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Agriculture in changing climate

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online

BOOK OF ABSTRACTS

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- Andrey Alekseev – Institute of Physicochemical and Biological Problems of Soil Science, Russian Academy of Sciences, Pushchino, Russia
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- Taru Palosuo – Finnish Environment Institute, Department of Climate Change Programme, Finland

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10:25-10:40	Samreen Shehzadi	Efficient utilization of organic wastes for environmental protection and their potential assessment as organic fertilizers
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10:55-11:10	Viet San Le	Sustainability of agroecological tea management and land conversion practices for restoring soil health: A case study of Thai Nguyen province in Northern Vietnam
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12:30-12:45	Marie Berger	Using darkfield and fluorescence macrovision on large images to assess anatomical and chemical variability of tissues in whole cross sections of maize stems
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14:00-14:15	Jolanta Cieśla	Gelling ability of diluted alkali-soluble pectin from pear fruit determined using the physicochemical and optical indices
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OPENING LECTURE

O1. Soils and climate change

Lipiec, J.

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There exists a close link between soil quality/functions, land use and climate change. As the greatest terrestrial carbon pool, soils play a key role in emission, capturing (sequestration) and storage of CO_2. The intensification of agriculture along with climate change results in depletion of soil organic carbon (C), accelerated processes of disrupting soil structure, increased frequency or intensity of droughts and floods, erosion, compaction, acidification and salinization, greenhouse gases emission and loss in biodiversity. Restoring soil C and quality can be achieved by adoption of soil improving cropping systems (SICS) including diverse crop rotation, continuous cover cropping and/or applying exogenous organic matter (e.g. manure, recycled organic matter, biochar), minimal soil disturbance (reduced tillage), controlled trafficking, smart irrigation and liming of acidic soils (Bolinder et al., 2020). These SICS can result in significant improvement of pore structure, structural stability and fertility of soil and ecosystem resilience in a changing climate while protecting the environment. Soil C stocks vary with land-use change. For ex. conversion of arable land into forest and grassland benefits the C stocks. Protection and restoration of peatlands and wetlands is critical to increase soil C and decrease CO_2 emission. Forest ecosystems are a stabilising force for the climate. Urban sprawl and the associated soil sealing largely affect hydrological conditions and flood hazards. Therefore, water harvesting and recycling in urbanised areas is a viable strategy. The management practices should be adapted to the local environmental and socio-economic conditions.
Further studies in connection with recent international initiatives and developments e.g. “4 per mille” (soil C stock increase per year), the soil quality application (SQAPP) (www.isqaper-is.eu) and soil and climate databases are needed to save non-renewable soil resources for agriculture (food security) and to combat global warming.

References

Bolinder, M., Crotty, F., Elsen, A., Frąc, M., Kismányoky, T., Lipiec, J., Tits, M., Tóth, Z., Kätterer, T., 2020. The effect of crop residues, cover crops, manures and nitrogen fertilization on soil organic carbon changes in agroecosystems: a synthesis of reviews. Mitig. Adapt. Strateg. Glob. Change. https://doi.org/10.1007/s11027-020-09916-3

ORAL PRESENTATIONS
SESSION I - SOIL AND PLANT

O2. Soils of the steppe zone of the East European Plain in the context of global climate change

Alekseev, A., Alekseeva, T.

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Modern landscapes of the steppe zone of the European part of Russia reflect a long history of natural evolution, which was characterized by complexity and dynamism due to changes in natural conditions and the increasing impact of anthropogenic factors. Without analyzing the role of the natural trend of climate change and its impact on soils and landscapes, it is impossible to predict the long-term consequences of geoecological changes. During the three-year route expeditions, the material was collected from more than 90 soil sections evenly covering the climatic zones of the steppe zone of the south-east of the Russian Plain, covering the soils of the forest-steppe, steppe and semi-desert zones. New qualitative and quantitative functional dependences of the geochemical properties of mineral and organic components of modern soils of the steppe zone with climatic parameters (precipitation, temperature, aridity index) are obtained, which allow us to use the obtained indicators for the analysis and adjustments of already conducted paleo- reconstructions based on the study of a large set of Quaternary paleosols (Holocene, Pleistocene). Analysis of the parameters of 13C NMR data of organic carbon of clay fractions of modern and buried soils has demonstrated direct correlations of the qualitative characteristics of soil organic matter with variations in climatic conditions in the past and present-with an increase in aridity, the content of alkyls increases and the content of aromatic structures decreases, and vice versa. Estimates of the variability of fixation of macro- and microelements in different plants of steppe landscapes, depending on the geochemical properties of soils and climatic parameters, have been carried out. The data obtained contribute to a better understanding of the geochemical function of plants in steppes, which is crucial for predicting the response of landscapes to climate change. Regional calibrations of the dependence of the magnetic properties of modern soils in the south of the East European Plain on climatic data made it possible to quantify the shift in the boundary of the dry-steppe and desert-steppe zones in this region due to global climatic variations during the late Holocene.

Acknowledgments
This study was supported by the Russian Foundation for Basic Research (Grant No. 19-29-05178).

References

Alekseev A. O., Mitenko G. V., and Sharyi P. A. (2020). Quantitative Estimates of Paleoenvironmental Changes in the Late Holocene in the South of the East European Plain as Recorded in the Magnetic Properties of Soils. Eurasian Soil Science, 53, 1677–1686.

Kudrevatykh I. Y., Kalinin P. I., Mitenko G. V., Alekseev A..O. (2021) . The role of plant in the formation of the topsoil chemical composition in different climatic conditions of steppe landscape . Plant Soil , 465,453–472.

Kalinin P.I., Kudrevatykh I.Yu, Malyshev V.V., Pilguy L.S., Buhonov A.V., Mitenko G.V., Alekseev A. O. (2021) Chemical weathering in semi-arid soils of the Russian plain. Catena, 206 ,105554

O3. Soil deformation – how far are shear induced coupled mechanical and hydraulic processes fundamental for the predictions of trafficability

Horn, R. [1], Huang, J.[1], Ren, T.[2]

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Soils are the most critical life-supporting compartments of the biosphere. They provide numerous ecosystem services such as habitat for biodiversity, water and nutrients, as well as producing food, feed, fiber and energy. However, soils undergo intense and irreversible changes due to a non-site adjusted land management and improper application of machinery and techniques in its broadest sense. In combination with the growing population (until 2050 we will have approx. 9 Billion people) the urgent need for a more reliable dataset of soil properties and soil functions gains in importance in order to even prepare more reliable models for various requests. Deformation processes during stress application are the more pronounced the higher the shear component of the total stress, and may even result in a complete liquefaction if soil water cannot be drained off adequately. Shear and vibration induced soil deformation therefore enhances the deterioration of soil properties especially if the soil water content and the internal soil strength are very low. The same is true for animal trampling in combination with overgrazing of moist to wet pastures, which subsequently causes denser (i.e. reduced proportion of coarse pores with smaller continuity) but still structured soil horizons and will finally end in a compacted platy structure. In combination with high water content and shearing due to trampling results in a complete muddy homogeneous soil with no structure at all. Thus, the consequence of dilatation (like compaction) and shearing in combination affect the internal soil strength as the pore water pressure as one component of the effective stress equation affects the total soil strength. During the oral presentation these interactions will be presented and consequences discussed.

Acknowledgments

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References

Huang,X., Horn,R., Ren,T 2021. Deformation and pore water pressure change during static and cyclic loading with subsequent shearing on soils with different textures and matric potentials Soil and Tillage Res. 104909, doi.org/10.1016/j. still.2020.

O4. Efficient utilization of organic wastes for environmental protection and their potential assessment as organic fertilizers

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Climate change, land degradation, reduction in soil organic matter and excessive use of chemical fertilizers are the threats to soil sustainability, environmental quality and food security. Environmental pollution resulting from industrial wastes, municipal wastes and fertilizer losses represents worldwide alarming situation for human life. The recycling of various organic wastes into organic fertilizer is an efficient management approach to enhance soil physico-chemical and biological properties and improve environmental quality. Therefore, a study was conducted at Central Analytical Facility Division (CAFD), PINSTECH, Islamabad, Pakistan with the objective to collect various types of organic solid wastes and after formulation/development, evaluate their potentiality as organic fertilizers. The organic wastes were analyzed for their nutrient composition, heavy metals toxicity and other physico-chemical characteristics. Three different categories of organic wastes including farm wastes, sugar industrial waste and municipal solid wastes were collected from various locations. Some composts were developed at CAFD using water melon peel waste, kitchen waste and fruit market waste. After formulation and preparation, these wastes were analyzed using Atomic Absorption Spectrometry and Inductively Coupled Plasma- Optical Emission Spectrometry. The results obtained revealed that all the organic wastes were found under safe limits of toxic heavy metals (Pb, Cd, Ni,Cr, Hg, As) as recommended by WHO guidelines. The C:N ratio of the organic wastes ranged from 7 in the filter cake to 100 in wheat residues. The results showed that sugar industrial waste (filter cake) had the best potential for using as organic fertilizer because of its low C: N ratio (7.0), high N (3.5%), total P (4.0 %) and total K (1.0%) content. Moreover, it is also a rich source of micro-nutrients including Zn, Fe Cu and Mn. The results further revealed that water melon peel waste compost is good source of organic fertilizer with narrow C: N ratio (7.5), organic matter (64%), N (3.2%) and total K (3.0 %.). It is concluded that among various organic wastes tested, filter cake, water melon peel waste compost and fruit market waste compost are eco-friendly, economically viable and rich source of nutrients indicating great potential to be used as organic fertilizers.

Acknowledgments
This study was supported by Central Analytical Facility Division, PINSTECH, Islamabad, Pakistan.

O5. Structure stability of soils from long–term irrigated orchard and field crops: compering with polyacrylamide effects

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Soil structure formation and stability are critical aspects of sustainable land management and crop productivity in irrigated lands. We evaluated the effects of long-term land use, orchard (soil organic matter, SOM=3.0-3.5%) and field crops (SOM=0.6-1.2%), and that of adding anionic polyacrylamide (PAM = 0, 25, 50, 100 and 200 mg L^{-1}) to field crops, on soil pore size distribution and structural stability of 4 semi-arid Israeli soils (loam to clay) of weak structure, using the high energy (0-50 hPa) moisture characteristic (HEMC) method. Soil water retention curves were characterized by a modified van Genuchten model that provides parameters α (location of the inflection point) and *n* (steepness), and soil structure index (SI). Land use and PAM treatments yielded significantly different shapes of the water retention curves (α, *n*) and SI, that transpired in different ranges of the macro-pore sizes (> 250-300, 125-250, 60-125 µm) (Lipiec et al., 2008; Mamedov et al., 2021). Increase in clay content and SOM or PAM rate increased α and SI, and decreased *n*. Field crops soils yielded SI values lower (~2 fold) than those of the orchard soils. Yet, field crops soils treated with (i) low PAM rates (25-50 mg L^{-1}) gave SI comparable to that obtained for the orchard soils, and (ii) high PAM rate (100-200 mg L^{-1}) yielded higher SI (~1.6 fold) than that for orchard soils. The magnitude of land use (orchard) and PAM effects was inversely related to soil clay content. An exponential type of relations existed between SI and α and *n*, that could be associated with the effects of land use (i.e., tillage intensity) and amendments (PAM), on pore- and aggregate size distribution of the soils, and its resistance to slaking. These relations could be linked to soil characteristics (Mamedov et al., 2021) and be of importance for devising C sequestration strategies and sustainable management with consideration of climate fluctuations (Tian et al., 2020). Detailed effects of the treatments and soil wetting conditions on the studied soil quality indices, model parameters, and their relations are discussed in the paper.

Acknowledgments

This study was supported by Israel ARO.

References

Mamedov A.I., Fujimaki H., Tsunekawa A.,. Tsubo M., Levy G.J. (2021a). Structure stability of acidic Luvisol: effects of tillage type and exogenous additives. Soil and Tillage Research. 206, 104832.

Lipiec J., Walczak R., Witkowska-Walczak B., Nosalewicz A., Slowinska-Jurkiewicz A., Sławinski C., 2007. The effect of aggregate size on water retention and pore structure of two silt loam soils of different genesis. Soil and Tillage Research, 97, 239–246.

Tian X., Fan H., Wang J., Ippolito J., Li Y., Feng S., An M., Zhang F., Wang K. (2019). Effect of polymer materials on soil structure and organic carbon under drip irrigation. Geoderma 2019, 340, 94–103.

