, a short description of the current openings will be made, and where to access them will be showed.

**Key words:** *resources, procedure, portal.*

## THE ANAEE DATA & MODELLING CENTRE SHARING FAIR DATA AND INTEGRATING MODELLING IN ANAEE

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The AnaEE DMC, hosted by CREA Agricoltura e Ambiente, is the IT and data management hub of the AnaEE RI, providing expertise and infrastructures in the field of environmental modelling and data science in general. The goal of the DMC is to create and enable an environment of services that will support researchers in publishing, sharing, and reusing environmental research data, and to foster the development of data products built on top of said data. In this context it is of paramount importance to provide a platform where the various products of research work can be accessed as a service. Accessing data and models as services in the cloud has multiple benefits and allows researchers to quickly design and run experiments since this paradigm offers interoperability by design, workload distribution, and abstraction over the architectures that support the services.

In this session we will present the AnaEE Developer Portal and show a practical demonstration of the API usage loop.

**Key words:** *API, developer services, service catalogue, demonstration.*

## FATI PLATFORM: A NEW APPROACH TO EXPERIMENTAL CLIMATE CHANGE STUDIES

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PLECO (University of Antwerp) has recently developed a highly-instrumented, large-scale outdoor facility named FATI ("Free Air Temperature Increase") as part of the European ESFRI-AnaEE infrastructure, where ecosystems can be exposed to virtually any combination of precipitation and warming regimes for prolonged periods. Twelve large identical experimental units allow for both fundamental and applied research investigating multi-level, interacting factors in a variety of experimental ecosystems. The combination of a programmable dripper irrigation system and automated rain-out screens enables accurate simulation of precipitation scenarios. Moreover, the cutting-edge infrared heater system controlled by real-time energy balance calculations, offers both custom adjustable target temperatures and unconstrained vegetation responses. This advantage over traditional control especially benefits studies that combine warming with precipitation manipulation by explicitly taking the interdependence between the water and the energy balance into account. As such, the platform also enables us to test different management options to make agriculture more climate-proof. Recently, we used this facility to explore the relationship between increasing summer precipitation persistence (longer dry and wet periods) and plant diversity by subjecting experimental grassland mesocosms to a broad gradient of dry-wet alternation frequencies with equal total precipitation. Regimes with longer alternating dry and wet spells led to a severe loss of species richness (up to -75%) and functional diversity (enhanced dominance of grasses relative to forbs). Treatments where long droughts ( $\geq 20$  days) and high temperatures coincided showed more signs of physiological plant stress, greater plant mortality, and less diverse communities by the end of the season. Despite preclusion of non-native colonization in the experiment, these findings suggest that more persistent summer precipitation regimes can lead to diversity loss, at least on a short timescale.

**Key words:** *ecosystem, experimental, system, relationship.*

## CARBON BALANCES OF ANNUAL VERSUS PERENNIAL CROPPING SYSTEMS

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To meet the growing challenges of food security, sufficient biomass for biorefineries and mitigation of climate change, perennial grass is recommended as an alternative for annual grain crop to increase biomass production while protecting soil C stock. However, the long-term biomass yield production, soil C stock, and ecosystem CO<sub>2</sub> flux are rarely simultaneously evaluated in the same study site, limiting the understanding of C flows in different cropping systems. We compared the annual grain crop triticale (*Triticosecale*) grown every year since 2012 with the productive perennial grass festulolium (*Festulolium braunii*) established in 2012. Annual yield production, five-year changes in soil C stock, and ecosystem CO<sub>2</sub> fluxes in 2020 are documented. The first five-year field observations showed that festulolium produced 76% more biomass as compared to triticale (grain and straw). Meanwhile, there was an increasing trend of soil C stock in festulolium but a declining trend of soil C stock in triticale across the first five years, despite both changes were statistically non-significant. We will present carbon fluxes measured in triticale and festulolium during the growth season of 2020 with automatic ECO2Flux chambers ([www.prenart.dk](http://www.prenart.dk)). The results are derived from the experimental research platform Biobase as part of the European research infrastructure AnaEE ([www.anaee.dk](http://www.anaee.dk)).

**Key words:** *continuous monoculture; perennial grass; biomass production; soil carbon content; ecosystem CO<sub>2</sub> flux.*

# ANAE ECOTRONS: VERSATILE ECOSYSTEM ANALYSERS FOR ECOLOGY, AGRONOMY AND ENVIRONMENTAL SCIENCE

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Ecotrons are advanced controlled environment facilities that enable the simulation of a wide range of natural environmental conditions in replicated and independent experimental units whilst simultaneously measuring various ecosystem processes.

In this talk we will present the multiple experimental platforms available in the AnaEE Ecotrons and exemplify their capabilities with results from several experiments, including but not limited to the impact plant species richness for ecosystem functioning and the effect of earthworms on soil greenhouse gases in an agricultural setup.

**Key words:** *controlled environment facilities, biodiversity-ecosystem functioning, earthworms, greenhouse gases, carbon fluxes.*

## **ABSTRACTS**

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## **POSTER PRESENTATIONS**

## THE INFLUENCE OF DIFFERENT NITROGEN FORMS OF FERTILIZERS AND METEOROLOGICAL CONDITIONS ON NITROGEN TRANSFORMATION AND EVAPORATION

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The transformation of nitrogen compounds in the soil are important processes for crop growth and environmental protection.

For this reason, investigations were carried out at the Experimental Station of Vytautas Magnus University Agriculture Academy in Lithuania during the period 2015–2018. The study was aimed to estimate the changes in ammonium ( $\text{N-NH}_4$ ), nitrate ( $\text{N-NO}_3$ ) and mineral ( $\text{N-NH}_4 + \text{N-NO}_3$ ) nitrogen in the soil, nitrogen loss via volatilization and uptake as influenced by the nitrogen fertilizer form applied, soil moisture and temperature in the crop stand of the winter wheat at the tillering stage.

The experiment was carried out according to a two-factor design: factor A – fertilizer application time: beginning of spring growth of winter wheat (BBCH 23–25) – control, 4, 8, 12 and 16 days after resumption of spring growth; factor B – nitrogen fertilizer forms: ammonium nitrate and urea.

The content of ammonium nitrogen in the soil, 7 days after winter wheat fertilization was found to be higher in the plots applied with urea, also higher nitrate nitrogen and mineral nitrogen contents. When winter wheat had been applied with ammonium nitrate or urea 4 days after resumption of spring growth, the contents of ammonium, nitrate and mineral nitrogen in the soil were significantly higher compared with the plots fertilized later, 8–16 days after beginning of spring growth. Volatilization of ammonia in the winter wheat plots fertilized with ammonium nitrate was negligible and totaled 0.12–0.51%, while in the plots applied with urea 5.5–9.4%.

At winter wheat tillering stage, the content of mineral nitrogen in the soil was found to depend on soil temperature and moisture. The data of the multiple correlation analysis showed a strong relationship between mineral nitrogen and soil temperature and moisture, significant at  $P < 0.05$  level.

**Key words:** *nitrogen forms, moisture, temperature, fertilization.*

## DYNAMICS OF CHANGES IN SELECTED SOIL TRAITS IN THE PROFILES OF ARABLE SOILS ANTHROPOGENICALLY ALKALISED WITHIN THE KIELECKO-ŁAGOWSKI VALE (POLAND)

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This study presents the influence of cement and lime industry on the physico-chemical properties of arable soils. In spite of using modern forms of environmental protection against dust emissions, this type of industry causes unfavourable phenomenon of excessive alkalinisation of soil cover. This process is relatively rare in Poland however in the Świętokrzyskie Province it has been responsible for the largest transformation of soils in recent years. The analysis included soil samples taken from 5 profiles located in the vicinity of Dyckerhoff Polska Sp. z o.o. Nowiny Cement Plant. The study results obtained in 2019 were compared with those obtained in 1977 and 2005. The most attention was paid to: soil pH, CaCO<sub>3</sub> content, organic carbon and nitrogen content, concentrations of such bioavailable components as: P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O, Mg, as well as the saturation level of sorption complex with alkaline cations. It was found that long-term emission of pollutants caused significant changes in the basic soil properties, which remain in soils despite the evident decrease in the cement-lime dust emission. These include: high pH values, excessive CaCO<sub>3</sub> content, high soil saturation with alkaline cations, and decrease in total carbon content which were especially visible in soil humus horizons.

**Key words:** *alkalinisation, cement plant, arable soils, physicochemical properties.*



## INFLUENCE OF BIOLOGICAL PREPARATIONS ON SOIL PROPERTIES

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Biological preparation with microorganisms are not only important in maintaining the soil structure, but they also perform organic matter degradation, increase the availability of nutrients to plants. Biological preparations promote the absorption of nutrients even in extreme conditions. However, there is a lack of research to explain how biological preparations affect soil agrochemical properties and how their distribution is affected by different rate of nitrogen fertilizer.

The investigations were carried out at the Experimental Station of Vytautas Magnus University Agriculture Academy, Lithuania, in 2018–2019. The aim was to investigate the influence of biological preparations on soil pH, phosphorus (P), potassium (K), nitrogen (total, N) and humus content.

A two-factor field experiment was conducted to determine the effect of biological preparations on soil properties. Field experiment treatments: spraying of biological preparations (Factor A): 1) not sprayed, 2) Bactogen + Aurin spray, 3) BactoMix5 spray (in spring), 4) Stimulin spray, 5) BactoMix5 spray (in autumn). Different rates of nitrogen fertilization (factor B): 1) N105; 2) N165.

The use of biological preparations had positive influence on the agrochemical soil properties. Biological preparations significantly ( $P < 0.05$ ) increased available phosphorus, potassium, nitrogen and humus content. Fertilization with a lower nitrogen rate (N105) showed a better effect of biological preparations on soil properties. In general, the use of biological preparation had positive effect on soil agrochemical properties, especially the use of BactoMix5 in autumn on the pre-stubble. The use of Bactomix5 significantly increased the humus content 1.2 time, available phosphorus and potassium – 1.3 time on the soil fertilized lower nitrogen (N105) rate.

**Keywords:** *biological preparation, soil pH, available phosphorus, potassium, nitrogen, humus.*

## BIOCHAR SYSTEMS AS CARBON STORAGE TECHNIQUE IN AGRICULTURE: DEALING WITH A NEW PHARMAKON

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In ancient Greece, the term *pharmakon* designated at once the poison and the cure. As proposed by Stiegler (1998), all technical objects are pharmacological, their effects depending on the conditions of their application. New techniques, like biochar, suffer from not knowing well these boundaries. In this presentation, I will present attempts to constraint better the systems in which biochar can be applied, in terms of carbon storage and soil fertility potential. Regarding carbon in soils, biochar is potentially much more persistent than any other kinds of organic material. Its mean residence time is one to two degrees of magnitude higher than bulk soil organic matter. However, this value depends on the method considered and processes determining its stability may be very different from other types of organic materials. In particular, physical processes like fragmentation may play a major role in degradation, making its dynamic prediction more difficult. At global level, biochar tends to increase crop yields (+10% in average from a global meta-analysis), but this effect can be negative as compared to control in about 15 to 20% of the studies considered. One way to improve this efficiency may be to combine biochar to other sources of organic materials, or even minerals, as we showed in a series of experiments under tropical conditions. But one of the major boundaries which is currently overlooked is the socio-economical context where biochar systems should be implemented. In a study in different rural communities in India, we observed that external human constraints were much more critical than soil quality or carbon budget in order to set up an efficient biochar systems.

**Key words:** *biochar, system boundaries, carbon storage, soil-plant fertility.*

## DIURNAL SOIL CO<sub>2</sub> EFFLUX VARIATIONS IN MATURE SCOT PINE (*PINUS SYLVESTRIS*) STANDS

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Various processes taking place in forest soil have a big role in the forest carbon cycle and contribution to soil CO<sub>2</sub> efflux and soil respiration (SR). Soil CO<sub>2</sub> efflux, also known as soil CO<sub>2</sub> emissions, are formed in symbiosis between soil microorganisms metabolism and plant roots respiration. They two combined release about 10 times more CO<sub>2</sub> then all anthropogenic factors. In order to understand and determinate sources and sinks of C we have to have more knowledge of the local variability of carbon. For this reason, diurnal carbon efflux rates were measured in Lithuanian Scot Pines (*Pinus sylvestris*) forests. To determinate CO<sub>2</sub> efflux rates and the relative importance of various climatic factors that can influents belowground factors thus changing CO<sub>2</sub> efflux and SR rates during day and night. The aim was to investigate the variation in diurnal CO<sub>2</sub> efflux caused by soil temperature (Ts) and soil water content (SWC) in *P. sylvestris* forests. There were continuous field measurements of CO<sub>2</sub> efflux and other environmental parameters conducted using automated soil pot chamber system. Overall, CO<sub>2</sub> efflux and SR rates were strongly correlated with the Ts variable during day and night. These variations were related to micro environmental activities below soil surface. If we consider biological activities to be the only source of the CO<sub>2</sub> emission, then Ts and SWC are very important factors. Results demonstrated that CO<sub>2</sub> efflux and SR of *P. sylvestris* forests in the somewhat cool climatic zone of Lithuania depends on Ts and SWC.

**Key words:** *soil CO<sub>2</sub> efflux, soil respiration, carbon dioxide, soil temperature.*

## THE PHYSICAL-MECHANICAL PROPERTIES EVALUATION OF EXPERIMENTAL GRANULATED POULTRY MANURE AND BIOFUEL ASH FERTILIZER

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Experimental research investigations of poultry manure and biofuel ash waste preparation and conversion into granular fertilizers were carried out in laboratory basis of Institute of Agricultural Engineering and Safety. Poultry manure used in this study was obtained from industrial poultry farm. Sample manure was collected from different places in the poultry house. Biomass ash to mix with poultry manure was collected from the industrial burner unit of a power plant of an energy company where biomass was used as fuel. The biomass burned was comprised of forest residues and wastes from the wood processing industry, in the form of sawdust and chips. The aim of this work is to carry out a feasibility study for the combination of agricultural waste biomass ash and poultry manure recycled into granular fertilizer by considering the technological means of raw waste material preparation, a theoretical pressure analysis, and a physical-mechanical property determination of the obtained product. There were investigated 3 selected variants (1A+1M, 1A+2M and 1A+4M) of poultry manure granules that were produced by granulation method in the laboratory conditions. After the granules cooled, their biometric parameters were evaluated, including their dimensions, volume and density. During the experiment, the cylindrical chamber was filled with samples and pressed. There were obtained dependence of poultry manure and biomass ashes density on compression. According to the obtained curves the changing mass density and pressure and the density change coefficient and energy demand have been calculated. It was found that increasing the ash concentration from 25 to 50% in samples increases the energy demand for raw material pressure up to 6.8 times. Increases in ash content, from 25 to 50% in the raw material granules, led to strength increases to 55%.

**Key words:** *Poultry manure, biomass ash, waste, granules, physical-mechanical properties.*

## SPECIFIC SOIL MICROORGANISMS EFFECT ON SOIL ORGANIC MATTER STABILIZATION AND QUALITY PARAMETERS UNDER DROUGHT CONDITIONS

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Returning of plant residues reveal options for restoring soil OM (organic matter). Specific microorganisms degrade substrates and compounds. In this way we can reduce nutrient losses and increase SOM (soil organic matter).

To determine the influence of specific soil microorganisms to decompose plant residues on soil CO<sub>2</sub> and C sources.

Soil CO<sub>2</sub> emission was determined with IRGA, soil C sources and biodiversity – with Biolog EcoPlate.

In 2018 SOC in treatment No. 3 (*Trichoderma reesei*) was 9.1% higher than in control 1 and 6.7% than in control 2. Average soil CO<sub>2</sub> flux was highest in treatment No. 6 (*Trichoderma reesei* + *Acinetobacter calcoaceticus* + *Bacillus megaterium*) OD (optical density) values after 96 h for C sources detection were higher than in both controls respectively: Carbohydrates in treatment No. 6 by 13.6% and 15.6%, Carboxylic acids in treatment No. 5 (*Bacillus megaterium*) by 36.5%, Polymers in treatment No. 4 (*Acinetobacter calcoaceticus*) by 6.7 and 11.7%, amino acid by 2.7 and 3.3%, amines in treatment No. 6 by 33.1 and 27.3%, miscellaneous compounds in treatment 4 by 10.4 and 8%. AWCD in treatment 6 was 17.4 and 18%, R was 4.2 and 4.5 % higher than in controls.

In 2019 highest SOC was in treatment No. 5 (*Bacillus megaterium*).

Mean soil CO<sub>2</sub> flux was highest in treatment No. 6. The highest OD values after 96 h for C sources detection were as follows: Carbohydrates in treatment No. 6, Carboxylic acids and Polymers in treatment No. 6, amino acids in treatment No. 5, amines in treatment No. 6 and miscellaneous compounds in treatment No. 6. In treatment No. 6 AWCD was 17.9 and 22.2% higher than in controls, R was 6.5 and 7.7% higher than in controls as well.

Microbiological products had positive effect on soil CO<sub>2</sub> emission, C sources and biodiversity in Endocalcari – Endohypogleyic Cambisol.

**Key words:** soil C, rhizosphere bacteria, soil microorganisms, soil microscopic fungi, SOM.

**THE INFLUENCE OF ORGANIC MULCHES ON BEETROOT  
(*BETA VULGARIS* L.) AGROCENOSIS**

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People are becoming more aware of polluting less environment and choosing healthier, organic products for food.

The field experiment was carried out in 2019 on the Pranas Palubinskas Farm located in Paigiai Village, Kelmė District. Research aim – to determine the influence of different organic mulches on soil agrophysical properties (temperature, moisture), weed germination dynamics, and on the yield of beetroot.

In the experiment soil temperature and moisture were measured with a mobile device, weed germination was calculated every 15 days, and the yield of beet (*Beta vulgaris* L.) was weighed. Experiment treatments: Factor A – mulches: 1) without mulching; 2) straw mulch; 3) grass mulch; 4) sawdust mulch. Factor B – thickness of mulch layer: 1) 5 cm; 2) 10 cm.

Research results showed that all organic mulches reduced from 3.1 to 3.6 times weed germination and growth. Organic mulches had a different effect on the species composition of perennial and annual weeds. Mulching with a thicker (10 cm) mulch layer was less effective than a thinner (5 cm layer). The grass and straw mulches significantly reduced from 1.8 to 4.7% the soil temperature compared to the non-mulched plots. Organic mulch significantly increased from 1.2 to 2.0 times soil moisture. A thicker (10 cm) mulch layer significantly increased soil moisture (1.5 times) and temperature (1.0 times) compared to thinner (5 cm) mulch layer. All organic mulches significantly increased from 1.4 to 1.5 times the yield of beetroots. The highest yield was obtained in treatment with grass-mulched soil.