O6. Sustainability of agroecological tea management and land conversion practices for restoring soil health: A case study of Thai Nguyen province in Northern Vietnam

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Tea is one of the most important cash crops in Vietnam. The continual use of conventional tea cultivation strategies in the country has led to numerous issues that are reducing tea yield and quality, and ultimately profitability for tea growers. Key issues affecting production include soil health degradation and environmental pollution with serious consequences on human health. In recent years, there has been a rapid conversion from conventional tea management practices and annual croplands to agroecological tea cultivation methods. This is driven by an increasing interest in high tea quality and awareness of the harmful effects of agrochemicals on human health and the environment. To date, the sustainability of this conversion regarding soil health properties has been poorly understood. Therefore, this study was conducted to investigate impact of agroecological tea management and land conversion practices on soil health indicators in northern Vietnam. Our research results demonstrated that agroecological management practices significantly increased soil organic matter, soil pH and AMF colonization compared to conventional management. While with conventional management, soil total nitrogen was significantly higher compared to agroecological tea plantation soils, this could be explained by intensive applications of nitrogen-based fertilizers in conventionally managed tea plantations. Soil macro and microfauna diversity was significantly greater in agroecologically managed tea gardens than in conventional tea plantations. Interestingly, for both management practices, the highest AMF intensity (M%) was only 48.7%, suggesting that there is room for options to improve AMF root colonization of tea plants with a benefit on soil health and plant growth. As for AMF, our result highlights the possibilities for enhancing soil fauna diversity by management practices for improving soil conditions such as soil acidity. Effects of field lime applications on soil pH and soil health parameters are currently being investigated. Based on the outcomes of these trials, additional management practices such as biochar application will also be investigated. The overall objective is to sustain a high-quality tea production while improving soil diversity and soil health, with overall outcomes towards achieving long-term economically and environmentally sustainable tea production for Vietnam.

Acknowledgments

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O7.Strategies of *Lolium-Festuca* forage grasses to survive drought conditions

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The plant strategies to survive water deficit can be classified generally as drought escape, avoidance and tolerance. Though, the efficient plant recovery after drought cessation often occurs in a combination with drought avoidance and/or tolerance, this strategy can be also associated with 'quiescence' of plant metabolism under drought conditions and its further regeneration after re-watering. A development of particular survival strategies depends both on plant species and environmental conditions. *Lolium* (ryegrass) and *Festuca* (fescue) species as well as their intergeneric hybrids are important forage grasses in the temperate region. Among them, *F. arundinacea* and *F. glaucescens* have been proven to be valuable models to analyze different strategies of drought survival in grasses. *Festuca arundinacea* possesses the ability to develop a deep root system under drought conditions (drought avoidance strategy) but *F. glaucescens* becomes 'quiescent' under drought and regenerates efficiently after drought cessation (recovery strategy). *Lolium* species, including *L. multiflorum*, are generally drought susceptible, however their intergeneric hybrids with *F. arundinacea* reveal a wide range of diversity with respect to their drought survival. Herein, we present results on two *L. multiflorum*/*F. arundinacea* introgression forms with distinct levels of drought survival in different experimental trials, including field conditions, 'tube system' and pots. Our study was focused on leaf/root morphology, cellular metabolism at the level of proteome, primary metabolome, and lipidome as well as on the performance of photosynthesis and the stability of biological membranes with respect to drought avoidance, tolerance and plant recovery after stress cessation in the analyzed hybrids.

References

Perlikowski D., Augustyniak A., Masajada K., Skirycz A., Soja A. M., Michaelis A., Wolter G., Kosmala A. (2019). Structural and metabolic alterations in root systems under limited water conditions in forage grasses of *Lolium-Festuca* complex. Plant Science, 283, 211-223.

Perlikowski D., Augustyniak A., Skirycz A., Pawłowicz I., Masajada K., Michaelis Ä., Kosmala A. (2020). Efficient root metabolism improves drought resistance of *Festuca arundinacea*, Plant and Cell Physiology, 61, 492-504.

Perlikowski D., Czyżniejewski M., Marczak Ł., Augustyniak A., Kosmala A. (2016a). Water deficit affects primary metabolism differently in two *Lolium multiflorum/Festuca arundinacea* introgression forms with a distinct capacity for photosynthesis and membrane regeneration. Frontiers in Plant Science, 7, 1063.

Perlikowski D., Kierszniowska S., Sawikowska A., Krajewski P., Rapacz M., Eckhardt Ä., Kosmala A. (2016b). Remodeling of leaf cellular glycerolipid composition under drought and re-hydration conditions in grasses from the *Lolium-Festuca* complex. Frontiers in Plant Science, 7, 1027.

O8. The application of high-speed cameras technique for quantitative description of soil splash phenomenon

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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. This process is initiated by the splash phenomenon when impacting raindrops cause the detachment and transport of soil material. Considering the increasing problem of soil protection against erosion, a thorough understanding and recognition of the mechanisms governing this phenomenon at all stages could contribute to the improvement of effective methods for preventing this undesirable phenomenon. The aim of this study was to present the possibilities of high-speed cameras and image analysis technique in quantitative description of soil splash phenomenon.

The experiments were conducted on moistened *Haplic Luvisol* soil sample. The splash was caused by water drop with diameter of 4.2 mm and the impact was registered by three synchronized Phantom Miro M310 high-speed cameras recording with 3260 fps. The recorded images were subjected to image processing sequence allowing for the maximum identification of ejected soil particles and reconstruction of 3D flight trajectories of particles.

The analyze of the processed images and obtained trajectories of splashed particles gave the possibility to determine the following parameters describing soil splash phenomenon: a) number of ejected particles, b) ejection angle (for each particle), c) ejection velocity, d) displacement range, e) altitude (the maximal height reached by the particle), f) geometrical parameters of particles (diameter, shape). The above quantities could be implemented in the development of mathematical models of splash erosion based on the physical description. Moreover, the issue related with displacement of splashed soil particles seems to be significant due to the transport processes of pollutants and pathogenic microorganisms (transported with soil particles).

Acknowledgments

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References

Beczek M., Ryżak M., Sochan A., Mazur R., Polakowski C., Hess D., Bieganowski A. (2020). Methodological aspects of using high-speed cameras to quantify soil splash phenomenon. GEODERMA 378

O9. The new approach for cleaning the environment - entomoremediation

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Among the many different methods of broadly understood bioremediation, entomoremediation is certainly the least known field. This technic was firstly mentioned in the theoretical work of Ewuim (2013) and defined as the use of insect for cleaning contaminated soil. Many different articles from such filed like ecotoxicology, food and feed safety or insect physiology dealt with issues related to the influence of heavy metals or toxic organic compounds on insects. The results showed e.g. that insect are able to bioaccumulation of some inorganics as well as to degrade organics compounds, but all those publication focused on their specific research field with isolation from the practical environmental context. Entomoremediation tries to turn abovementioned phenomenons into practical ways of solving problems of environmental pollution. Currently, entomoremediation is defined broadly as the use of specialized insects and their associated microorganisms to utilize, sequester and/or detoxify pollutants from soil, sediments and organic biomass (Bulak et al., 2018). The presentation will discussed unique characteristic of entomoremediation as well as examples of the results of recent experiments from this field.

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References

Bulak P., Polakowski C., Nowak K., Waśko A., Wiącek D., Bieganowski A. (2018). *Hermetia illucens* as a new and promising species for use in entomoremediation. Science of the Total Environment 633, 912-919.

Ewuim S.C. (2013). Entomoremediation - a novel in-situ bioremediation approach. Animal Research International 10, 1681-1684.

O10. Using darkfield and fluorescence macrovision on large images to assess anatomical and chemical variability of tissues in whole cross sections of maize stems

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The stems of widely cultivated grass species such as maize perform multiple architectural and physiological functions, while contributing the most to non-grain biomass for the production of fodder and biochemicals. Stem histology and composition are highly implicated in those functions and are highly dependent on the genotype, growing and climate conditions. Here we propose a method to quantify histology and to compare genotypes.
Macroscopic imaging has been retained to study large samples such as whole stem sections of about 1 cm². At this scale, morphological features such as stem area, rind thickness, vascular bundle density can be obtained.
Two kinds of images were acquired without section labelling. Visible images were obtained using a dedicated device equipped with darkfield illumination. Multispectral fluorescence images were acquired after UV and visible excitations using a fluorescence macroscope to detect lignin and phenolic acids thanks to their autofluorescence properties. Both types of imaging were used with the goal of highlighting variability of the tissues from the stem for a series of 14 maize genotypes.
Rind, vascular bundles and parenchyma were segmented in both images. About 20 morphological descriptors were measured from the darkfield images. Autofluorescence pseudo-spectra were extracted from the multispectral images for each tissue.
Huge variability between the 14 inbred lines was revealed. The most discriminant morphological descriptors were the relative amount of rind and parenchyma tissues together with the density and size of individual bundle, the stem area and the parenchyma cell diameter and distribution. Specific fluorescence signatures have been identified with a predominant tissue effect and the inbred line effect was always significant. In particular, the relative fluorescence emission after Blue excitation seemed to be similar within a genotype whatever the tissue. A higher level of lignin resulted in a higher visible-induced fluorescence in all tissues. The amount of para-coumaric acid was correlated with the UV-induced fluorescence of the rind and the parenchyma near the rind while ferulic acid was correlated with the parenchyma near the rind.
Darkfield and fluorescence macrovision imaging techniques showed their potential to quantify tissue morphology and phenolic compounds in maize stem sections without any labelling. The image analysis pipeline is semi-automated and adapted to following the impact of climate change on stems.

References

Corcel, M., Devaux, M.-F., Guillon, F., and Barron, C. (2016). Comparison of UV and visible autofluorescence of wheat grain tissues in macroscopic images of cross-sections and particles. Computers and Electronics in Agriculture, 127, 281-288.

ORAL PRESENTATIONS
SESSION II – FOOD AND BIO-BASED PRODUCTS

O11. Nanocelluloses/hemicelluloses complexes as versatile building blocks for self-assembled materials

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Cellulose is a major source of renewable carbon available to face tomorrow's environmental concerns. During the two last decades, research efforts have focused on a new class of cellulose-derived products: the nanocelluloses. Nanocelluloses are produced from cellulosic fibres and comprise cellulose nanocrystals and semi-crystalline cellulose nanofibrils. In plant cell wall, cellulose is intimately associated with hemicelluloses that are complex families of polysaccharide displaying limitless structural variability. The use of nanocellulose for materials implementation have been the subject of last decades while their association with hemicellulose for material elaboration is less documented. In this talk, adsorption process of hemicelluloses (more specifically xyloglucan, XG) and their uses for the implementation of nanocellulose based material will be addressed and discussed. Interactions between cellulose and XG have been widely studied and XG adsorption to cellulose surfaces is now understood as an entropically-driven process[1] that can be modulated either by kinetic effects[2,3] and/or by the limited solubility of hemicelluloses in water[4]. The properties of the final nanocellulose/XG network can thus be tune by controlling XG/nanocellulose ratio, concentrations or mixing condition. They offer thus a wide panel of properties offering opportunities to elaborate thin films allowing enzymatic detection[5,6], thermosensitive hydrogels [7,8] and aerogels with shape recovery capacity[9,10].

References

1.Benselfelt, T.; Cranston, E. D.; Ondaral, S.; Johansson, E.; Brumer, H.; Rutland, M. W.; Wågberg, L., Adsorption of Xyloglucan onto Cellulose Surfaces of Different Morphologies: An Entropy-Driven Process. Biomacromolecules 2016, 17, (9), 2801-2811.
2.Villares, A.; Moreau, C.; Dammak, A.; Capron, I.; Cathala, B., Kinetic aspects of the adsorption of xyloglucan onto cellulose nanocrystals. Soft Matter 2015, 11, (32), 6472-6481.
3.Villares, A.; Bizot, H.; Moreau, C.; Rolland-Sabate, A.; Cathala, B., Effect of xyloglucan molar mass on its assembly onto the cellulose surface and its enzymatic susceptibility. Carbohydrate Polymers 2017, 157, 1105-1112.
4.Kishani, S.; Vilaplana, F.; Ruda, M.; Hansson, P.; Wågberg, L., The influence of solubility on the adsorption of different Xyloglucan fractions at Cellulose Water Interfaces. Biomacromolecules 2019.
5.Cerclier, C.; Lack-Guyomard, A.; Moreau, C.; Cousin, F.; Beury, N.; Bonnin, E.; Jean, B.; Cathala, B., Coloured Semi-reflective Thin Films for Biomass-hydrolyzing Enzyme Detection. Advanced Materials 2011, 23, (33), 3791–3795.
6.Cerclier, C.; Cousin, F.; Bizot, H.; Moreau, C. l.; Cathala, B., Elaboration of Spin-Coated Cellulose-Xyloglucan Multilayered Thin Films. Langmuir 2010, 26, (22), 17248-17255.
7.Talantikite, M.; Stimpson, T. C.; Gourlay, A.; Le-Gall, S.; Moreau, C.; Cranston, E. D.; Moran-Mirabal, J. M.; Cathala, B., Bioinspired Thermoresponsive Xyloglucan-Cellulose Nanocrystal Hydrogels. Biomacromolecules 2021, 22, (2), 743-753.
8.Talantikite, M.; Gourlay, A.; Le Gall, S.; Cathala, B., Influence of Xyloglucan Molar Mass on Rheological Properties of Cellulose Nanocrystal/Xyloglucan Hydrogels. Journal of Renewable Materials 2019, 7, (12), 1381-1390.
9.Jaafar, Z.; Quelennec, B.; Moreau, C.; Lourdin, D.; Maigret, J. E.; Coradin, T.; Fernandes, F. M.; Cathala, B., Xyloglucan and cellulose nanocrystals biomimetic aerogels produced by freezecasting. Abstracts of Papers of the American Chemical Society 2019, 257.
10.Mandin, S.; Moreau, S.; Talantikite, M.; Novales, B.; Maigret, J.-E.; Cathala, B.; Moreau, C., Cellulose Nanofibrils/Xyloglucan Bio-Based Aerogels with Shape Recovery. Gels 2021, 7, (1).