**Key words:** *organic mulch, soil temperature, moisture; soil weediness.*

## EFFECT OF DIFFERENT TILLAGE ON SOIL PROPERTIES IN WINTER RAPE CROP

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There is a significant increase in the concentration of greenhouse gases in the atmosphere, so global warming is a very important issue. The research was carried out at Vytautas Magnus University Agriculture Academy Experimental Station in 2018. The soil in the experimental field was Endohypogleyic-Eutric Planasol – Ple-gln-w, according to FAO, moderate loam on light loam. The aim of the research was to evaluate and compare the effect of different tillage on soil physical properties, CO<sub>2</sub> emission in soil in winter rape crop. Soil tillage treatments:

1. Conventional plowing at depth of 23–25 cm (CP); 2. Shallow plowing at depth of 12–15 cm (SP); 3. Deep loosening at depth of 23–25 cm (DP); 4. Shallow loosening at depth of 12–15 cm (SL); 5. Direct sowing in stubble with 5 cm tillage (DS).

Reduced soil tillage increased soil moisture from 3.5 to 71.7% but soil temperature affected unevenly. Direct sowing in stubble with 5 cm tillage soil moisture increased from 9,3 to 64,8 % but decreased soil temperature from 0.2 to 7.0% during the winter rape growing season. Direct sowing in stubble with 5 cm tillage and reduced soil tillage had an uneven effect on CO<sub>2</sub> emissions in soil. Reduced soil tillage decreased CO<sub>2</sub> emissions by 9.3–22.5% only at the beginning of winter rape vegetation and by 23.9–32.9 % at the end of vegetation. Direct sowing (with tillage up to 5 cm) showed lower methane (CH<sub>4</sub>) content from 3,1 to 4,0 % and higher oxygen (O<sub>2</sub>) content from 0.2 to 2.1 % in the soil compared to conventional tillage.

**Key words:** winter rape, reduced soil tillage, physical properties of soil, CO<sub>2</sub> emissions.

## ORGANIC MULCHES IN VEGETABLE CROPS

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The influence of organic mulches has been studied thoroughly worldwide. In contrast, in Lithuania there are a lack of investigations on this topic. Especially in using new organic materials for mulching under the changing climate conditions. Investigations with different mulches in different crops are actual.

For this reason, investigations were carried out in Lithuania, Mažeikiai district, Zastaučiai, in 2018–2020. The aim was to investigate the influence of different organic remains used for mulching in vegetable crops on weed density and vegetable yield.

Mulches were investigated in field experiment. Weeds were counted in each experimental plot in squares of 0.1 m<sup>2</sup>. Crop yield was determined by weighing

In 2018 organic mulches significantly affected the yield of *Beta vulgaris* var. *atrorubra*. The highest yield was investigated in plots mulched with grass mulch. In plots covered with buckwheat husk mulch significantly lower *Beta vulgaris* var. *atrorubra* yield was investigated. The similar results were obtained in 2019 when was grown *Allium cepa*. The effect of organic mulches on weed density in crops was different. The tendency of lower weed density in mulched plots was obtained. Buckwheat husk mulch influenced crops and weeds due to its allelopathic properties.

Organic mulches influenced weed density in vegetable crops. The significant influence of mulches and there residual effect was established on crop yield. The effect of organic mulches is wide and diverse.

**Key words:** organic mulches, vegetables, weed density, yield.



## LONG-TERM CROP ROTATION AND FERTILISATION EFFECT ON SOIL ORGANIC MATTER DYNAMICS IN SUSTAINABLE AGRICULTURE MANAGEMENT SYSTEMS

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One of the most important indicators of soil fertility is the soil organic matter and/or humus content. Humus content has the greatest importance for plant nutrition.

Organic fertilisers is a key sustainable technology that needs to be integrated into agricultural practices to make agricultural management systems more efficient, as well as less negative for the environment. Long-term field experiments were conducted at the Lithuanian Research Centre for Agriculture and Forestry in 2006–2017. The objective of this research was to determine the impact of long-term crop rotation and organic and mineral fertilisation on soil humus content, humic and fulvic acids, organic matter humification in organic and sustainable agricultural management systems with low (1.90–2.01 %) and medium (2.10–2.40 %) humus levels. Results of the long-term use of organic and sustainable agricultural management systems with different crop rotations and fertilisation revealed the positive effect of the applied agro-means on soil humus, especially that of farmyard manure in combination with green manure.

Analysis of humification showed that in organic system II where nitrogen rich biomass of white mustard was incorporated, which stimulated more intensive decomposition of organic matter, it was found significantly lower degree of humification in comparison to other agricultural management systems. In soil with low humus level the degree of humification under all agricultural management systems was significantly higher on average by 0.9 percentage points compared to that in soil with moderate humus level. Different forms of organic fertilisers are the main sustainable technology that should be integrated with other agricultural practices in order to make organic and sustainable agricultural management systems more productive and efficient and less negative to the environment.

**Key words:** *green manure, crop rotation, organic and sustainable agriculture, humus, humic and fulvic acids.*

## THE INFLUNCE OF NON-CHEMICAL WEED CONTROL ON THE PRODUCTIVITY OF SPRING OILSEED RAPE

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There is a considerable amount of investigations on oilseed rape cultivated in an organic production system, but there is a lack of investigations in Lithuanian climate conditions, particularly involving innovative weed control methods.

Field experiment was carried at Experimental Station of Vytautas Magnus University Agriculture Academy in 2014–2016. The aim of the study was to determine the influence of non-chemical weed control methods and bio-preparations on spring oilseed rape (*Brassica napus* L. spp. *oleifera annua* Metzg.) productivity. Treatments of the experiment: Factor A: weed control methods: 1) thermal (weed control with water steam, inter-row spacing 48 cm), 2) mechanical (weed control with an inter-row cultivator, inter-row spacing 48 cm), 3) self regulation (natural crop-weed competition, inter-row spacing 12 cm); Factor B: bio-preparations application: 1) with bio-preparations, 2) without bio-preparations.

In the plots of thermal and mechanical weed control an increase was established in plant above-ground mass (from 1.52 till 2.40 times), area (from 1.59 till 186 times), length (from 1.55 till 2.00 times) and mass (from 1.42 till 1.60 times) of spring oilseed rape root, compared with the self-regulation plots. Bio-preparations increased oilseed rape above-ground mass, area, length and mass of root in the plots of thermal weed control. In the treatments of thermal and mechanical weed control in combination with bio-preparations, compared with self-regulations treatments, there was recorded higher plant height, dry matter mass, number of branches, number of siliques and number of seeds per silique. In the crop without the use of bio-preparations, the efficacy of mechanical weed control for oilseed rape biometric and yield structural indicators was higher, compared with that of thermal weed control. The highest oilseed rape seed yield was formed in the thermal weed control treatment in combination with bio-preparations (from 1.12 till 1.25 times compared with mechanical and self regulation plots).

The application of thermal and mechanical weed control in combination with bio-preparations in most cases increases biometric, yield structural indicators and seed yield of spring oilseed rape.

**Key words:** *spring oilseed rape, weed control methods, bio-preparations, productivity, organic production system.*

## MULTIFUNCTIONAL AGROCENOSSES BIODIVERSITY, SUSTAINABILITY AND FUNCTIONALITY IN SHORT VEGETATION CONDITIONS

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Crops with high energy potential provide not only the main nutritional and/or feeding production (grains, seeds, sugar), but also the secondary production, including yield refuse, which can be used to produce feeds or biofuel. One of the way to increase crops biomass production is to increase crop functionality and biodiversity, when some other fast developed crops are intercropped to the main crop. These plants also should to protect the main crop against weeds, diseases and pests spreading.

The aim of the study was to investigate the high productivity multicropped (multifunctional) agroecosystems for the impact on environment, soil, pests and weeds, productivity and energy potential stability in short vegetation conditions. A stationary field experiment carrying out at the Experimental Station of Vytautas Magnus University in 2020-2022. Maize (*Zea mays* L.), cannabis (*Cannabis sativa* L.) and faba bean (*Vicia faba* L.) as mono, binary and trinomial crops cultivations are investigated. The experiment has 7 combinations (treatments), 3 replications and 21 experimental plots.

During experimental research, we investigating soil penetration resistance, gas flows, soil water stability and nutritional composition. Also indices of crop development, photosynthesis, productivity and quality. First year experiment results showed, that the most biomass had maize and cannabis, which were growing as mono crop. Nevertheless, the most biomass of faba bean had treatments with trinomial crops cultivations. In the end of experiment, the biomass of multicrop cultivation will be evaluated for energy purposes too.

**Key words:** *multicropping, maize, cannabis, faba bean, soil quality, biomass, biofuel.*

## THE INFLUENCE OF BIOLOGICAL PREPARATIONS AND THEIR MIXTURES ON SOIL PROPERTIES IN WINTER WHEAT

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Intensive tillage and the use of chemicals unbalance natural biological processes in the soil. There is a lack of knowledge about the patterns of decomposition of organic matter and the possibilities of reducing soil degradation. A two – factor field experiment in 2017/2019 was carried out at the Vytautas Magnus University Experimental Station on the winter wheat 'Sailor' crop test fields. Biological preparations and their mixtures was applied using different tillage technologies.