O12. Combined deep eutectic solvents pretreatments of pomaces act synergistically to ease access to texturing soluble dietary fibers

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Fruit and vegetable juice industries generate pomaces that are sources of nutritional valuable compounds, such as antioxidants and dietary fibers. The latter can also play important technological roles as texturing agents in food matrices. The recent advent of food-safe natural deep eutectic solvents (NADES) composed of donor and acceptor proton molecules, which when combined allow forming liquids at room temperature offers new means of extracting molecules from biomasses. We recently reported that sequential pretreatments of apple pomace by NADES based on glycerol (CC:Gly) and lactic acid (CC:LA) as proton donor molecules and choline chloride as proton acceptor molecule markedly improved water extraction of pectins enriched in distinct chemical characteristics according to the NADES used (Chen et al, 2021). To follow up on this study, the impact of combining both solvents was assessed to access valuable secondary metabolites and increase the solubility of pectins. The rational of this study was to enrich pomaces in dietary fibers, to potentialize their texturing effect in food matrices while recovering secondary metabolites in NADES extracts. To that end, the yield of water-soluble pectins from hydrated pomaces of carrot, broccoli florets, broccoli stems and orange was compared after pretreatment with CC:Gly, CC:LA and the combination of both NADES. The yield of soluble polysaccharides was always higher in the combined NADES pretreatment compared to the sum of the polysaccharides yield recovered in water after the two individual NADES pretreatments. Pretreatment of larger amounts of carrot and broccoli floret pomaces by recycling combined CC:Gly and CC:LA enriched the NADES extracts in secondary metabolites. The freeze-dried pomaces recovered after a rapid water-wash to remove residual NADES were enriched in dietary fibers. The effect of these pretreatments on the solubility of pectins and the rheology of the dispersed suspensions of the NADES-pretreated carrot and broccoli floret pomaces will be presented as a proof of concept of a NADES-based process to increase the solubility of food texturing dietary fibers.

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References

Chen M., Falourd X. Lahaye M. (2021). Sequential natural deep eutectic solvent pretreatments of apple pomace: A novel way to promote water extraction of pectin and to tailor its main structural domains. Carbohydrate Polymers, 266, 118113.

O13. Gelling ability of diluted alkali-soluble pectin from pear fruit determined using the physicochemical and optical indices

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Pectin is an important biopolymer for the food industry, where it is used e.g. as a texturizer, a prebiotic carrier and a gelling agent. Functional properties of pectin are strongly connected with the ability of its macromolecules to form three-dimensional network in the liquid media. The process of gelation depends on the chemical structure, molecular weight and concentration of pectin, the composition of dispersing medium (pH and presence of mono- and multi-valent cations) and the environmental conditions (e.g. temperature). (Moslemi, 2021). Gel point is determined usually using the rheological methods.

It was hypothesized that the indices based on the back- and forward- light scattering and the counter-ions binding can be used for the monitoring of structural changes in the pectin suspensions, especially for the gel point determination.

Investigations were performed for diluted alkali-soluble pectin (DASP) sequentially extracted from the pear fruit (*Pyrus communis* L. cv. 'Conference'). Chemical composition, presence of specific functional groups, molecular weight as well as an intrinsic and apparent dissociation constants of pectin were determined. The indices (aggregation index and shape factor) based on the back and forward dynamic light scattering, the changes in pectin surface electrical charge and the counter-ions binding were applied for characterization of self-organization of the DASP macromolecules in liquids (Cieśla et al., 2021a,b).

The DASP from pear fruit revealed a gelling ability in the water and salt solutions. Proposed indices were useful for a gel point determination that was confirmed by the results of rheological tests, the analyses of FT-IR spectra and the images obtained from the atomic force microscopy (Cieśla et al., 2021a,b).

Acknowledgments

This study was supported by the National Science Centre, Poland [grant number DEC-2015/17/B/NZ9/03589].

References

Moslemi, M. (2021). Reviewing the recent advances in application of pectin for technical and health promotion purposes: From laboratory to market. Carbohydrate Polymers, 254, 117324.

Cieśla, J., Koczańska, M., Pieczywek, P., Szymańska-Chargot, M., Cybulska, J., Zdunek, A. (2021a). Structural properties of diluted alkali-soluble pectin from *Pyrus communis* L. in water and salt solutions. Carbohydrate Polymers, 273, 118598.

Cieśla, J., Koczańska, M., Pieczywek, P., Cybulska, J., Zdunek, A. (2021b). The concentration-modified physicochemical surface properties of sodium carbonate-soluble pectin from pears (*Pyrus communis* L.). Food Hydrocolloids, 113, 106524.

O14. AFM observation of carrot pectin growth by adding calcium

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Pectin is an important substance that contributes to the texture of fruits and vegetables. Recently, nano-imaging using atomic force microscopy (AFM) has been applied to evaluate pectin characteristics. For industrially purified pectin, modification of its self-assembly properties due to various situations was reported in the past studies. However, because the industrially produced pectin experiences many dynamic changes during the purification process, it cannot mimic the phenomena occurring in or around the cell wall. In this study, the self-assembly properties of pectin extracted from carrot roots were observed using AFM. Pectin fractions were sequentially extracted from alcohol insoluble solid (AIS) with distilled water, 0.05 M CDTA solution and 0.05 M Na_2CO_3 + 20 mM $NaBH_4$ solution, and water-soluble pectin (WSP) fraction, chelator-soluble pectin (CSP) fraction, and diluted alkali-soluble pectin (DASP) fraction were collected, respectively. After each fraction was dialyzed to remove impurity, 0.2, 1.0, and 5.0 mmol/L calcium chloride solution were added to the pectin fractions. Then, they were observed by AFM and analyzed. The AFM images were successfully captured for all the pectin fractions and the calcium addition conditions. In the WSP fractions, many granules appeared in the AFM images. The particle size of the granules increased with the calcium concentration. These results indicated pectin molecules aggregated in intra- and intermolecular by calcium ions. In the CSP and the DASP fractions, fibrous pectins were observed. In both fractions, the pectin fibers became longer and thicker as the calcium chloride content increased. In addition, the network structures also appeared in the higher concentration of calcium. This indicated crosslinked structures (“egg-box” model) were formed by calcium ions. The CSP was more affected by the calcium addition than the DASP. These results suggest that adding calcium chloride to carrot pectin causes the growth of pectin particles and fibers, forming an egg-box model, especially in CSP and DASP.

O15. Drying as a method of bio-based products preservation

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One of the most common method of bio-based products preservation is drying. In order to meet expectations regarding the energy efficiency and quality of the dried products some novel methods of drying can be considered. Usually combined methods are used to increase the drying speed and ensure a high bioactive potential together with excellent sensory attributes of the final product. These methods include various techniques that facilitate the removal of water from a plant material with a severely limited negative effect on the chemical and physical properties of the material. Noteworthy is the use of pre-treatment, sonication as well as energy supply using infrared radiation and vacuum-microwaves. The use of microwaves at vacuum not only significantly reduces the drying time, but also allows the dried material to obtain a favorable, crispy texture. Much attention is also paid to the microencapsulation of active ingredients by spray drying. There are many phenomena occurring in the biological material during drying responsible for the quality of the dried product. Some of them are of chemical nature such as forming of new compounds under heat treatment while other concern structure of dried product, leading to shrinkage or puffing. Therefore the effect of drying parameters on the chemical profile, bioactive potential, sensory attributes and selected physical properties of food products is the subject of many scientific reports. This is of particular importance in the production of nutraceutical ingredients using drying. The use of renewable energy sources in drying also has many advantages especially in terms of ecological and energy aspects concerning “European Green Deal” initiative. Drying plays a special role in waste-free food production due to the convenience of managing all kinds of post-production waste and by-products by using appropriate techniques for removing water from the material and thus ensuring microbiological safety. This is especially important taking into account the chemical composition of some waste materials, which is often dominated by compounds with high biological activity. An approach comprising using of some waste materials generated during food processing to improve the quality of selected food products, known as “Industrial Symbiosis”, is important in sustainable development of food production.

References

Figiel A., Michalska A. (2017). Overall quality of fruits and vegetables products affected by the drying processes with the assistance of vacuum-microwaves. International Journal of Molecular Sciences, 18, 71.

Hasan M.U., Malik A.U., Ali S., Imtiaz A., Munir A., Amjad W., Anwar R. (2019). Modern drying techniques in fruits and vegetables to overcome postharvest losses: A review. Journal of Food Processing and Preservation, 43, 12.

Majerska J., Michalska A., Figiel A. (2019). A review of new directions in managing fruit and vegetable processing byproducts. Trends in Food Science & Technology, 88, 207-219.

Nicoli M.C., Parpinel M.T., Franceschi S., Lerici C.R. (1997). Loss and/or formation of antioxidants during food processing and storage. Cancer Letters. 114 (1-2), 71-74.

Sagar V. R., Suresh Kumar P. (2010). Recent advances in drying and dehydration of fruits and vegetables: a review. Journal of Food Science and Technology 47(1), 15–26.

O16. Effect of cold plasma processing of plant tissue on macromolecular structure of pectic compounds

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Cold plasma processing is considered as the effective non-thermal method of food preservation via inactivation of microorganisms and enzymes. It was observed that cold plasma treatment influences strongly on bioactive components of food, its sensory properties, water and oil absorption capacities and other determinants of food quality. However, the effect of cold plasma on pectin macromolecular structure has not been studied up to now.

In the experiment okra pods, as the polysaccharide-rich plant source, was subjected to cold plasma treatment applied for 5, 15 and 30 s. Water, chelator and sodium carbonate soluble pectin fractions were then collected using sequential extraction. Atomic force microscopy, rotational rheometer and high-performance liquid chromatography were applied to characterize the morphological, rheological and chemical properties of pectin fractions.

It was observed that cold plasma treatment of okra pods triggered an increase of extraction efficiency of pectin. Short application of cold plasma caused pectin debranching and reduction of molecules dimensions, mainly of water soluble pectin. Longer treatment influenced also for chelator and sodium carbonate soluble pectin by modification of pectin arrangement and induction of aggregates formation. Macromolecular reorganization of pectin resulted in viscosity changes of pectin solutions, especially of water soluble pectin fraction.

The results of this experiment show a new effect of cold plasma processing of plant tissue. Observed high susceptibility of pectic compounds on cold plasma treatment can be used for tailoring pectin properties for specific applications and a design of extraction process.

Acknowledgments

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References

Zielińska S., Cybulska C., Pieczywek P., Zdunek A. Kurzyna-Szklarek M., Liu Z.-L., Staniszewska I., Pan Z., Xiao H.-W., Zielińska M. 2022. The effect of high humidity hot air impingement blanching on the changes in molecular and rheological characteristics of pectin fractions extracted from okra pods. Food Hydrocolloids 123, 107199.

O17. Characteristics of selected domestic varieties of common wheat using various rheological tests

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Obtaining wheat flour with specific technological suitability requires the use of wheat grains of appropriate quality for milling. Due to the need to predict the technological and rheological characteristics of flour as early as possible, the number of methods used to assess the quality characteristics of wheat grain is constantly growing. These methods should be standardized, repeatable, reproducible and predict the quality of the final product as much as possible. The aim of the study was to determine the possibility of using devices such as Mixolab (Chopin Technologies., Villeneuve La Garenne, France) and single kernel characterization system (SKCS 4100, Perten Instruments, Springfield, IL) to predict the quality of various wheat grains. Grain quality parameters were tested of ten domestic varieties of winter wheat (Bonavita, Bertold, IS Danubius, Expo, Hondia, Kilimanjaro, Komandor, IS Laudis, IS Patinas, Pananonikus) harvested in 2020. Standardized methods were used to vitreousness, ash content, and falling number. Zeleny's index, wet gluten content, and protein content were determined with NIR. Mixolab and SKCS data were compared with various wheat quality traits. The following features were tested: hardness index, weight, diameter, moisture, water absorption (WA), dough development time (DDT), dough stability (C1), protein weakening (C2), starch gelatinization (C3), amylase activity (C4), starch gelatinization (C5) as well as predicted values such as baking strength (W), dough strength (P), extensibility (L) and elasticity index (Ie). There were found Pearson's correlation coefficients to analyze interactions between wheat properties.

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O18. Comparative study on the performance of solar dryer with finned chimney

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The performance of indirect passive solar dryers is often poor due to the low airflow rates that occur through them. Low airflow rates reduce the efficiency of the solar collectors and limit the rate of drying that can be done with such systems. Integrating a chimney into these dryers can enhance the airflow rate of the systems (Habtay et al., 2020). This study, presents the results of an experimental investigation into the effects of the solar chimney and varying the chimney air gap under the weather conditions of Gödöllő, Hungary, using two 50 cm high solar chimneys with an air gap of 5 and 10 cm. The period for testing was between 09:00 A.M and 5:30 P.M for each day in August. Plexiglass, a polystyrene box, and a cardboard absorber with a copper fin make up the solar chimney. The surface of the chimney cardboard plate with the copper fin was selectively painted with black paint to improve the airflow inside the dehydrator (Misha et al., 2013). Sliced potatoes, about 458 g, were used and spread on the drying trays in a way that allows for air passage. Weight loss was measured at 2 h intervals during drying using a weight balance. During the experiments, the ambient air temperature ranged from 19 to 35 °C, and the solar radiation ranged from 203 to 1231 W/m^2, with the highest values recorded between 12:00 A.M and 1:30 P.M. The summary of the obtained results is presented in Table 1. Based on the findings, a solar chimney with 10 cm air gap is superior to that of a 5 cm air gap chimney.