The aim: influence of biological products on organic carbon content and CO<sub>2</sub> emissions from soil by comparing the performance of different formulations using zero tillage and disk harrow technologies. Soil organic carbon was not significantly influenced by the tillage technology, but the use of biological preparations and their mixtures increased the organic carbon content of the soil better than the use of nitrogen to stimulate straw mineralization. Organic carbon content was significantly better compared to compensatory nitrogen in the use of a mixture of biological preparations R+P (15.6%), R+A (13.6%), P+A (8.4%) and a mixture of all three preparations (25.0%). In the early spring vegetation, in no-till crop fields, CO<sub>2</sub> emissions ranged from 2.82 to 3.77 CO<sub>2</sub> efflux. Disk harrowing, after application of preparations, had a slight 3.4% effect on bigger CO<sub>2</sub> emissions. A bigger CO<sub>2</sub> emission was determined by spraying crops with a combination of R+P+A. CO<sub>2</sub> emission release became more active in the middle of vegetation, more intensive processes were noticed in no-till background when P and A preparations were used alone.

Organic carbon in the soil increased more with the use of biological agents than with the release of compensatory nitrogen. At the start of vegetation, CO<sub>2</sub> emissions were increased by the use of the mixtures of biological preparations. In the middle of the vegetation, the release of CO<sub>2</sub> emissions was activated by using not only P and A preparations alone but also a mixture of them.

**Key words:** *biological preparations, winter wheat, no till, disk harrowing.*

## IMPACT OF TILLAGE INTENSITY WITH VERTICAL SOIL STRATIFICATION ON SOIL PHYSICAL QUALITY INDEXES

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In many cases, the impact of tillage and vertical stratification on SDexter (soil physical quality) and WSA (stability of soil aggregates) indexes have been studied nevertheless, there is a lack of investigations through these indexes in a semi-humid subarctic climate of the Baltic States.

A long-term field experiment was performed at the Experimental Station of Vytautas Magnus University since 1988. The aim was to investigate the impact of different tillage intensity on the upper layers SDexter and WSA indexes.

The plots of spring barley (*Hordeum vulgare* L.) were divided in five subplots: conventional ploughing (CP) at a depth of 23–25 cm, shallow ploughing (SP) at a depth of 12–15 cm, deep cultivation (DC) (chiselling) at a depth of 23–25 cm, shallow cultivation (SC) (discing) at a depth of 12–15 cm and no-tillage (direct drilling) (NT). WSA index was obtained using dry aggregates samples. SDexter index was calculated using water content data. Soil samples were collected in 2018.

The significantly highest value of SDexter index was obtained under NT along with the lowest value under SC tillage, 0.102 also 0.089, respectively. The deeper soil depth (20–30 cm) was significantly higher than the upper soil depth (0–5 cm), 0.104 also 0.092, respectively. Different intensity of tillage and vertical stratification of soil had a significant effect on the stability of soil aggregates. The significantly highest values of WSA index were determined under NT, however the lowest value was under SP and CP tillage, 64.53% with 35.33 and 31.62%, respectively. The deeper soil depth (20–30 cm) was significantly lower than the middle soil depth (5–20 cm), 35.01 and 48.80% and 49.18%, respectively.

The results showed that NT increased the soil physical quality also soil aggregate stability.

**Key words:** *soil quality, stability of soil aggregates, tillage, soil depth, SDexter.*

## SUSCEPTIBILITY OF DIFFERENT VARIETIES OF TULIPS TO VIRAL DISEASES

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The research was carried out in the Botanical Garden of Vytautas Magnus University. During 2016–2018 period 28 varieties of tulips were observed during flowering. Plants infected with viral diseases were identified visually by characteristic symptoms. Most of the observed tulip varieties had the least viral diseases in 2016. However, the prevalence of the disease increased in the following years, with many varieties suffering the most in 2019. Some varieties of tulips ('Vivex', 'Burgundy', 'Texas Flame') were infected with almost all plants.

**Key words:** *viral diseases, susceptible varieties, tulip growing, viral disease symptoms.*

# EVALUATION OF POTATO VARIETIES AND CLONES OF BREEDING MATERIAL IN THE INTEGRATED FARMING MANAGEMENT SYSTEM IN THE NORTH KURZEME REGION OF LATVIA

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In Latvia, the potato market has a very wide range of varieties from abroad, and with aim to introduce and offer created in Latvia potato varieties to farmers, a research trial was set up according project founded by the Latvian Ministry of Agriculture: "Support for the Evaluation of Breeding Material to Implement Integrated and Organic Agriculture Crop management"

To assess the suitability of potato varieties and clones of breeding material to an integrated farming system. To achieve the goal, a field trial was set up with 9 potato varieties: Monta, Rigonda, Lenora, Prelma, Brasla, Imanta, Magdalena, Jogla, Gundega and 10 breeding clones: S 07169-35, 2002-3317, 07131 -15, S10063 -178, S 10063 -48, S 09035-22, 19694.5, S 07156-22, 19922.29, 2008 -6.5.

The study was carried out over several years (2015–2020). Evaluated traits: potato tuber yield, yield structure, phenological phase, resistance of varieties and clones to diseases during the growing season and post-harvest tuber infection.

The analysis of the data shows that the potato tuber yield, using all agrotechnical measures, achieved very good results in average of three (2018–2020) years. Yields varied significantly between varieties ( $F_{\text{fact}} > F_{\text{crit}}$ ), but the average yield varied from 42.19 t ha<sup>-1</sup> (variety 'Brasla') to 63.89 t ha<sup>-1</sup> (variety 'Jogla'). When evaluating the yield level of clones of breeding material, the most highyielding were: S 07131-15 (63.92 t ha<sup>-1</sup>); S 10063-128 (58.33 t ha<sup>-1</sup>); 19922.29 (61.93 t ha<sup>-1</sup>). When evaluating the yield structure, varieties and breeding clones with the highest commercial yield and larger tubers of food fraction (> 50 mm) were noted (S09035-22; S07169-35; 19922.29; 'Jogla', 'Rigonda', 'Monta').

Breeding clones and varieties will be selected from the evaluated material, the traits of which are best suited to the integrated management system in Latvia.

**Key words:** *potato variety, tuber yield, yield structure.*

## EFFECTS OF SUBSEQUENT DROUGHT EVENTS AND ABILITIES TO RECOVER OF ALFALFA AND RYEGRASS FORAGE CROPS

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Climate change and meteorological extremes are one of the most relevant environmental issues in the world. Moreover, intensity and frequency of weather extremes are predicted to increase even more in the future. Its effects on crops are relatively well investigated. However, the effects on forage crops, that are essential for the maintenance of an efficient livestock sector, are much less investigated. This research was conducted in a greenhouse in Vytautas Magnus University in March–May of 2020 in order to evaluate the effect of subsequent drought events on two important forage crop species: alfalfa (*Medicago sativa*) and hybrid fescue (*Festulolium loliaceum*). The plants were grown in pots with a mixture of loam, sand and perlite in a greenhouse with partly regulated environment. The first event of drought was applied 60 days after sowing. Drought was applied by retention of watering for 7 days, which was followed by 7 days of recovery period with normal irrigation. The second drought event was applied immediately after recovery period. After 7 days of the second drought, recovery was also applied. Growth of forage crops was evaluated after each different period (after 2 drought events and 2 recovery periods). The effects of subsequent droughts and abilities to recover after it were analyzed based on the changes of morphological parameters of forage crops, such as length, fresh and dry biomass (FW and DW, respectively) of shoots and roots. Growth of dry and fresh biomass of both forage species was significantly restricted by subsequent drought events. FW of shoots of alfalfa reduced by ~50% after each drought and was unable to recover completely; effect on roots was less pronounced (33 and 20% reduction of FW). Hybrid fescue was found to be more resistant to drought than alfalfa. FW and DW of roots and shoots reduced by ~20% after the 1<sup>st</sup> drought and recovered completely. However, the subsequent drought induced much stronger reduction of growth (especially shoot FW), that was unable to recover completely.

**Acknowledgements:** This project has received funding from the Research Council of Lithuania (LMT), agreement No. S-SIT-20-4.

**Key words:** *subsequent drought, climate extremes, recovery, forage crops, alfalfa, hybrid fescue.*



## INFLUENCE OF FIBER HEMP CROP DENSITY ON WEEDS AND PRODUCTIVITY

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Relevance of the topic. In Lithuania, hemp has been grown for a long time, but its cultivation technologies have not been widely studied. Therefore, conducting research will allow you to analyze, determine how efficiently sown hemp can be grown.

The research was carried out in a field experiment in Varkaliai village, Plungė district. The research was conducted in 2019.

The aim of this study was to evaluate the influence of sowing rates on the weediness and productivity of sown hemp crops. "Sowing hemp": variety – "FUTURA 75" Seed rate – 5 kg ha<sup>-1</sup>, 25 kg ha<sup>-1</sup>, 16 kg ha<sup>-1</sup>, 69.12 kg ha<sup>-1</sup>. Sowing depth – 2 cm.

Research results. Different crop densities did not have a significant effect on weed seed bank compared to the sowing density of 25.00 kg ha<sup>-1</sup>. Lower weed content and biomass were found in the densest (69.12 kg ha<sup>-1</sup>) crop of sowing hemp. Using a seed rate of 16.00 kg ha<sup>-1</sup>, higher weed content and biomass were determined. The rarest (5.00 kg ha<sup>-1</sup>) crop of sown hemp had a different effect on weediness. Significantly higher biomass of sowing hemp flowers, stems and leaves was found in the densest crop (69.12 kg ha<sup>-1</sup>) compared to the control variant fields. The minimum amount of 2.28 cannabidiol (CBD) was found in the fields with the highest seed rate. Significantly, the highest content of 4.03 cannabidiol (CBD) was found in the fields with the lowest applied seed rate (5.00 kg ha<sup>-1</sup>). A higher but insignificant amount of cannabidiol (CBD) was found in the fields where the seed rate was 16.00 kg ha<sup>-1</sup>, compared to the sowing density of 25.00 kg ha<sup>-1</sup>.

**Key words:** *hemp, weediness, cannabidiol.*

## THE EFFECT OF LONG-TERM CROP ROTATION ON THE AMOUNT OF WEED SEEDS IN THE SOIL

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The spread of characteristic weeds is one of the main factors limiting crop productivity and soil productivity in crop rotations. The similar chemical composition of weeds and agricultural crops leads to interspecies competition in agrocenoses – for nutrients, moisture, heat and light.

The investigations were carried out at Vytautas Magnus University Experimental Station in 2018.

The aim of the experiment was to determine the influence of long term crop rotations influence on weed seeds in the soil.

The three courses, the Norfolk, the field with row crops, the fodder, the intensive, for green manure crop rotations, the rye monoculture and the 50 year bare fallow. In these crop rotations, the studies of amount of weed seeds are carried out on the crops of wheat *Triticum aestivum* L. (summer form), rye *Secale cereale* L. (summer form) and barley *Hordeum vulgare* L. (summer form).

Seeds of frost-blite (*Chenopodium album* L.), pale persicaria (*Polygonum lapathifolia* L.), cockspur (*Echinochloa crus-galli* L.) and lady's thumb (*Persicaria maculosa* L.) dominated in different crop rotations, monocultures and continuous bare fallow. Different crop rotations and continuous bare fallow had not significantly differed of amount of weed seeds. Short-lived weeds dominated in wheat, barley and rye crops. Distribution trends of short-lived weed in different crop rotations, monocultures and continuous bare fallow was established similar like general distribution of weeds. The amount of perennial weed seeds in the soil was established in continuous bare fallow and barley crops where pre-crops were potatoes, sugar and fodder beets.

**Key words:** *crop rotation, monoculture, weeds, continuous bare fallow.*

## WEED SPREADING IN THE MULTI-CROPPING SYSTEM

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Both economic and environmental challenges in the world are increasing interest in multi-cropping system. Therefore, field experiment was carried at Experimental Station of Vytautas Magnus University Agriculture Academy in 2017–2019. The aim of the study was to determine and compare weed spread in the sole (spring barley, spring wheat, pea, caraway), binary (spring barley-caraway, spring wheat-caraway, pea-caraway) and trinary (spring barley-caraway-white clover, spring wheat-caraway-white clover, pea-caraway-white clover) crops. In the crops the most common weeds were *Tripleurospermum perforatum*, *Chenopodium album* and *Sinapis arvensis*. In the second and third years of caraway cultivation, the abundance of perennial weeds in crops increased. In the first year, during main crops cultivation, significantly from 3.0 to 31.6 times higher dry matter mass of weeds was determined in non-sprayed with herbicides binary crops with under sown caraway and in trinary crops with under sown caraway and white clover, compared to sole crops. In the second year, significantly 6.9 and 6.6 times higher dry matter mass of weeds was found in the caraway binary crops, when they were grown after spring barley and spring wheat without white clover, compared to sole crops. In the third year, significantly from 2.7 to 7.4 times higher dry matter mass of weeds was obtained in the caraway binary and trinary crops, when they were grown after barley, wheat and pea without white clover and after barley and wheat with white clover, compared to sole crops. This was due to the intense spread of *T. perforatum* and *Taraxacum officinale* in the binary and trinary crops. In the second year, the highest yield of caraway seeds were formed, when they were grown as binary crop after pea without white clover, in the third year – when they were grown as trinary crop after wheat with white clover.

**Key words:** *carum carvi*, multi-cropping system, seed yield, weed.

## CONSERVATION TILLAGE IN FABA BEAN CULTIVATION: WEED SEED BANK

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The current agricultural system aims to reduce tillage intensity through the use of innovative tillage technologies. Faba beans are particularly sensitive to weed competition, so detailed research is needed due to the lack of experimental data on the effects of different tillage technologies on weed seed bank content. For this reason in Vytautas Magnus University, Agriculture Academy (Lithuania), five contrasting tillage system were tested: deep and shallow mouldboard ploughing, deep cultivation-subsoiling, shallow cultivation-disking and no-tillage. The experimental data of 2016–2018 is discussed. Sampling was performed at the end of the growing season of faba bean (BBCH 75–79). Samples were taken from the 0–15 and 15–25 cm soil layers.

Investigations concluded, that the insignificantly highest weed seed bank was found in the disked and no-tilled plots. The weed seed bank was almost evenly distributed between the two soil layers.

**Key words:** *conservation tillage, soil layers, weed seed bank, Vicia faba L.*

## THE CHANGES OF CHLOROPHYLL FLUORESCENCE PARAMETERS OF *MEDICAGO SATIVA* UNDER DROUGHT STRESS AND RECOVERY AFTER IT

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Drought is one of the major causes for crop loss worldwide. Responses to drought are multiple and consistent. It is well established that drought stress impairs numerous metabolic and physiological processes in plants. It leads to growth reduction, reduction in the content of chlorophyll pigments and water, and changes in fluorescence parameters. The aim of this study was to investigate the response of chlorophyll *a* fluorescence parameters of lucerne (*Medicago sativa*) under partly regulated environment and drought stress effect. Plants were grown in pots filled with a mixture of field soil, perlite and fine sand (volume ratio 5:3:2) in the greenhouse of Vytautas Magnus university in 2020. Drought stress lasted one week, after that plants were left for one week recovery period. Under drought effect grown plants were watered only 50 % of norm during exposure time. Chlorophyll *a* fluorescence parameters measurements were taken with the Plant Efficiency Analyser, PEA (Hansatech Instruments, Ltd., King's Lynn, Norfolk, England) with randomly selected youngest fully expanded leaves on the last (7<sup>th</sup>) day of the exposure of drought and after recovery. Drought stress statistically significant decreased several investigated chlorophyll *a* fluorescence parameters. The changes of Fv/Fm, which is an indicator of the efficiency of second photosystem (PSII), were statistically insignificant during both experiment stages. The increase of specific energy flux per reaction centre (RC) for absorption ABS/RC was followed by an increase of trapping energy (TRo/SCo) under drought stress effect. The efficiency with which an electron can move from the reduced intersystem electron acceptors to the PSI and electron acceptors ( $\Delta Ro$ ) was lower under drought stress. Higher energy usage under drought stress also indicated slightly decreased values of dissipated energy flux per cross section (Dio/CSO). After the recovery period, differences of several investigated parameters narrowed, but some still remained statistically significant. Our experiment results show that a one-week recovery period is too short for the photosynthetic system of lucerne to fully recover from the aforementioned drought stress.

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**Key words:** *climate change, drought, chlorophyll fluorescence, alfalfa.*

## THE EFFECT OF THE BIOPRODUCTS ON THE INCIDENCE OF SEPTORIA LEAF BLOTCH IN WINTER WHEAT CROPS

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Diseases in organically grown winter wheat crops are becoming an increasingly pressing problem. A very limited choice of biological plant protection products is one of the reasons restricting effective control of harmful organisms in organic farms. Septoria leaf blotch (*Mycosphaerella graminicola* (Fuckel) J. Schröt. (anamorpha *Zymoseptoria tritici* (Desm.) is difficult to control winter wheat (*Triticum aestivum* L.) disease. The relevance of the problem prompts a search for alternative means intended for this disease control.

For this reason, investigations were carried out at the organic farm of the Experimental Station in Kazliškiai village in 2018–2019. The aim was to investigate the effects of the bioproducts Biokal 1 and Fitokondi on occurrence of Septoria leaf blotch during the growing seasons.

The experiment included the following treatments: 1) control (not sprayed), 2) Biokal 1 sprayed at a rate of 10 l ha<sup>-1</sup>, 3) Fitokondi sprayed at a rate of 6 l ha<sup>-1</sup>. Winter wheat was sprayed at tillering (BBCH 20), booting (BBCH 35–38) and heading (BBCH 55–58). Disease incidence and severity were estimated on three upper fully expanded leaves.

During winter wheat tillering stage (BBCH 25–30) Fitokondi and Biokal 1 have reduced the intensity of the disease very slightly (2018 – 0.1% and 2019 – 0.7%), compared to control – not significant. During BBCH 40–45 in 2018 wheat sprayed with Biokal 1 disease intensity increased by 0.3%. Only Fitokondi has a 0.7% reduction in intensity, but it did not differ significantly from the control. In 2019 Fitokondi has a 1.4% reduction in intensity, compared to control – not significant. During BBCH 60–65 stage in 2018 wheat sprayed with Biokal 1 and Fitokondi disease intensity slightly increased compare.