Table 1. Summary of the obtained results

Type	Absorber temperature, °C		Efficiencies, %		Final weight loss, g	
	Collector	Chimney	Collector	Chimney	Tray-1	Tray-2
5 cm & no load	58.50	52.40	35.5	42.99	-	-
5 cm with load	59.55	50.19	22.98	42.92	101	126
10 cm & no load	73.55	65.66	53.98	43.33	-	-
10 cm with load	70.28	58.00	47.76	49.59	94	103

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References

Habtay G., Buzas J., Farkas I. (2020). Heat transfer analysis in the chimney of the indirect solar dryer under natural convection mode. FME Transactions, 48, 701-706.

Misha S., Mat S., Ruslan M.H., Sopian K., Salleh E. (2013). Review on the application of a tray dryer system for agricultural products. World Applied Sciences Journal, 22, 424-433.

O19. Silencing and over-expression of prolyl 4 hydroxylase 3 induce changes in the tomato fruit growth and abscission programmes

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Tomato is the main model plant species for fruit growth and ripening and among the important model plants for abscission. Proline hydroxylation is a major post-translation modification of hydroxyproline-rich glycoproteins (HRGPs) which is catalyzed by prolyl 4-hydroxylases (P4Hs). Tomato plants expressing a P4H3 RNAi construct as well as an over-expression construct were produced in order to investigate their physiological significance in fruit growth and ripening and flower and fruit abscission.
Silencing and over-expression lines resulted in of lower diameter fruits while over-expression lines exhibited, in addition, a smaller flower phenotype. The protein expression profiles of hydroxyproline rich glycoproteins such as AGPs- and extensins-bound epitopes was determined by using western blot and immunolocalization analysis during fruit growth indicating alterations in their content which might be associated with the observed alterations in pericarp cell division and expansion progression. Ethylene induced fruit abscission was accelerated in the overexpression lines while was delayed in RNAi lines compared to wild type. No changes were observed in ethylene induced leaf abscission. However, immunolocalization of Arabinogalactan proteins (AGPs) showed lower expression in flower abscission zones in the RNAi lines and higher in the over-expression lines. Proteomics analysis of the fruit and flower abscission zones resulted in the identification of HRGPs which might be responsible for the observed phenotypes.

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O20. High-throughput phenotyping of cowpea seeds during developmental stages using multichannel imaging

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Acquisition of good spectral data is very crucial for accurate detection, classification and quality prediction of essential food quality traits because poor data negatively affects many subsequent data processing and treatments. This study aimed to implement a multichannel spectral imaging system for the analysis of individual cowpea seeds harvested at different developmental stages. The changes in germination capacity and variations in moisture, protein and different sugars during twelve stages of seed development from 10 to 32 days after flowering (DAF) were estimated. The spectral data weremodeled using partial least square (PLS) regression to predict moisture, protein and sugar contents with coefficients of determination in prediction R_p^2 of 0.93, 0.80 and 0.78, respectively. Moreover, linear discriminant analysis (LDA) models were developed for classifying the seeds based on their germination capacity with overall correct classification of 96.33 and 95.67% in the training and validation datasets, respectively. The results of this study revealed that the proposed multichannel spectral imaging system designed for single seeds could be an effective choice as a rapid screening and non-destructive technique for identifying the ideal harvesting time of cowpea seeds based on their chemical composition and germination capacity. The developed image processing routines were very efficient in producing chemical and classification images to visualize the concentrations and spatial distributions of moisture, protein and sugars during different developmental stages of cowpea seeds.

Acknowledgments

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References

ElMasry, G., Mandour, N., Ejeez, Y., Demilly, D., Al-Rejaie, S., Verdier, J., Belin, E., & Rousseau, D. (2021). Multichannel imaging for monitoring chemical composition and germination capacity of cowpea (*Vigna unguiculata*) seeds during development and maturation. The Crop Journal.

ElMasry, G., Mandour, N., Wagner, M. H., Demilly, D., Verdier, J., Belin, E., & Rousseau, D. (2019). Utilization of computer vision and multispectral imaging techniques for classification of cowpea (*Vigna unguiculata*) seeds. Plant methods, 15(1), 1-16.

O21. Following autofluorescent compounds of developing wheat grain by autofluorescence multispectral macroscopic imaging

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Wheat is the second-most produced cereal crop in the world, widely used for human consumption and animal feed. In recent decades, wheat yields have tended to stagnate and fluctuate from one year to the next. Grain yield is a complex trait, partly determined by final grain weight and size, which are affected by climate changes. The properties of outer tissues could contribute to limit grain size. The cell wall composition according to tissues and developmental stages could partly determine the extensibility or stiffness of the outer tissues (Chateigner-Boutin et al., 2018). Multispectral autofluorescence imaging in the UV-Vis domain can be used to follow the evolution of wheat grain outer tissues during development taking advantage of the autofluorescence properties of plant compounds such as lignin and hydroxycinnamic acids (Ghaffari et al., 2019). However, their fluorescence properties largely overlap requiring the use and development of chemometric methods adapted to the analysis of multisets of images.

In the present work, we propose to use multispectral autofluorescence imaging to quantify variations in the cell wall composition of wheat grain outer tissues according to the development stages. Macroscopic imaging was retained to acquire multispectral images of whole grain sections with a pixel size of 1.4 µm. Four filters corresponding to UV and visible excitation conditions allowed the acquisition of 12 channels multispectral images. 8 multispectral images from 5 grains were acquired for 4 development stages. Principal Component Analysis adapted to the analysis of series of large images (Devaux et al., 2017) have been applied to the set of the 32 images.

Loadings and principal component score images revealed the tissue fluorescence variations and their localization in the sections. Component 1 showed a strong visible-induced fluorescence assigned to chlorophyll and mainly observed at the first two development stages. Component 2 described the development of the aleurone layer thanks to the UV fluorescence of the aleurone cell walls. The lignification of the outer layers of wheat grain was revealed in component 4. The analysis of the distribution of pixel scores according to stages quantified the differences between stages by considering the fluorescence spectral differences over the whole sections.

References

Chateigner-Boutin A.-L., Lapierre C. et al. (2018). Ferulate and lignin cross-links increase in cell walls of wheat grain outer layers during late development. Plant Science. 276, 199-207.

Ghaffari M., Chateigner-Boutin A.-L. Et al. (2019), L. Multi-Excitation Hyperspectral Autofluorescence Imaging for the Exploration of Biological Samples. Analytica Chimica Acta , 1062, 47–59.

Devaux M;-F., Barron C. et al. (2017). Autofluorescence variability in maize stems by multispectral image analysis of series of large images at the macroscopic scale. 1st International Plant Spectroscopy Conference 29-30 August 2017, Umeå, Sweden

O22. Dynamic changes in the composition and structure of pectin and its relationship with the storage of strawberry

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Strawberry fruit is extremely perishable. This process is at least partly due to the softening of the cell wall structure related to the high susceptibility of strawberries to bacterial and fungal infections. The study compares the impact of conventional and organic farming systems on pectin structure as well as the composition of strawberry microbiota and mycobiota. During 12 days of cold storage, the enzymatic activity, monosaccharide composition, pectin nanostructure, microbiota and mycobiotic composition were tested. It was shown that the post-harvest processes of strawberry depend on the activity of pectinolytic enzymes. Based on the activity of polygalacturonase, α-L-arabinofuranosidase and β-galactosidase, the fifth day was designated as the day on which fruit rotting begins. The loss of strawberry quality was related to the reorganization of the pectin network structure, which was degraded faster in the fruit grown in the conventional system. The pectin molecules of organic strawberry were longer and more branched compared to conventional strawberry, indicating that organic fruit was more resistant to mechanical damage and rotting processes to which strawberries are exposed during storage. The onset of rotting processes was associated with the activity of pathogenic microorganisms. In the initial period of storage, fungi belonging to *Botrytis* sp. and *Robillarda* sp. (conventional cultivation), *Botrytis* sp. and *Sclerotinia* sp. (organic cultivation) and bacteria of the genus *Acidobacteria* for both cultivation systems were dominated.

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References

Paniagua, C., Santiago-Doménech, N., Kirby, A. R., Gunning, A. P., Morris, V. J., Quesada, M. A., Mercado, J. A. (2017). Structural changes in cell wall pectins during strawberry fruit development. Plant Physiology and Biochemistry, 118, 55-63.

O23. Extrusion-cooking process of food pellets with coffee husk

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The extrusion cooking process is increasingly used in the food industry to produce snack pellets, which have been gaining in popularity over the past few years. It allows the processing of many raw materials from the agri-food industry, as well as wholesome by-products. This results in functional snacks while managing by-products, which is in line with the idea of sustainability. Coffee husk is a raw material characterized by a relatively high protein content of 9.2 - 11.3% and a significant amount of lignins, making it a raw material with high processing potential.
The aim of this study was to obtain food pellets with coffee husks addition (from 0 to 30%) using TS-45 single screw extruder-cooker with L/D=18 plasticizing system configuration and variable process parameters (different screw speed ratio from 60 to 100 rpm and temperature from 80 to 95˚C). As a result of the study, differences in quality characteristics of obtained food pellets were observed depending on the extrusion-cooking process conditions and the amount of the used additive.

Keywords: extrusion-cooking, by-products of the food industry, extruded food pellets, food quality, coffee husk.

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ORAL PRESENTATIONS
SESSION III - MICROBIOME BIODIVERSITY

O24. Taming the plant microbiome for a sustainable agriculture

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Conventional agriculture relies heavily on nutrient inputs that will be taken up directly by the plants as well as massive use of pesticides. In these systems, plants are considered as sole players, disregarding plant traits that can improve the recruitment of beneficial soil microbes for nutrient mobilization and plant protection. As a consequence, conventional practices have resulted in low nutrient use efficiencies, groundwater pollution, biodiversity loss increased and soil erosion to non-sustainable levels. High loads of fertilizers as well as pesticides have made many beneficial soil biota, especially microbes, redundant, and their interactions with the plant have been neglected in breeding strategies.
During my talk I will discuss approaches where we make use of plant microbial interactions to increase the sustainability of agricultural practices. The first approach relies on the identification of microbial interactive traits in plants and their potential use in breeding strategies. For instance, varieties with increased root biomass should be able to recruit beneficial soil microbiota more efficiently than conventional varieties, selected to work alone and on high nutrient availability. The second approach focuses on the direct engineering of soil microbial communities, by making use of ecological principles to improve the survival of beneficial microbes that can lead to the suppression of pathogens or higher nutrient uptake by plants. The combination of these strategies will promote belowground diversity in the soil as well as the ability of plants to recruit beneficial microbes, improving plant and soil resilience to environmental stress factors including changes in climate

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O25. Biological control of potato diseases guided by plant microbiome approaches

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Plant protection against fungal pathogens is a crucial aspect of modern agriculture and mostly relies on chemical inputs. However, phytopathogens often become resistant against conventional fungicides[1]. Additionally, the microbial diversity in agricultural soils decreases through the application of pesticides, fertilizers and the soil tillage[2]. The aim of the ongoing SusCrop – ERA-NET project 'potatoMETAbiome' is to establish a formulation containing four strain microbial consortia, which are applicable for potato cultivation to mediate the resistance against soil-borne fungal pathogens (*Rhizoctonia solani* and *Verticillium dahliae*) and support the microbial diversity in soil.
For the consortium assembly, pre-selected microorganisms from the strain collection for antagonistic microorganisms SCAM (Institute of Environmental Biotechnology, Graz University of Technology) were implemented. The most promising strains were combined to microbial consortia and the best performing consortia were detected via *in vitro* assays and preliminary greenhouse trials. Furthermore, two microbial consortia were successfully applied to the potato breed 'Arkula' infected with *R. solani* AG-3 in a field experiment. Through the application of the microbial consortia a significant decrease of the distinct symptoms of *R. solani* was observed.
The most promising microbial consortium, labelled as 'Patricia', was combined to a formulation with substrates which can act as 'boosters' with the aim of increasing the antifungal effect. Furthermore, the best performing formulation, consisting of consortium 'Patricia' (*Bacillus subtilis*, *Pseudomonas corrugata*, *Pseudomonas putida*, *Serratia fonticola*) and the volatile 2-methyl-1-butanol, was detected via *in vitro* assays and preliminary greenhouse trials. Furthermore, this formulation was tested for production of antifungal volatiles employing GC-MS SPME. Finally, the antifungal effect of this formulation *in vivo* is monitored in ongoing greenhouse and field experiments.

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References

Oerke, E. C. (2006). Crop losses to pests. The Journal of Agricultural Science, 144(*1*), 31 – 43.