**Key words:** *bioproducts, fungi, organic farming, wheat*

## INCIDENCE OF SEED-BORNE FUNGI IN WINTER WHEAT AND SPRING BARLEY SEEDS

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Seed-borne fungi are important for quality of *Poaceae* grain crops. Fungi may reduce seed germination capacity, viability, weight, weaken the root system, to decrease on green mass and yield of plants.

The aim of the research was ascertain the abundance of seed-borne fungi and estimate the influence of moisture content, weight, viability on the intensity of contamination by fungi.

The grain of 3 winter wheat (*Triticum aestivum* L.) and 5 spring barley (*Hordeum vulgare* L.) varieties grown on Lithuanian seed production farms was used. In 2018 the total number of seed samples tested was 54 for winter wheat and 58 for spring barley, in 2019 – 48 and 44, respectively. The grains were analysed for moisture content, viability or germinating power, and 1000 grain weight. Fungal infection on seed was determined according to Satton et al. (2001) and Mathur, Kongsdal (2003) methods in a sterile environment in Petri dishes on Czapek–Dox agar medium (CDA).

During the experimental period all the wheat seed samples were found to be dominated by the fungi of *Alternaria*, *Fusarium*, *Penicillium* and other fungi genera. The seed infection level was 52.9, 5.7, 5.9 and 35.5%, respectively. In all the barley seed samples were found to be dominated by the fungi of *Alternaria*, *Penicillium*, *Fusarium*, *Drechslera* and *Cladosporium* genera, the seed infection level was 40.3, 25.2, 16.3, 7.8 and 0.7 %, respectively. The highest *Fusarium* infection level was recorded when the moisture content of stored grain exceeded 14.1%. A higher correlation between grain moisture content and occurrence of *Fusarium* fungi ( $r=0.72$ ,  $P=0.05$ ) was identified for winter wheat.

The occurrence of seed-borne fungi depended on the moisture content of stored grain. The differences in seed infection with pathogenic and saprophytic fungi in relation to grain weight were inappreciable. With increasing *Fusarium* infection level seed viability and germinating power declined.

**Key words:** seed-borne fungi, wheat, barley, moisture content, viability, germinating power.

## THE INFLUENCE OF DIFFERENT SOIL MOISTURE CONDITIONS AND NITROGEN RATES ON THE FORAGE GRASSES PRODUCTIVITY

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The economic and environmental importance of forage crops, their response to climate extremes and productivity are of high importance but still are little studied. The vegetative experiment was carried in 2020 at a greenhouse of Vytautas Magnus University Agriculture Academy Open Access Joint Research Center of Agriculture and Forestry. The aim of the study was to estimate the effect of different soil moisture conditions and nitrogen rates on the red clover and forage timothy mixture productivity.

Treatments of the experiment: Factor A: soil moisture conditions: 1) lack of soil moisture (drought), 2) optimal soil moisture conditions, 3) excess of soil moisture (waterlogging); Factor B: nitrogen rates: 1)  $N_{25}P_{60}K_{90}$  (background fertilization), 2)  $N_{25}P_{60}K_{90} + N_{60}$ , 3)  $N_{25}P_{60}K_{90} + N_{120}$ . The mixture of red clover (*Trifolium pratense* L.) 'Vyčiai' and forage timothy (*Phleum pratense* L.) 'Gintaras II' was grown in the vegetative containers (7.5 l, 0.047 m<sup>2</sup> area). The imitation of drought and waterlogging was performed twice: at the seedling stage and during the intensive growth of the plants.

Under drought conditions above-ground dry biomass of red clover and forage timothy mixture decreased on average by 39.6 and 45.4%, compared with the optimal soil moisture and waterlogging conditions, respectively. Under waterlogging conditions with increasing nitrogen rates the above-ground dry biomass of forage grasses mixture decreased by 15.5 and 19.0%, respectively, compared to the lowest nitrogen rate. Under waterlogging conditions at the lowest nitrogen application rate root dry biomass of forage grasses mixture was significantly by 2.1 times higher than under drought conditions. A significant, positive and strong correlation ( $r = 0.86$ ,  $P < 0.01$ ) was found between above-ground dry biomass and root dry biomass of red clover and forage timothy mixture. The lowest above-ground and root dry biomass of red clover and forage timothy mixture was found under drought conditions.

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**Key words:** drought, waterlogging, nitrogen rate, red clover, forage timothy, productivity.



## THE EFFECT OF SOWING TIME ON *ALTERNARIA BRASSICAE* AND *PHYLLOTRETA NEMORUM* L. SPREADING IN SPRING OILSEED RAPE CROP

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In Lithuania, spring oilseed rape is classified as an early sowing crop because it tolerates slight  $-2$ – $-3^{\circ}\text{C}$  frosts, it is demanding for soil moisture, and most importantly – early sowing helps to partially avoid spread of *Phyllotreta nemorum* L. However, delay of the sowing time can help to prevent spread of *Alternaria brassicae* in spring oilseed rape crop, but decreases the yield. Sowing time affects the phytosanitary condition of crop and the spread of pests, so determining the optimal sowing time for spring oilseed rape in changing climate conditions remains the most important factor for optimal yield.

The field experiments were carried out in the Experimental Station of Vytautas Magnus University Agriculture Academy in 2018–2019. The aim of the experiment was to evaluate the influence of sowing time on spreading of diseases and pests in spring oilseed rape crop. The first sowing occurred when soil reached physical maturity and the other sowing dates were every 7 days. In 2018, sowing was started on 20<sup>th</sup> April and continued until 8<sup>th</sup> June and in 2019, started on 5<sup>th</sup> April and continued until 7<sup>th</sup> June. *Phyllotreta* spp. were counted at BBCH 10–19 in 5 locations in meter. Damaged leaf area (%) of pests was assessed on 25 plants using 5 points scale. *Alternaria brassicae* assessed at (BBCH 80–87). From each replication, 100 siliques were harvested for analyses. The percentage of damaged pods and disease intensity were calculated.

In 2018, the highest intensity of *Phyllotreta nemorum* damage was estimated in the spring oilseed rape crop sown during the first 10 days of May. The highest damage of *Alternaria brassicae* were in the latest sown spring oilseed rape crop. In 2019, the intensity of *Phyllotreta nemorum* damage was significantly the lowest in the earliest sown spring oilseed rape crop, and later sowings significantly increased the intensity of this damage. The prevalence of *Phyllotreta nemorum* was influenced by soil temperature, a strong significant linear correlation was found between these indicators ( $r = 0.71$ ;  $P \leq 0.05$ ), as the soil temperature increased, the intensity of *Phyllotreta nemorum* damage increased. Later spring oilseed rape sowing significantly influenced more intensive spread of *Alternaria brassicae* on pods. The studies should be continued to prepare recommendations for spring oilseed rape sowing time.

**Key words:** spring oilseed rape, sowing time, diseases, pests.

## FORAGE QUALITY OF SEMI-NATURAL AND CULTURAL GRASSLANDS IN THE ECOLOGICAL FARM

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Plant species composition and forage quality were evaluated in cultural and two types of semi natural grasslands (molinia meadow and lowland hay meadow) in Central part of Lithuania. Grassland fields were located in private ecological farm, fields were cultural grasslands, one field was molinia meadow and one was lowland hay meadow. Species composition was evaluated in ten test plots in each cultural grassland field, and ten test plots were chosen in lowland hay meadow. The size of the test plot was 1 m<sup>2</sup>, plots were chosen randomly in the boundaries of the field, the least distance to the field margins and between the plots was 10 m. Each test plot was harvested for forage quality evaluation. Crude protein, dry matter digestibility (DMD), neutral detergent fiber (NDF), water soluble carbohydrates (WSC) were evaluated using near-infrared spectrometer NIRS-6500.

As expected number of plant species was 2–3 times higher in semi-natural grasslands compared to cultural. Cultural grassland plant biomass accumulated also contained higher percentage of NDF and lower percentage of proteins. Semi natural grasslands differed significantly among each other in several forage quality parameters as well as number of plant species. The lowest NDF, highest DM was assessed in molinia meadow plant biomass samples.

**Key words:** *farm, grassland, biomass.*

## INFLUENCE OF SEED RATE AND ROW SPACE ON WINTER WHEAT YIELD AND GRAIN QUALITY

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Grain yield and quality of winter wheat (*Triticum aestivum* L.) depend upon the interaction of environment and genotype. An important element of agricultural technology for all crops is the correct sowing rate.

The aim of investigations was to evaluate the influence of seed rate and distance between rows on winter wheat yield and grain quality. The field trials with four winter wheat varieties were set up at Institute of Agricultural Resources and Economics (Latvia) during 2017–2019. Fertilizers and plant protection products were used in accordance with commercial practices and rates common to the area. The varieties were grown on plots 12 m<sup>2</sup> in four replications. Sowing rates were 500 germinating kernels m<sup>-2</sup> and in other treatment reduced by 40% (300 germinating kernels m<sup>-2</sup>), as well as in the treatment with reduced sowing rate, the distance between rows was 12 cm in treatment 1 and 25 cm in treatment 2.

Wintering conditions in both years were satisfactory and estimation after wheat plant vegetation renewal was 7 to 9 points (on a scale of 1–9; 1 – low).

Grain yield assessed from all plot and corrected for dry matter 14%. Protein content analysed by express method using Infratec Nova 6.

In 2017/2018 grain yield of winter wheat variety 'Edvins' varied from 6.40 to 7.42 t ha<sup>-1</sup> and from 8.96 to 10.08 t ha<sup>-1</sup> in 2018/2019. Variety 'Brencis' showed 7.25–8.40 and 9.61–10.33 t ha<sup>-1</sup>; variety 'Talsis' 6.2–7.6 t ha<sup>-1</sup> and 10.54–11.33 t ha<sup>-1</sup>; variety 'Skagen' 5.96–7.11 t ha<sup>-1</sup> and 10.93–11.67 t ha<sup>-1</sup>, accordingly.

The results of the experiment conformed winter wheat varieties characterized to high productive tillering capacity at the optimal sowing time with the favourable conditions for plant development can reduce the sowing rate by 30–40%. By using reduced sowing rates and increasing row width (25 cm), grain quality increased significantly for all varieties in both years.

**Key words:** winter wheat, varieties, yield, quality.

## **CROP ROTATION OUTPERFORM ORGANIC AND CONVENTIONAL CROPPING SYSTEMS IN STRUCTURING SOIL MICROBIAL COMMUNITIES**

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Sustainable agriculture is the main aim in crop production. To identify the farming systems that would be sustainable for a longer period, the field experiment was established at Estonian University of Life Sciences (58°22' N, 26°40' E) on 2008. The experiment was set up in systematic block design with four replicates of each treatment. The organic system had three subtreatments: Org0, org1 with cover crops, and org3 with cover crops and composted cattle manure. Conventional system had four subtreatments: N<sub>0</sub>P<sub>0</sub>K<sub>0</sub>; N<sub>40</sub>P<sub>25</sub>K<sub>95</sub>; N<sub>80</sub>P<sub>25</sub>K<sub>95</sub>, and N<sub>120</sub>P<sub>25</sub>K<sub>95</sub>. The five-field crop rotation based on following order of the crops: barley with undersown red clover, red clover, winter wheat, pea, potato. Soil samples were collected on 2013 and 2018 (beginning and end of the second rotation). Our analysis revealed that bacterial and to a lesser extent fungal diversity increased by the end of the rotation in all organic treatments and in conventional treatments with low to medium nitrogen rate (20–100 kg of nitrogen per hectare). Crop rotation decreased pathogenic and increased mycorrhizal fungi abundance. Five years crop rotation significantly increased the relative abundance of aerobic ammonia oxidation, nitrate reduction, dark hydrogen oxidation and aromatic compound degradation and decreased fermentation and aerobic chemoheterotrophy relative abundance. Our results propose that crop rotation may perform better than cropping systems in structuring soil microbial communities.

**Key words:** *diversity, fungi, bacteria, organic, conventional, cropping system, nitrogen.*

## THE ASPECTS OF SPLASH EROSION IN THE EYE OF HIGH-SPEED CAMERA

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Soil as the important component of many ecosystems and non-renewable resource, may undergo processes of different degradation. One of the form of physical degradation is water erosion which is initiated by the splash phenomenon. This process occurs when impacting raindrops cause the detachment and transport of soil material. The precise nature of the phenomena that cause this degradation is necessary to develop and improve methods to prevent it.

The aim of this study was to present the possibilities of high-speed cameras in observation of main aspects of splash erosion caused by the single drop impact.

Laboratory experiments were conducted on soil samples with different texture and initial moisture content in context of the most effective observation of phenomena occurring on the soil surface. The splash was caused by water drop with diameter of 4.2 mm. A single drop impact was registered by a set of Phantom Miro M310 high-speed cameras recording with 3260 fps (frames per second).

After the splash phenomenon on different soil surfaces, the following aspects were observed by cameras and quantitatively characterized with developed algorithms: a) micro-crater – a shallow cavity as a deformation and compaction of soil surface; b) ejection of particles – the effect of detachment and transport over different distances soil particles and water droplets; c) crown formation – the layer of water lifted up as a ‘crown’ shape affected by the drop impact onto moistened soil surface.

In general, the high-speed cameras are effective are an effective tool for quantitative and qualitative description of splash erosion aspects taking place on the soil surface.

**Key words:** *splash erosion, water erosion, high-speed cameras, cratering, soil particles.*

## LEAF SENESCENCE OF SPRING WHEAT IN CONTRASTING AGROECOSYSTEMS

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Soil tillage influences affects soil moisture and nutrient status, which in turn condition the senescence process of plants. There is still lack of knowledge about the leaf senescence of spring wheat affected by tillage, straw and nitrogen management. The aim was to evaluate the influence of tillage and nitrogen application in combination with crop residues on leaf senescence of spring wheat. The investigation was carried out at the Institute of Agriculture, LAMMC. Tillage treatments – no-tillage (NT) and conventional tillage (CT) – were main plots; fertilization – without fertilizers (1), moderate rates (2) and maximum rates of NPK (3) were as sub-plots in combination with residue return. The senescence of leaves (SPAD, Fv/Fm and normalized differences both indices (NDF and ND SPAD)) was evaluated in 1st, 2nd and 3rd leaves from the top during generative development stages three times.

It was established that simplification of tillage resulted in faster senescence of the leaves. NT reduced SPAD in 1st, 2nd and 3rd leaves in most of cases, in comparison to CT between measurements. The fertilization postponed senescence in terms of both SPAD and Fv/Fm, especially in flag leaf at grain filling stage.

The correlation coefficients between grain yield (GY), quality indices and NDF, ND SPAD varied with different growth stages, leaf positions and tillage methods. At BBCH 67–69, the relationship between ND SPAD 1/2 and GY was significant under CT ( $r = -0.704$ ,  $P \leq 0.05$ ). ND SPAD 1/2 explained 50% of GY variation under CT and considerably less – only 14% – under NT. The correlation coefficients for ND SPAD 1/3 and ND SPAD 2/3 with GY were the most significant and stronger ( $r = -0.934$  and  $0.913$ , respectively,  $P \leq 0.01$ ) under NT than CT; ND SPAD 1/3 and ND SPAD 2/3 were responsible for 87 and 83% of GY variation. The relationship of NDF 1/3 and NDF 2/3 with GY, conversely, was stronger ( $r = -0.871$  and  $0.860$ , respectively) under CT than NT.

**Key words:** *fertilization, senescence, tillage.*

## CHANGES IN THE MINERAL CONTENT OF WILD STINGING NETTLE (*URTICA DIOICA* L.) AS INFLUENCED BY THE HARVESTING TIME

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The human requires different amounts of vitamins and minerals to stay healthy, especially in the spring when the immunity becomes weaker. The diet can be supplemented with edible plants starting to grow in early spring. The nettle is considered a weed, but herewith can be used as a medical herb with a high content of minerals.

Object of the investigation was the leaves of wild stinging nettle's (*Urtica dioica* L.). Nettle leaves were collected once a month from April to September 2019 in the same place, Vytautas Magnus University Agriculture Academy orchard (54° 53' N, 23° 50' E) in Kaunas district. The aim of this research was to determine effect of different harvesting time on stinging nettle mineral composition.

The amount of crude ash in leaves was determined by dry burning samples at a temperature of 550 °C. The nitrogen content was established by the standard Kjeldalh method, phosphorus and potassium – by flame photometric method. Magnesium, iron, copper, manganese, zinc, boron was determined by atomic absorption method.

The crude ash content from April to August in plants increased but in September decreased again. The highest content of ash was established in the leaves of nettles in August (4.70%). The nettles harvested in April characterized by the highest level of nitrogen (4.69%), phosphorus (1.02%), potassium (3.60%), iron, (526.20 mg kg<sup>-1</sup>), and zinc (34.20 mg kg<sup>-1</sup>). The highest amount of calcium (3.97%), magnesium (0.81%) and boron (62.13 mg kg<sup>-1</sup>) were found in leaves of plants collected in September at the end of the growing season. The highest amount of copper (18.43 mg kg<sup>-1</sup>) was determined in plants harvested in June. Nettle leaves in July was distinguished by manganese (57.40 mg kg<sup>-1</sup>) content.

The research data have shown that the amount of crude ash and mineral elements in nettle leaves depends on harvest time.

**Key words:** *crude ash, mineral content, leaves of stinging nettle.*

## QUALITY EVALUATION OF HONEY

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For a long time, honey is valued for exceptional taste and beneficial effects on human health. Also, honey is special because it can be stored more than a year suitable for use without any further processing.

The purpose of this work was to evaluate honey acidity and diastase activity changes over a 12 months' storage period.

For research was being used three different botany composition of honey collected in July, August and September in Farmer located in East part of Lithuania. The experiences have been done on fresh honey, and after storage 4 and 12 months. Acidity was determined by sample titration with sodium hydroxide until acid neutralization. Diastase activity was measured using a buffered solution of soluble starch, which fulfils the requirements of the method (Codex Alimentarius Commission, 1981).

The averaged experiment results showed that during storage honey acidity increased. The average acidity of fresh honey in depending on botany composition was 11.6 mekv kg-1, after 4 months – 16.94 mekv kg-1 and after 12 months –17.6 mekv kg-1. Storage of honey under warm conditions should lead to reduced diastase activity, however, melting by the device resulted in different variations depending on the botanical species of honey. The average experiment results of enzyme activity showed that after 4 months' honey storage it decreased 1.56 times, and after 12 months –2.26 times.

In summary, it can be said that during storage honey quality changes and it's getting worse, therefore honey should be consumed as fresh as possible.