Matson et al. (1997). Agricultural Intensification and Ecosystem Properties. Science, 277(*5325*), 504-509.

O26. Prospects of biocontrol of oilseed rape pathogens

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Oilseed rape (*Brassica napus*) is a main source of oil for cold and temperate zones of the world. The main growing regions are located in the North and Central China, Canada Europe and Australia. Both winter and spring forms of the crop suffer from numerous pests and diseases. Pathogens belong mainly to the kingdom of Fungi, but oilseed rape is infected also by oomycetes, protists, phytoplasms and viruses. Many of them can cause economically important diseases which decrease yield quality and quantity. The number of pathogens is high, they can attack the below and above ground part of the plant, starting from the germination till plant senescence, post-harvest processing and storage.

The recent study of the soil microbiome, carried out using New Generation Sequencing methods, greatly helps us to learn about microorganisms accompanying the rhizosphere and phyllosphere of oilseed rape. Many of these microorganisms can serve as farmers' allies and help us combat the pathogens. They can promote plant growth, stimulate plant defense responses, induce systemic resistance and stress tolerance and thus work for the well-being of rapeseed plants. However, until now the number of microorganisms contributing to the welfare of rapeseed plants is much smaller than the number of known pathogens. The most recognised and commercially used is the fungus *Coniothyrium minitans*, a superparasite of *Sclerotinia sclerotiorum*, the cause of stem rot. The bacteria of the *Bacillus subtilis* species contained in the 'Serenade' bioformlation limited the development of *Plasmodiophora brassicae*, the protist causing clubroot. Some strains of *Bacillus amyloliquefaciens* limited the growth and development of a number of pathogens, including *Alternaria brassicae* (dark spot), *Botryotinia fuckeliana* (grey mold), *Verticillium longisporum* (Verticillium wilt) and *Leptosphaeria maculans* (stem canker). Recent studies suggested the potential of the endophytes to control clubroot either introduced directly (*Cladophialospora chaeterospira* or indirectly by their cell wall extracts (*Acremonium alternatum*). The mechanism involves the upregulation of specific host genes playing key roles in jasmonic acid, ethylene and auxin biosynthesis, leading to induced plant resistance. Other health-promoting endophytes include *Aspergillus flavipes, Chaetomium globosum* and *Clonostachys rosea*. The fungi of the genus *Trichoderma* can greatly help in the decomposition of rapeseed straw infested with pathogenic fungi. Volatiles produced by the pathogen *Fusarium oxysporum* limited the growth of other pathogens such as *S. sclerotiorum* and *B. cinerea*. It was also found that the fungi *Alternaria alternata*, *Fusarium tricinctum* and *L. biglobosa* as well as the bacteria *Pseudomonas fluorescens* enhanced the growth of oilseed rape plants. Unfortunately, biofungicides show substantial effect in controlled environment conditions and much smaller effect in real field situations.

O27. Comparison of bacterial communities and their organosulfur utilization in the potato rhizosphere, tuberosphere and bulk soil

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The bacterial communities colonizing the potato rhizosphere have broadly been studied with the aim to improve agricultural productivity. In contrast, few studies have investigated the bacterial communities of the tuberosphere (narrow soil zone surrounding the tubers) and their similarities or differences with the rhizosphere and bulk soil communities. In the present study, we sampled the rhizosphere, tuberosphere and the corresponding bulk soils, of two potato varieties (Kerr's Pink and Rooster) grown in two Irish farms with different physicochemical properties. The structure of the bacterial communities in the three soil compartments, was characterized by 16S rDNA sequencing and their organosulfur utilization, was evaluated using the arylsulfatase activity test and by measuring the population of sulfonate utilizing bacteria with the Most Probable Number (MPN) approach. We didn't observe any statistically significant differences in alpha diversity between the three soil compartments of both varieties. Non-metric Multidimensional Scaling (NMDS) and ANOSIM testing showed that the bacterial communities in the rhizosphere were different from the communities in the tuberosphere and bulk soil. The main phyla present in all samples were Proteobacteria, Firmicutes, Actinobacteriota and Acidobacteriota, but with different relative abundances among the three soil compartments in both varieties. The arylsulfatase activity and the population of sulfonate utilizing bacteria were also influenced by the soil compartment and the highest organosulfur utilization was recorded in the rhizosphere of both varieties. These results suggest that while the rhizosphere and tuberosphere are in close proximity in the soil environment, differences in their nutritional status, act as a selective force that shapes their bacterial communities. Contrary to the tuberosphere, rhizosphere is a nutrient rich environment that actively selects bacteria mediated plant nutrient acquisition, as exemplified by the higher organosulfur utilization in this compartment.

Acknowledgements

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O28. The changes of rhizospheric and endophytic bacterial communities of white mustard during phytoextraction supported by Pseudomonas sp. H15 strain

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Environmental pollution with heavy metals is currently one of the most serious threats to the proper functioning of both soil and water ecosystems. Among the currently used methods for the bioremediation of polluted sites, phytoremediation seems to be the most promising. The phytoextraction of soils contaminated with heavy metals can be supported by introducing selected strains of active microorganisms into the soil (bioaugmentation). In order to fully utilize the potential of the bacteria that exhibit the activity of the biochemical mechanisms that could potentially be useful for supporting plant growth, it is necessary to know the ecological consequences of soil bioaugmentation using these strains. It is believed that significant changes in the structure of the rhizospheric and endophytic microbial communities of plants as a result of soil inoculation with beneficial strains, may be crucial for the success or failure of the microbial-assisted phytoextraction of heavy metals from soil. In this study, the impact of the *Pseudomonas* sp. H15 strain that was introduced into the soil on the bacterial community structure of the white mustard rhizo- and endo-sphere during enhanced phytoextraction was determined. To track the changes in the structure of rhizospheric and endophytic bacterial communities during bacterial-assisted phytoextraction, the next generation sequencing (NGS) was used.
Introducing living cells of the H15 strain into soil planted with white mustard caused different changes in the structure of the rhizosphere and endophytic bacterial communities of the plants compared to the group in which the dead bacterial biomass was used. Furthermore the inoculation of living cells of the H15 strain only caused short-term changes in the structure of the rhizosphere bacterial communities of white mustard. Each of the examined parts of white mustard had its own characteristic endobiome. For example, the leaves contained unique orders of *Bacteroidales*, *Lactobacillales* and *Clostridiales*, which were not observed in the rhizosphere or the other parts of plants. In group treated with bacterial necromass the bacterial DNA, which was released from the dead bacterial biomass, was very rapidly taken up by the plants and transported to the leaves and the sequences of the thermally inactivated strain were detected during sequencing and significantly affected the structure of the examined bacterial communities.
In order to improve the efficacy of the phytoextraction and better understand the interactions between microorganisms and plants during microbial-assisted phytoremediation, the use of molecular methods such as metagenomics, metabolomics and transcriptomics is strongly recommended.

O29. Is an integrated strategy exploiting the application of pre-, pro-, post- and synbiotics suitable for 4.0 agriculture?

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Agriculture 4.0 is a term for the next big trends facing the food industry, including a greater focus on precision agriculture, the internet of things (IoT) and the use of big data to drive business efficiencies in front of rising populations and climate change. Plant beneficial microorganisms (PBM) have been designed and thought to improve crop productivity in view of sustainable agriculture and, currently, also as a tool to mitigate increasing environmental and climate concerns. The emphasis of the scientific activity in the field of PBM is now on developing environmentally friendly and efficient microbial formulations taking into consideration also how introduced microorganisms affect the microbial communities, the specific plant–microorganisms interactions as well as the overall impact on biodiversity. However, it is now becoming clearer that an approach combining pro-, pre- and postbiotics could be applied to better exploit both the characteristics of PBM and those of the existing beneficial soil and plant microorganisms. Using prebiotics, products that can improve microbial diversity by promoting the growth of microorganisms already present within the soil–plant system, together with probiotics, i.e. PBM which present health promoting and nutrient mobilizing properties, can be a strategy that could overcome some of the bottlenecks and limitations currently hampering a wider use of microbial-based products. Moreover, an integrated approach could also foresee the use of synbiotics, organic substances which can provide autochthonous microorganisms with beneficial properties or be additionally inoculated with PBM, as well as the application of postbiotics, metabolic derivatives of PBM which can avoid the risks associated with the application of “alien” microbial cells to the field crops. A review of the different issues related to the use of these kinds of plant and soil biostimulants, the interactions with the plant and crop management methods, as well as some regulatory aspects concerning the marketing and field application of these products will be presented suggesting that these products are fully suitable for the goals of 4.0 Agriculture.

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References

Vassilev N, Malusà E, Neri D and Xu X (2021) Editorial: Plant root interaction with associated microbiomes to improve plant resiliency and crop biodiversity. Front. Plant Sci. 12:715676. doi: 10.3389/fpls.2021.715676

Kowalska J, Tyburski J, Matysiak K, Tylkowski B and Malusá E (2020) Field exploitation of multiple functions of beneficial microorganisms for plant nutrition and protection: real possibility or just a hope? Front. Microbiol. 11:1904. doi: 10.3389/fmicb.2020.01904

O30. Bacterial communities associated with the surface of fresh sweet pepper (*Capsicum annuum*) and their selection as biocontrol agents to minimize postharvest losses

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Fresh produce vegetables are colonized by different bacterial species, some of which are antagonistic to microbes that cause postharvest losses. However, no comprehensive assessment of the diversity and composition of bacteria inhabiting surfaces of fresh pepper plants grown under different conditions has been conducted. In this study, 16S rRNA amplicon sequencing was used to reveal bacterial communities inhabiting the surfaces of red and green pepper (fungicides-treated and non-fungicides-treated) grown under hydroponic and open field conditions. Results revealed that pepper fruit surfaces were dominated by the bacterial phylum *Proteobacteria*, *Firmicutes*, *Actinobacteria*, and, *Bacteroidetes*. The majority of the bacterial operation taxonomic units (97% similarity cut-off) were shared between the two habitats, two treatments, and the two pepper types. Phenotypic predictions (at phylum level) detected a high abundance of potentially pathogenic, biofilm-forming, and stress-tolerant bacteria on samples grown on open soils than those from hydroponic systems. Microbial diversity tended to be higher in the fungicide-treated compared to untreated samples, in the open field compared to the hydroponic system samples, and in the green compared to the red samples. Furthermore, bacterial species of genera mostly classified as fungal antagonists, including; *Acinetobacter*, *Agrobacterium*, and *Burkholderia* were the most abundant on the surfaces. Amplicon sequencing and several microbial functions depicted *Bacillus cereus* strain HRT7.7, *Enterobacter hormaechei* strain SRU4.4, *Paenibacillus polymyxa* strain SRT9.1, and *Serratia marcescens* strain SGT5.3, as potential antagonists of *R. solanacearum* BD 261, a Causative agent of bacterial wilt diseases. The strains exhibited a strong antagonistic pathogens' inhibition *in vitro* by secreting lytic enzymes such as cellulase and protease. The strains further exhibited the capability of solubilizing phosphate and siderophores production, making them good candidates as biocontrol and noble plant growth-promoting (PGP) agents. These results suggest that peppers accommodate substantially different bacterial communities with antagonistic activities on their surfaces, independent of employed agronomic strategies. The beneficial bacterial strains could be important for peppers established on open fields, which seems to be more vulnerable to abiotic and biotic stresses.

Acknowledgments

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References

1. Caporaso J.G. (2010). QIIME allows analysis of high-throughput community sequencing data. Nature Methods, 7, 335-336.
2. Edgar R.C. (2010). Search and clustering orders of magnitude faster than BLAST. Bioinformatics, 26, 2460-2461.
3. Nautiyal C.S. (1999). An efficient microbiological growth medium for screening phosphate-solubilizing microorganisms. FEMS Microbiology Letters, 170, 265-270.
4. Oliveira M., Usall J., Vin˜as I., Anguera, M., Gatius, F. (2010). Microbiological quality of fresh lettuce from organic and conventional production. Food Microbiology, 27, 679-684.
5. Saitou N., Nei M. (1987). The neighborjoining method: A new method for reconstructing phylogenetic trees. Molecular Biology and Evolution, 4, 406-425.

O31. Analysis of the differences in the composition and function of bacterial communities during bioaugmentation of aged petroleum-contaminated soil

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Contamination of soil by petroleum hydrocarbons is a serious global problem. One of the method for cleaning up of polluted environments is bioaugmentation - a technique in which selected microbial strains are introduced into a contaminated environment to increase the rate of pollutant removal. The very important part of bioaugmentation studies is analysis of the changes in the biodiversity and activity of bacterial communities that occur in soil during bioremediation.

Our objective was to study the bacterial community changes that determine enhanced removal of petroleum hydrocarbons from soils subjected to bioaugmentation with the hydrocarbon-degrading strains *Rhodococcus erythropolis* CD 130, CD 167, and their combination. To achieve this, a high-throughput sequencing of the 16S rRNA gene and prediction of the functional composition of the metagenome of the bacterial communities from its 16S rRNA sequences were performed.

The changes in the bacterial community composition were most apparent the day after bacterial inoculation. These changes represented an increase in the percentage abundance of *Rhodococcus* and *Pseudomonas* genera. Surprisingly, members of the *Rhodococcus* genus were not present after day 91. At the end of the experiment, the bacterial communities from the CD 130, CD 167, and control soils had a similar structure. Nevertheless, the composition of the bacteria in the CD 130 + CD 167 soil was still distinct from the control. Metagenomic predictions from the 16S rRNA gene sequences showed that the introduction of bacteria had a significant influence on the predicted pathways on day one. On day 182, differences in the abundance of functional pathways were also detected in the CD 130 and CD 130 + CD 167 soils. Additionally, we observed that on day one, in all bioaugmented soils, the *alkH* gene was mainly contributed by the *Rhodococcus* and *Mycobacterium* genera, whereas in non-treated soil, this gene was contributed only by the *Mycobacterium* genus. Interestingly, from day 91, the *Mycobacterium* genus was the main contributor for the tested genes in all studied soils.

Our results showed that hydrocarbon loss in the analyzed soil resulted from the activity of the autochthonous bacteria. Nevertheless, the observed hydrocarbon degradation occurred due to changes in the composition and functional activity of the indigenous bacteria induced by the introduced strains.

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O32. Endophytes of *Salicornia europaea* L.: diversity, functions and applications

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Salicornia europaea (*herbacea*) L. (Amaranthaceae) is one of the obligatory halophytes that accumulate salt in their tissues and is very popular due to its unique properties and practical application. Halophytes have developed many basic adaptation mechanisms that allow them to grow and develop in areas characterized by high salinity. Secondary mechanisms that can alleviate salt stress in plants under unfavorable conditions may be endophytes associated with them and their unique microbiomes. The close interaction of endophytes and plants can directly influence the properties of the plant host, especially under stressful conditions. The above-mentioned research aspects are studied in detail by the scientists of our team, who chose *S. europaea* as a model species to study the mechanisms of salinity tolerance in terms of its microbiome and the use of endophytes in modern agriculture.

Acknowledgments

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O33. Plant growth-promoting fungal endophytes in non-host plants: a transcriptome view under salt stress

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Microbes such as the "endophytes" inhabit inner parts of the plant and are known to produce metabolites that assist in the host plants development, growth and diversification. But the question arises if they are able to confer these beneficial traits if inoculated in other non-host plant species?

In this study, a non-host grass *Lolium perenne* was inoculated with two plant-growth promoting and salt-tolerant fungal endophytes that are isolated from a halophyte *Salicornia europaea*. *L. perenne* is a popular cool-season grass, one of the major turf and forage species in the world and belongs to the group of moderately salt-tolerant plants. This grass species is also naturally colonized by a clavicipitaceous asexual endophyte *Epichloë* sps which produce alkaloids to deter herbivores and insects. Hence, in this experiment we selected two grass varieties: one *Epichloë* infected and the other *Epichloë* free for fungal inoculation and the plants were subjected to three salinity stress levels ranging from no salt to medium and high salinity.

Our results showed an increase in plant growth and biomass after inoculation of endophytes *Stereum gausapatum* (E1) and *Parasarocladium gamsii* (E2). A higher osmolyte (proline) accumulation was found in the colonized plants. Comparative transcriptome analysis revealed E1 inoculated plants showed higher number of differentially expressed genes compared to E2. In both the grass varieties the effects of endophyte inoculation were observed only in the roots but not in leaves. The gene ontology classification showed genes for transcription factors, secondary metabolism, oxidative stress scavenging, cell wall organization and synthesis, transporters and growth factors that were positively regulated after endophyte inoculation. In conclusion, this study provides an understanding of how non-host plants respond to inoculation with other endophytes and if the native micro-community hinders endophyte colonization and function in their new plant host.

Keywords: fungi, endophyte, halophyte, salinity, ryegrass, salt tolerance

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ORAL PRESENTATIONS
SESSION IV – CLIMATE AND AGRICULTURE

O34. Climate-smart and sustainable agriculture: challenges for research

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Agriculture is facing the challenge of providing food and nutrition for growing population under changing climate while at the same time trying to avoid negative impacts to the environment. Solutions have been sought from various concepts and approaches such as climate-smart agriculture, sustainable agriculture, regenerative agriculture, and organic production. All these concepts, with slightly different emphasis, share the attempt to handle and solve simultaneously occurring, multi-dimensional challenges of agriculture.

Developing agricultural management strategies and policy decisions requires understanding on the impacts of global drivers and agricultural management practices on food production, environment, and livelihood of farmers. Research is needed to define indicators of sustainability impacts and to develop methods for quantifying them at multiple scales, also for ex-ante assessments. The methods need to be robust and based on easily available data, but it is also important that the methods cover the essential interconnections within the systems studies. For cropping systems, process-based crop or agroecosystem models are considered suitable for this purpose, as they can synthesize the scientific knowledge on interactions of crop genotype, environment, and management. Their system descriptions are still limited in many respects and there are major uncertainties in the model results. Such limitations are, for example, models' capacity to describe diversified cropping systems and roots and their growth dynamics. Also, many management practices and their impacts are still weakly covered in the models. The models are still valuable tools for synthesizing the latest understanding and for highlighting needs for further studies.

To adequately support decision making and climate-smart and sustainable management of agro-ecosystems, multi-disciplinary and collaborative research is increasingly important. Model-based ex-ante assessments, when applied in well-designed participatory approach, can effectively support discussions with stakeholders and to help them to make informed decisions.

This talk aims to discuss the challenges and requirement research faces when working on multi-dimensional questions linked to climate-smart and sustainable agriculture, how the model-based approaches can best be used to solve these questions and what are currently their key limitations in this respect.

O35. Water for agriculture in 2050 climate. Threads, challenges, technologies, solutions for Vistula catchment

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The hydrological analysis, performed in the Soil and Water Assessment Tool model for the RCP 4.5 climate change scenario and the average GCM (average of 12 models) (Stocker et al., 2013) indicates a decrease in the annual values of the climatic water balance (CWB) over the entire Vistula catchment area, with the largest decrease expected in central and northern Poland. Despite higher annual rainfall totals, their distribution over time (maximum in winter and minimum in summer) favors rainfall deficiencies in the growing season, while increasing rainfall deficits will be combined with increased field evaporation and intense runoff during heavy rainfall. In all cases, an increased annual runoff is to be expected, due to the accumulation of rainfall over short periods. A significant part of this runoff should be kept in small retention reservoirs. Soil retention alone in conditions of full soil saturation in cold periods will probably not be sufficient to stop more runoff.
The warming climate will further increase evaporation from the earth's surface and will increase the use of water by plants.
The upcoming change in climate in the region of Vistula catchment is will probably induce the change of agricultural practices, shifting from rain-fed to irrigated agriculture, especially as estimated 6t0% of soil cover remains sandy soils with limited water capacity and fast percolation rates.
There are numerous technologies in AgTech branch already suitable for decision support (EIP-AGRI, 2018) in terms of optimizing the use of assets in farming practices, including water use (Wawer et al, 2016). It covers sensors with IoT functionality (Tzounis et al., 2017), smart farm management systems, autonomous systems of control and operation. Upcoming revolution bound to the development of AI and its potential influence of farming models are a big unknown yet.

References

Stocker T.F., Qin D., Plattner G.-K., Tignor M., Allen S.K., Boschung J., Nauels A., Xia Y., Bex V., Midgley P.M. (red.), (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 ss., IPCC, http://www.climatechange2013.org/images/report/WG1AR5_Frontmatter_FINAL.pdf

EIP-AGRI, (2018). Shaping the digital (r)evolution in agriculture. https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/eip-agri_brochure_digital_revolution_2018_en_web.pdf.

Wawer R., Matyka M., Łopatka A., Kozyra J., (2016). Systemy wspomagania decyzji w nawodnieniach upraw rolniczych. ss. 165-182. W: Innowacyjne metody gospodarowania zasobami wody w rolnictwie; Dembek W., Kuś J., Wiatkowski M., Żurek G. (red.), Wyd. CDR w Brwinowie, ISBN: 978-83-88082-18-4, 296 ss.

Tzounis A., Katsoulas N., Bartzanas T., Kittas C., (2017). Internet of Things in agriculture, recent advances and future challenges. Biosystems Engineering, 164: 31-48.

O36. Assessment of crop farming vulnerability to over- wetting effects under climate change in the humid zone of western Russia

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This research is devoted to the problem of sustainable crop production under the conditions of ongoing and forthcoming climate change in the Humid Zone (HZ) – is comprised between: 52-63º N and 28-53º E. With climate change incessant or heavy rains increasingly leads to significant losses in the value of final yields and their quality in this zone. Regarding this, focus is placed on field crops, as they have important food value and are the forage base for dairy farming. Their vulnerability to over- wetting effects is characterized by recurrence of years with the G.T. Selyaninov Hydrothermal Coefficient (HTC) values in July greater than 1.8, 2.5 and 3.5, which correspond to external conditions for the lodging severity. The proposed gradation of precipitation amounts and accumulated air temperatures allowed us to conclude about changing contribution of their anomalies to the occurrence of HTC values greater than 2.5 and 3.5 under ongoing climate change since 1945 to 2017. The comparison of maps with plotted isolines of recurrence of years with severe crop over- wetting effects indicates the expansion of vulnerable areas in a northern direction (north of 58º N) in recent decades. This fact can be explained by the increasing precipitation amounts as a consequence of the intensified advection of moisture-saturated air masses as well as the intensification of convective processes due to an increase in the air temperature. The transient GCMs are being used as an instrument to climate projection for coming decade. Among the models, the latest versions are chosen, the regular grid box of which completely cover the territory under study, namely: MPI – ESM 1-2 – HR, Had GEM3- GC3.1 – LL, EC – Earth3 and Can ESM5. Based on the results obtained from the model runs, the year- to-year change in air temperatures, precipitation totals and the HTC values in July for slice 2021 – 2030 is assessed. Although the simulated estimates somewhat differ, nevertheless all models demonstrate that when the scenario of controlled greenhouse gas emission into the atmosphere is implemented, the northern and waterlogged part of the HZ (north of 60º N) is revealed as most vulnerable to crop over- wetting effects. In the middle part of the HZ, the effects of severe crop over- wetting may occur as well. In conclusion, the set of adaptation measures and strategies is discussed.

Keywords: Humid Zone, crop over- wetting, climate change, vulnerability assessment

References

Nikolaev M.V.(2021). Geospatial assessment of crop farming riskiness under change in climate in the Non – Chernozem Zone of European Russia. Proceedings of 3th Int. Conference *'Agrophysics Trends: from actual challenges in arable farming and crop production towards advanced technologies'*, 14-15 September 2021, St.-Petersburg, Russia (in press).

Nikolaev M.V.(2021). Vulnerability of field crops to over-wetting under climate change in the Non – chernozem Region of European Russia and adaptation options. Journal of the Russian Geographic Society, 153(4), 47-67.

Nikolaev M.V. (2020). Integrated Assessment of Change in Contribution of Excessive Moisture to Farming Risks in the Humid Zone of Western Russia. Meteorology, Hydrology and Water Management, 8(1), 46-53.

Nikolaev M.V.(2018). Assessing the changing contribution of abundant precipitation to farming risks in the Non-Chernozen zone of European Russia. Journal of the Russian Geographic Society, 150 (6), 1-14.

Nikolaev M.V.(2017). Climate monitoring for assessing crop areas vulnerability to over-wetting in the Non-Chernozem zone of European Russia. Journal of the Russian Geographic Society, 149 (5), 4-16.

O37. Factors influencing ammonia emission from urea fertilizers

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Agriculture is the second largest emitter of greenhouse gases (GHGs) after the energy sector, the concentration of which in the atmosphere increases as a result of human activities. Nitrogen is the basic nutrient for plants, contributing to the growth of crops. Improving the efficiency of nitrogen fertilization is a key aspect in large-scale plant production, especially in the context of the lost value due to ammonia and nitrous oxide emissions, connected with leaching of fertilizers. EU legislation also focuses on this issue. The recommendations contained in Directive (EU) 2016/2284 on the reduction of domestic emissions of certain types of atmospheric pollutants were introduced. In accordance with the above-mentioned normative acts, after 2030, urea-based fertilizers with reduced NH_3 emissions by at least 30% will be allowed for use in the EU. Furthermore, presently on the table there is the legislative package “Fit for 55” that will drive EU to at least 55% reduction target for GHG emission and in consequence the agriculture input in this effort is unavoidable.

The cropland and livestock emissions are response for approximately 80% contribution of the total ammonia emissions (Fu et al. 2020). Under real conditions, the amount of ammonia emission from urea fertilizers depends not only on pH, humidity, temperature, soil type and structure, but also on the activity of soil urease, which accelerates the process of urea hydrolysis in soil. It is estimated that in the cycle of enzymatic transformations nitrogen losses from urea-based fertilizers reach up to 50% (Kawakami et al. 2012), depending on climatic and soil conditions, its uptake by plants.

New formulations of urea-based fertilizers containing additives influencing the level of ammonia emission were developed - the ones limiting urolysis were selected on the basis of the available literature. Measurements of ammonia emissions were carried out in 14-day incubation tests with the use of closed dynamic chamber coupled with a portable FTIR gas analyzer. The research confirmed the high effectiveness of the urease inhibitor - NBPT, which, according to literature reports, can reduce ammonia emissions from urea fertilizers by 30-80% (Canteralla et al. 2018).