**Key words:** *honey, acidity, enzyme activity.*



## EFFECT OF FREEZING ON THE CHEMICAL COMPOSITION OF STRAWBERRIES

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One of the most popular ways of berries preservation is freezing. Freezing prolongs the shelf life of berries, inhibits the growth of microorganisms and helps maintain their nutritional value. Most vitamins and other biologically active compounds remain in frozen products.

The object of the investigation was fresh and frozen strawberries (*Fragaria* × *ananassa* (Duchesne ex Weston) Duchesne ex Rozier) 'Rumba', 'Asia', 'Sonsation' and 'Malwina' cultivars grown on a farm in Joniškis district, Lithuania. The research aim was to evaluate changes in the chemical composition of strawberries during the freezing process.

3 kg of fresh strawberries of each cultivar were placed in polyethylene bags for refrigeration (3 bags of 1.0 kg each) and frozen at -37 °C. In the fresh and frozen strawberries were determined amount of dry matters, soluble solids, ascorbic acid by standard methods. The total phenolic content was determined spectrophotometrically using the Folin-Ciocalteu reagent. Total anthocyanins were established by measurement of absorbance at 538 nm with two-ray UVS-2800 spectrophotometer. The antiradical activity was determined using the DPPH method.

The decrease in dry matter and soluble solids of frozen strawberries was insignificant compared to fresh ones. Only in 'Rumba' berries, soluble solids content decreased by 8%. In different cultivars of frozen strawberries, vitamin C content was lower from 6 to 37%. The freezing process significantly reduced the total amount of phenolic compounds in the strawberries of all investigated cultivars but did not have a significant effect on anthocyanin's content. The total anthocyanin's content decreased for only 0.02–0.05 mg 100g<sup>-1</sup>. However, the antioxidant activity of strawberries after freezing decreased significantly.

The freezing process reduced the nutritional value of the studied cultivars of strawberries although some of the changes were not significant.

**Key words:** anthocyanin's, antiradical activity, phenolics.

## THE CONTENT OF MACROELEMENTS IN THE PULP AND PEEL OF DIFFERENT VARIETIES OF PEAR FRUIT

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Pear peels are usually discarded before processing of the fruits. However, it could be expected that pear peels contain more minerals.

Therefore, the aim of this study was to investigate and compare the amounts of macroelements in pulp and peels of four pear cultivars ('Ksenia', 'Beloruskaja Pozdniaja', 'Alna' and 'Aleksandr Lucas').

The amounts of five macroelements (nitrogen, phosphorus, calcium, magnesium and potassium) were determined using inductively coupled plasma atomic emission spectroscopy (ICP-AES).

The results showed that the amount of macroelements depends on pear cultivar and tissue. Pear peels have significantly higher amounts of calcium than the pulp. However, pulp contains the highest contents of nitrogen and potassium. Of the studied macroelements, potassium has the highest content in both parts of the pear fruit followed by nitrogen, phosphorus, magnesium and calcium. 'Beloruskaja Pozdniaja' and 'Ksenia' peels had the highest contents of phosphorus (90.22 mg 100 g<sup>-1</sup> and 75.12 mg 100 g<sup>-1</sup>, respectively) and magnesium (57.23 mg 100 g<sup>-1</sup> and 66.21 mg 100 g<sup>-1</sup>, respectively). The pulp of 'Alna' and 'Aleksandr Lucas' cultivars showed the highest contents of phosphorus (87.32 mg 100 g<sup>-1</sup> and 76.31 mg 100 g<sup>-1</sup>, respectively) and magnesium (63.12 mg 100 g<sup>-1</sup> and 52.25 mg 100 g<sup>-1</sup>, respectively). The peel of 'Alna' had the highest amounts of calcium.

Based on the present study, it can be concluded that the investigated pear peels showed only significantly higher calcium contents compared to the pulp.

**Key words:** calcium, macroelements, pear cultivars, potassium.

## POLYPHENOLS CONTENT IN ROSEHIPS *ROSA RUGOSA* THUNB. AND *ROSA CANINA* L. DEPENDENCE ON THE RIPENING STAGE

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Different harvesting time can largely influence the content of bioactive compounds in different variety rosehips.

The field experiment was carried out in an organic farm in Pakruojis district, Lithuania.

The aim of this study was to determine the effect of ripening stage on polyphenol content of two different rosehip flesh species *R. rugosa* and *R. canina*.

The fruits were harvested five times in season. The first stage (H-1) was performed when the fruit color changed slightly from green to yellow, pink or red no less than 10% of the surface. The second stage (H-2) was performed when the fruit color changed from green to tarnish – yellow, pink or red no less than 30% of the surface. The third stage (H-3) was performed when the fruit color changed from green to light orange or red or a combination thereof no less than 60% of the surface. The fourth stage (H-4) was performed when the fruit became pinkish or orange depending on the species. The fifth stage (H-5) was performed when the fruit surface was red.

Polyphenols were determined using HPLC system by the method described by Hallmann (2012).

The results demonstrated that the significantly highest contents of total flavonoids were identified in the *R. rugosa* species and the highest amount was in fully ripe fruits (H-5) (18.73 mg g<sup>-1</sup> DW). The total polyphenols and total phenolic acids contents in fruits of *R. canina* were significantly higher than in the fruits of *R. rugosa* and the highest concentration were determined at fifth harvesting stage (H-5) (respectively 70.90 and 59.60 mg g<sup>-1</sup> DW).

Total polyphenols, total flavonoids and total phenolic acids content showed that the main factor determining the differences in accumulation of biologically active compounds is the species of rosehips and ripening stage.

**Key words:** *phenolic acid, flavonoids, ripening stage, rosehips.*

## INFLUENCE OF ENCAPSULATION MATERIALS ON THE PHYSICOCHEMICAL PROPERTIES OF BLACKBERRY POWDER PRODUCED BY SPRAY DRYING

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Blackberries contain a great variety of phenolic compounds, especially anthocyanins, which are considered bioactive compounds with functional benefits. Encapsulation is using for protection from environmental conditions, avoiding oxidation and increasing the shelf life of bioactive compounds.

Different encapsulation conditions and agents influence the encapsulation efficiency, yield, and antioxidant activity. The aim of this work was to study the effect of different carrier agents (maltodextrin, acacia gum) on the physicochemical properties of blackberry powder produced by spray drying.

Research was carried out at VMU Agriculture Academy, Institute of Agricultural and Food Sciences in 2020. Spectrophotometric methods were used to analyze total phenols, total anthocyanins and antioxidant activity of spray dried blackberries powder. Color of powder was detected by spectrophotometer ColorFlex assessing the values of coordinates  $L^*$ ,  $a^*$ ,  $b^*$ . Statistical analysis was performed using one-way analysis of variance (ANOVA) (Statistica 12, StatSoft, USA). Fisher (LSD) test was applied to assess significant differences between the samples at  $p < 0.05$ .

As the concentration of maltodextrin increased from 10% to 20%, the total content of phenolic compounds in the obtained blackberries powder decreased from 1272 mg 100 g<sup>-1</sup> to 338 mg 100 g<sup>-1</sup>, the concentration of anthocyanins from 3314.68 mg kg<sup>-1</sup> to 1346.89 mg kg<sup>-1</sup>. Replacement of 50% maltodextrin with acacia gum was found to increase the total amount of phenolic compounds, concentration of anthocyanins and DPPH radicals scavenging activity.

The use of encapsulation agents such as maltodextrin and acacia gum mixture is more efficient than individual components.

**Key words:** *antioxidant activity, blackberries, encapsulation, maltodextrin, acacia gum.*

# THE COMPARATIVE ANALYSIS OF PHYSICOCHEMICAL PROPERTIES, AMINO AND FATTY ACIDS PROFILE OF MUSCULUS LONGISSIMUS DORSI BETWEEN LATE AND FAST MATURED CATTLE BREEDS

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Beef is an important source of amino acids, minerals and vitamins, so it plays an important role in human nutrition. In order to maintain a profitable farm, and to obtain quality meat production, it is very important for beef cattle farmers to calculate which breeds of beef cattle would be optimal for growing and whose carcasses have a higher demand in domestic and foreign markets.

The influence of the breed of beef on meat quality was investigated.

The experiment was performed with bulls of late maturing breed (Limousines) and fast maturing breed (Angus) from production farms. The animals of both breeds received the same concentrated feed depending on the weight (per 100 kg weight per 1 kg of feed) and the grass feed. Samples for the determination of the physicochemical properties, amino and fatty acids of the meat was taken from the longest dorsal muscle (*musculus longissimus dorsi*) at the last ribs. The chemical composition (dry matter, protein, lipid and ash contents), pH, water holding capacity, drip loss, cooking loss, color and texture (shear force) were measured. The structure of intramuscular fats fatty acids was determined using the gas chromatography method by analyzing the methyl esters of the fatty acids (Shimadzu GC – 2010 PLUS, Shimadzu Corporation, Japan) and the amino acids were determined using an amino acid analyzer (UF-Amino Station, Shimadzu Corporation, Japan).

The meat of late maturing breed (Limousines) showed the higher drip loss by 1,6% and hardness by 0,18 kg cm<sup>2</sup> comparing with Angus. The amino and fatty acids profile was influenced by the beef breed. The meat of Limousines animals showed the higher amount of alanine, methionine and valine while Angus meat of cysteine and glutamine. Saturated and polyunsaturated fatty acids content was higher in Limousines meat, while monounsaturated in Angus.

The beef breed influences the chemical content of meat.

**Keywords:** *musculus longissimus dorsi*, chemical content of meat, Limousines, Angus.

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