References

Cantarella H., Otto R., Soares J.R., de Brito Silva A.G. (2018). Agronomic efficiency of NBPT as a urease inhibitor: A review. Journal of Advanced Research, 13, 19-27.

Fu H., Lou Z., Hu S. (2020). A temporal-spatial analysis and future trends of ammonia emissions in China. Science of Total Environment, 731, 138897.

Kawakami E.M., Oosterhuis D.M., Snider J.L., Mozaffari M. (2012). Physiological and yield responses of field-grown cotton to application of urea with the urease inhibitor NBPT and the nitrification inhibitor DCD. European Journal of Agronomy 43: 147-154.

O38. Food electrical properties investigation and application

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Recently, increasing consumer demand for healthier foods has triggered the development of foods made with natural ingredients exhibiting functional properties and providing specific health (Ingle et al., 2017). Foods are a heterogeneous, hygroscopic natural materials that absorb moisture from the environment. Water plays a central role in food research since it affects all material properties relevant to the food quality.
Dielectric properties of various agri-foods and biological materials are finding increasing application, as fast and new technology is adapted for use in their respective industries and research laboratories (Venkatesh, Raghavan, 2005).
Electrical properties are also important at the sustainable control of food preparing and processing. Electrical properties of various agricultural products and food measurement is used to determine different parameters, mainly the moisture content, and also chemical components, germinability of seeds and grains or the resistance of fruits to frost (Khaled et al., 2018, Justicia et al., 2017).
Behaviour of any material in the electric field is unique, because of the unique molecular structure of each material which determine its quality. In case of food products, it is closely related to their commercial and nutritional values. The electrical properties describing each complex material (consisting of various substances mixed in different proportions), may provide information about its quality (Skierucha et al., 2012).

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References

Ingle M. et al. (2017). Nutritional evaluation of cookies enriched with beetroot (*B. vulgaris* L.) powder. International Journal of Current Microbiology and Applied Sciences, 6, 1888-1896.

Justicia M. et al. (2017). Low-frequency characterisation of mesocarp electrical conductivity in different varieties of olives (*Olea europaea* L.). Computers and Electronics in Agriculture, 142, 338-347.

Khaled A.Y. (2018). Development of classification models for basal stem rot (BSR) disease in oil palm using dielectric spectroscopy. Industrial Crops and Products, 124, 99-107.

Skierucha et al. (2012). Dielectric spectroscopy in agrophysics. International Agrophysics, 26, 187-197.

Venkatesh M.S., Raghavan G.S.V. (2005). An overview of dielectric properties measuring techniques. Canadian Biosystems Engineering, 47, 7.15-7.30.

O39. Dielectric spectroscopy of rapeseed

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Knowledge of dielectric properties of grains and seeds is important in the scope of moisture assessment and the optimization of radio and microwave processes like dielectric heat treatment. The determination of broadband dielectric spectra of granular materials requires using appropriate fixtures ensuring large measurement volume or special sample preparation like grinding in order to obtain fine material for measurement by open-ended probes.
The aim of the work is to examine the complex dielectric permittivity spectra of rapeseed with the use of a coaxial transmission line cell operating in the 20 MHz – 3 GHz frequency range. The dimensions of the cell were large enough for direct measurement of the seeds without grinding or any other special treatment. The cell was connected to an R60 vector-network-analyzer from Copper Mountain Technologies and a special electronic calibration unit. Samples of seeds of 10 moisture levels from 8.3% to 16.1% were measured in three repetitions at room temperature. The obtained spectra were analyzed with the use of dielectric models and the relations between dielectric permittivity and moisture content were examined.

References

Bansal N, Dhaliwal A.S, Mann K.S. (2016) Dielectric characterization of rapeseed (Brassica napus L.) from 10 to 3000 MHz. Biosystems Engineering, vol. 143, p. 1-8.

Lewandowski A., Szypłowska A., Wilczek A., Kafarski M., Szerement J., Skierucha W. (2019) One-Port Vector Network Analyzer Characterization of Soil Dielectric Spectrum. IEEE Transactions on Geoscience and Remote Sensing, vol. 57, p. 3661-3676.

O40. A survey of greenhouse gases production in central European lignites

Pytlak, A.[1], Szafranek-Nakonieczna, A. [2], Goraj, W.[2], Śnieżyńska, I.[3], Krążała, A.[3], Banach, A.[2], Ristović, I.[4], Słowakiewicz, M.[3,5], Stępniewska, Z.[6]

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Progressing climate changes force transformations in the energy market. It is estimated that due to a strong negative impact on the environment, the sector related to lignite mining and processing will be closed first. The cessation of exploitation will be related to the need to restore the areas left after the mines, most of which are opencast. It is assumed that most likely, depressions resulting from exploitation will be turned into water bodies (Pytlak et al., 2021). Flooded lignite mines are a potential source of greenhouse gases (GHG) (CH_4, CO_2 and N_2O). In our work, we aimed to recognize GHG release from the lignites collected from the main deposits of Poland, Slovenia and Serbia. GHG production was studied along with a range of physical and chemical parameters that are crucial for microbial growth and activity. The microcosm experiments showed that the main gas emitted from the lignites was carbon dioxide. Daily CO_2 production was highly variable. The highest values were recorded for detroxylitic lignite collected from the Konin deposit (402.05 nmol CO_2 g^{-1} day^{-1}) while the lowest were for the Kolubara xylitic lignite (19.64 nmol CO_2 g^{-1} day^{-1}). Methane production was much lower and ranged from nearly zero to 66.75 nmol g dry $mass^{-1}$ d^{-1}. Nitrous oxide production was not detected. It was found that CO_2 production, being a general measure of microbial activity, was positively affected by NO_3^- concentration and redox potential. With respect to methane formation, the lower atmospheric oxygen exposure of the sample from the Velenje underground mine compared to the samples from the opencast mines has been identified as a possible cause of the high methane production. The overall global warming potential (GWP) of the gases released by xylitic lignite was lowest among the samples. Preferential extraction of the detritic lignites is suggested as a means to reduce GHG emissions from the abandoned lignite mines (Pytlak et al., 2021).

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References

Pytlak A., Szafranek-Nakonieczna A., Goraj W., Śniezyńska I., Krążała A., Banach A., Ristović I., Słowakiewicz M., Stępniewska Z. (2021) A survey of greenhouse gases production in central European lignites. Science of the Total Environment, 149551. https://doi.org/10.1016/J.SCITOTENV.2021.149551.

O41. Fluctuating light as an important factor affecting crop productivity

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As area of croplands is limited, increase in food production must be achieved to meet growing population's requirements. Crop's improvement can be realized by introduction of new cultivars with increased productivity. Light intensity at the surface of crop's leafs is fluctuating at various time scales. Photosynthetic apparatus has to rapidly deal with various light energy to avoid damages caused by excessive light and to maintain photosynthesis at high efficiency even at low light. It was shown (Kromdijk et al. 2016, Grieco et al. 2020) that dynamics of non-photochemical quenching (NPQ) under fluctuating light (FL) are crucial for crops productivity. Acceleration of NPQ relaxation may increase productivity up to 15%. NPQ is an indicator of biochemical processes that allows harmless thermal dissipation. It is based on cooperation of several components: zeaxanthin-dependent component (qZ) related with carotheinoids' transformations, energy-dependent component (qE), characterized by fast reversions triggered by ΔpH and PsbS activity and qI, photoinhibitory quenching component (Malnoë 2018). Induction of NPQ is almost instantaneous, its goal is to rapidly dissipate potentially harmful energy, relaxation of this process takes much longer. During relaxation period, quantum efficiency of photosystem II (PSII) is lowered, but the level of resulting decrease in photosynthesis is yet not well known, especially at conditions typical for crops i.e. prolonged irradiation with FL. Thus the aim of our study was to evaluate impact of FL on functioning of PSII and related impact on photosynthesis. Here we analyzed the response of *Arabidopsis thaliana* wild type (wt) and it's NPQ mutants (npq1 and npq4) exposed to FL (55/530 mmol m^{-2} s^{-1} PAR) in comparison to constant light of similar average intensity (280 mmol m^{-2} s^{-1} PAR), to investigate contribution of various components of NPQ in lacking zeaxanthin and PsbS mutants of *Arabidopsis thaliana* in the dissipating process. In addition, associated impact of FL on CO_2 absorption was evaluated. Our results indicate that dissipation of constant light irradiance differs in term of dynamic with dissipation of FL. We observed significant differences in NPQ in response to FL of mutants lacking zeaxanthin and PsbS. Differentiation was especially clear during initial period of FL irradiation.

References

Kromdijk J., Głowacka K., Leonelli L., Gabilly S.T., Iwai M. Niyogi K.K., Long S.P. (2016). Improveing photosynthesis and crop productivity by accelerating recovery from photoprotection, Plant Science, 354, 857-861

Grieco M., Roustan V., Dermendjiev G., Dermendjiev G., Rantala S., Jain A., Leonardelli M., Neumann K.,Berger V.,Engelmeier D., Bachmann G., Ebersberger I., Aro E-M., Weckwerth W., Teige M. (2020). Adjustment of photosynthetic activity to drought and fluctuating light in wheat. Plant Cell Environ., 43, 1484-1500

Malnoë A. (2018). An intergrative approach of photoinhibition and photoprotection of photosynthesis. Environmental and Experimental Botany, 154, 1-11

O42. Quality assessment needs for soil water content sensors

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Electromagnetic-based water content sensor applications in monitoring networks, irrigation systems and research plots are expanding across the globe. This multi-million-dollar sensor market continues to grow despite a lack in test standards and misinformation about sensor performance. Past sensor assessments have presented mixed testing approaches and a commensurate measure of mixed results. Confusion regarding EM sensor-function, -failure rate and -value, stems from testing results that often use non-standard targets including inhomogeneous (variable density and water content) and complex materials (e.g., soils) that may not be widely available. EM sensors employ a variety of different measurement methods, both in the time- and frequency-domains (Table 1), which also operate at a variety of known or unknown measurement frequencies. Sensor output is affected by environmental impacts on circuitry (temperature) combined with effects of porous medium temperature, electrical conductivity, interfacial polarization and dielectric relaxation, which in many cases combine to increase apparent permittivity measurement error and the resulting inferred water content. Although attempts have been made to standardize testing, more work and research is needed before an international standard can be recognized and adopted.

Table 1. Breakdown of electromagnetic (EM) sensor measurement domain, theoretical basis, measurement method and sensor electrode configuration, i.e., point-scale or soil profile-scale.

	Time-Domain			Frequency-Domain		
Theory	**Ampere's- and Faraday's-Laws (GHz)**			**Gauss's Law (MHz)**		
Measurement Method	Time-Domain Reflectometry (TDR)	Time-Domain Transmissometry (TDT)	Tramission-Line Oscillator (TLO)	Impedance-Based	Frequency-Domain Reflectometry	Capacitance-Based
Point-Scale, Handheld, Mobile	TDR-P	TDT-P	TLO-P	I-P	FDR-P	C-P
Segmented, Soil-Profile	TDR-S	TDT-S	TLO-S	I-S	FDR-S	C-S

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O43. Biophysical modules in the agent based policy models

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Agent based modelling (ABM), as a support for the agricultural policies, proposes a new approach in which each farm is modelled as an autonomous decision-making entity which individually assesses its own context and makes decisions on the basis of its current situation and expectations (Kremmydas et al., 2018). The farm scale policy analysis is receiving increased attention at national and EU levels because it allows to simulate the interactions between individual farms and their context at various geographic scales – from regional to global. ABM can effectively form the policies towards the measures which are the combination of voluntary and compulsory aids related to selected functions of a farm, its environmental performance and capacity to provide ecosystem services.

Biophysical modelling plays an important role in the ABMs because it can provide data on how to determine economically, institutionally and socially achievable landscape configurations that are close to the biophysical optimum. By applying biophysical modelling, it is also possible to analyze different pathways of ecosystem services supply, based on an a defined set of the spatial planning policy interventions (Ohab-Yazdi & Ahmadi, 2018). When creating frames of the biophysical modules within large-scale ABM models some assumptions have to be made concerning spatial dimensions incorporated, farm-environment interactions and feedbacks, data requirements connected to existing data sources, sufficient detail of farm management and agronomic conditions, climate change constraints of agricultural production, etc. (Ruiz-Ramos et al, 2018). These modules should also employ comprehensive sensitivity and uncertainty analysis.

In this study we present the overview of the existing concepts of the biophysical modelling within ABMs and their evaluation in the context of delivering connections with a large set of databases including multiple data sources and geo-referenced datasets. The general concept of the biophysical module within AGRICORE suite will be also presented. AGRICORE project (Agent-based support tool for the development of agricultural policies) was funded in 2019 by the EC and is one of the selected project to address the needs described in the SC2-RUR-04-2018-2019.

Acknowledgments

This study was supported by AGRICORE“ Agent-based support tool for the development of agriculture policies” Horizon 2020 project (Project no. – 816078)

References

Kremmydas D., Athanasiadis I.N., Rozakis S. (2018). A review of Agent Based Modeling for agricultural policy evaluation, Agricultural Systems, 164, 95-106.

Ohab-Yazdi S.A., Ahmadi A. (2018). Using the agent-based model to simulate and evaluate the interaction effects of agent behaviors on groundwater resources, a case study of a sub-basin in the Zayandehroud River basin, Simulation Modelling Practice and Theory, 87, 274-292.

Ruiz-Ramos M., Ferrise R., Rodríguez A., Lorite I.J., Bindi M., Carter T.R., Fronzek S., Palosuo T., Pirttioja N., Baranowski P., Buis S., Cammarano D., Chen Y., Dumont B., Ewert F., Gaiser T., Hlavinka P., Hoffmann H., Höhn J.G., Jurecka F., Kersebaum K.C., Krzyszczak J., Lana M., Mechiche-Alami A., Minet J., Montesino M., Nendel C., Porter J.R., Ruget F., Semenov M.A., Steinmetz Z., Stratonovitch P., Supit I., Tao F., Trnka M., de Wit A., Rötter R.P. (2018). Adaptation response surfaces for 502.571managing wheat under perturbed climate and CO2 in a Mediterranean environment. Agricultural Systems 159, 260-274.

O44. Wireless sensor network for monitoring soil temperature, moisture content and meteorological parameters

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One of the main challenges of smart farming and land management is the rapid collection of a wide set of heterogeneous data on the state of crops, and different soil parameters. In recent years, significant efforts have been made to improve soil measurement and monitoring capabilities using various wireless sensor networks (WSN) (Abbasi et al., 2014).
To obtain real time information about soil moisture and temperature, humidity and temperature, precipitation etc. a wireless system was developed. The proposed system includes nodes equipped with sensors deployed in agriculture field and a local coordinator (agrometeorological station) for collecting soil and environmental data.
The hardware and software architecture for a flexible sensor node platform was developed to minimize the node power consumption for ensuring WSN autonomy. The sensor node includes: a five-channel or two-channel capacitance sensors deployed on different depth level i.e. 10, 20, 30, 50 and 100 cm (Blokhin et al., 2019).
The optimization of energy consumption is crucial in WSN applications for agriculture since usually the nodes are distributed in remote areas where the maintenance for changing or recharging the batteries is difficult (Estrada-López, et al., 2018). The data processing, storage and control unit of sensor node based on MicroConverter ADUC485 (Analog Devices, United States) which processes all the information, manipulates the peripherals and regulate the activation/deactivation of each employed sensor node (for obtaining energy saving). The sensor nodes wake up to collect and transmit data within a certain period (2-3 min per hour) and then return to sleep mode to conserve energy. Collected data stored at the MicroConverter internal memory and transmitting data using the ETRX357HR-LRS ZigBee module to local coordinator to meet the requirement on coverage performance for a certain period of time. The data packet is transmitted by ZigBee module to the network local coordinator with average speed 200 kbps up to a distance of one kilometer. ZigBee module analyzes the communication quality information and automatically select the most appropriate node in WSN for data collection. Experimental results obtained in the lab and on the field corroborate the system's performance and reliability.

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References

Abbasi, A. Z., Islam, N., & Shaikh, Z. A. (2014). A review of wireless sensors and networks' applications in agriculture. Computer Standards & Interfaces, 36(2), 263–270.

Blokhin Yu. I., Belov A. V., Blokhina S. Yu. (2019). Integrated system for control of soil moisture and local weather conditions for remote sensing data interpretation, Sovremennye problemy distantsionnogo zondirovaniya Zemli iz kosmosa, 16(3), 87–95.

Estrada-López, J.J.; Castillo-Atoche, A.A.; Vázquez-Castillo, J.; Sánchez-Sinencio, E. (2018). Smart Soil Parameters Estimation System Using an Autonomous Wireless Sensor Network with Dynamic Power Management Strategy. IEEE Sens. J., 18, 8913–8923.

O45. QTL analysis of morphological traits in the populations of doubled haploids of *Brassica rapa* L. under light culture conditions

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The genus *Brassica* (Cabbage) includes many economically valuable vegetable crops. Mapping populations of double haploids (DH) have been successfully used to study quantitative traits, including in *Brassica* [1, 2]. The purpose of this work is to identify and map the quantitative traits loci (QTL) responsible for the manifestation of morphological traits of quality of two *B. rapa* L. mapping populations DH-lines under light culture conditions.

Two mapping populations [3] were grown with modeling of short-light and long-light photoperiods – 12-hour and 16-hour illumination, other parameters were maintained at an optimal level [4].

A high degree of variation in the manifestation of the studied traits was shown between lines within a population and between plants within a line. The significant effect of long light hours on the acceleration of the transition to flowering has been shown. Identified and localized on the QTL linkage groups of such quality traits as length, width, color, pubescence, the nature of the surface of the leaf blade, length and width of the petiole, which determine the nutritional value of this plant species. It was confirmed that the formation of a complex quantitative trait is usually controlled by several QTLs located in different linkage groups [5]. In general, in populations of double haploid lines, QTL a complex of traits (the time of transition to flowering, the size of the plant and its productive organs – the petiole and leaf blade), are mainly found in the second, sixth and ninth linkage groups.

The percentage of phenotypic variability determined by the mapped QTLs has been established, which makes it possible to carry out molecular genetic screening of the collection samples for these economically valuable traits. The data obtained can be used in genetic selection work, including for breeding genotypes, lines, and varieties adapted for growing in light culture.

References

Collard B. C. Y., Jahufer M. Z. Z., Brouwer J.B. et al. (2005). An introduction to markers, quantitative trait loci (QTL) mapping and marker-assisted selection for crop improvement: the basic concepts. Euphytica, 1 (142), 169-196.

Artemyeva A. M., Solovyeva A. E., Kocherina N. V. et al. (2012). DNA marked lines of double haploids *Brassica rapa* L. and identified QTLs that control economically valuable traits for use in breeding cabbage foliage crops. Catalog of the world collection of VIR, 810, 174.

Lou P., Zhao J., Kim J. S. et al. (2007). Quantitative trait loci for flowering time and morphological traits in multiple populations of *Brassica rapa*. Journal of Experimental Botany, 14 (58), 4005-4016.

Egorova K. V., Sinyavina N. G., Kochetov A. A., Chesnokov Yu.V. (2020). Assessment of selectively significant morphological traits in the population of doubled haploids *Brassica rapa* L. under controlled conditions of a regulated agroecosystem. Vegetables crops of Russia, 4, 28-31.

Artemyeva A. M., Solovyeva A. E., Kocherina N .V. et al. (2016). Mapping of chromosomal loci that determine the manifestation of morphological and biochemical traits of quality in cultures of the species *Brassica rapa* L. Plant Physiology, 2 (63), 275-289.

POSTER PRESENTATIONS

P1. Potting media and seed pre-sowing treatments influenced emergence and early seedling growth of bitter kola (Garcinia kola Heckel) under humidity chamber environment

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Despite the enormous socioeconomic and therapeutic potentials of bitter kola (*Garcinia kola* Heckel), organized cultivation of the species is still very rare, owing to scarcity of the seedlings predicated on seed dormancy challenges. The present study aims to develop a workable protocol for seed germination of bitter kola using four growth media [ricehusk (RH), sawdust (SD), river sand (RS), and a soilless medium RH_3:PM_2:SD_1 formulated in volume ratios of RH, poultry manure (PM), and SD]; and five seed pre-sowing treatments [seed decortication by coat removal, soaking seeds in water for 24h, 48h, or 72h; plus the untreated control seeds]. Seedling emergence and early growth of bitter kola were studied across the treatments under humidity growth chamber in a Completely Randomized Design replicated in three baskets containing 10 seeds each. Results showed that seedling emergence was earliest in RH_3:PM_2:SD_1 (69 days) and RS (74 days), followed by SD (81 days), and latest in RH (104 days). Percentage emergence was high and statistically similar in RS (95.3%), SD (90.0%) and RH_3:PM_2:SD_1 (86.8%), but poor (55.9%) in RH. The earliest days (49.3) to seedling emergence were recorded in decorticated seeds sown in RS medium. Decorticated seeds with the 48h and 72h pre-soaked seeds recorded 100% emergence in RS. Decorticated seeds also had 100% emergence in SD and RH_3:PM_2:SD_1. Seeds pre-soaked for 48 or 72 h and raised in RS produced the tallest seedlings. Across the seed treatments, seed decortication, and the 48 and 72 h soaking durations produced seedlings with the highest number of leaves. Similarly, RS, SD and the soilless medium RH_3:PM_2:SD_1 produced seedlings with greater number of leaves compared to the RH medium. For prompt germination of bitter kola seeds with vigorous seedling growth, seed decortication or soaking for 48 – 72 h are the recommended pre-sowing treatments. As regards the potting media, river sand gave the best results (in terms of emergence and seedling growth); however, sawdust and the soilless nursery mix (RH_3:PM_2:SD_1) are equally good for raising bitter kola seedlings under a warm humidity growth chamber.

Keywords: *Garcinia kola*, dormancy, seed treatment, seedling emergence, juvenile growth, nursery media, controlled environment.

P2. New method for quantifying water stability of soil aggregates from air bubbling after immersion

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Water stability of aggregates is crucial to understand vast majority soil agricultural and geotechnical properties important for roads and building construction, tillage, erosion, compaction, aeration, water and solute transport, roots penetration and many others (Amezketa 1999, Rabot et al. 2018, Six et al. 2000). Many methods established long time ago are still being used for testing water stability of aggregates as e.g. wet sieving, slaking loss, destruction under falling water droplets or destruction in water (Almajmaie et al. 2017, Nweke and Nnabude 2014). All these methods describe rather a result of the aggregates destruction, mostly at arbitrarily defined conditions and not the process itself.
Therefore, a new quantitative method for testing the water stability of soil aggregates was developed. This method allowed for direct registration of the destruction mechanism and calculation of the kinetic parameters of this process. It is based on monitoring of air bubbling after aggregate immersion by recording a decrease in buoyancy of the aggregate during air evolution. Due to the fact that natural soil aggregates are highly heterogeneous, the research was carried out on model soil aggregates characterized by a high degree of homogeneity. This enabled the quantitative characterization of the stability of soil aggregates, while eliminating structure artifacts occurring in natural systems. The developed method makes it possible to find clear differences in the water stability of different soils and is also applicable to natural soil aggregates.

Acknowledgments

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References

Amezketa E. (1999). Soil aggregate stability: A review. Journal of Sustainable Agriculture, 14, 83-151.

Almajmaie A., Hardie M., Acuna T., Birch C. (2017). Evaluation of methods for determining soil aggregate stability. Soil and tillage research, 167, 39-45.

Nweke I.A., Nnabude P.C. (2014). Aggregate size distribution and stability of aggregate fractions of fallow and cultivated soils. Journal of Experimental Biology and Agricultural Sciences, 1, 514-520.

Rabot E., Wiesmeier M., Schluter S., Vogel H.J. (2018). Soil structure as an indicator of soil functions: A review. Geoderma, 314, 122-137.

Six J., Elliott E., Paustian K. (2000). Soil structure and soil organic matter: II. A normalized stability index and the effect of mineralogy. Soil Science Society of America Journal, 64, 1042-1049.

P3. Sorption capacity of exopolysaccharide synthesized by *Parachlorella kessleri*

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Nowadays, natural sorbents are increasingly being used to remove heavy metals from aqueous solutions. Among the biomaterials used in this process are biochar and agro-food processing waste. Microorganisms and products of their metabolism - exopolysaccharides - are also promising materials.
Exopolysaccharides are molecules with a complex structure. They have a number of functional groups, including carboxyl, hydroxyl, carbonyl, methylene, amine and phosphate groups, which may be involved in heavy metal sorption. The main sources of carboxyl groups in EPS are uronic acids and proteins. Therefore, determination of these components can help to assess the sorption capacity of exopolysaccharides.
The sorption of cadmium and lead ions was analyzed in this study. EPS samples were dissolved in a salt solution of cadmium and lead at concentrations of 10, 50, 100, and 150 mg L^{-1}. The final EPS concentration in the prepared sample was 100 mg L^{-1}. The solutions were agitated for 30 min, centrifuged, and filtered. The filtrate was used to determine the concentration of metal ions unbound by EPS. Based on the results, the sorption capacity was calculated. To identify the functional groups involved in the EPS-metal interaction, the centrifuged sediment was lyophilized and FTIR analysis was performed. Then, the content of total sugars, proteins, and uronic acids in the studied EPS was determined.
The results showed that EPS exhibited higher sorption capacity towards lead ions. The highest value was recorded in the presence of Pb(II) at a concentration of 100 mg L^{-1}. The analysis of FTIR spectra showed that mainly carboxyl, carbonyl, and hydroxyl groups are involved in the metal–EPS interaction.

References

Babiak,W.; Krzemińska, I. (2021) Extracellular Polymeric Substances (EPS) as Microalgal Bioproducts: A Review of Factors Affecting EPS Synthesis and Application in Flocculation Processes. Energies, 14, 4007.

Dobrowolski, R.; Szcześ, A.; Czemierska, M.; Jarosz-Wikołazka, A. (2017) Studies of cadmium(II), lead(II), nickel(II), cobalt(II) and chromium(VI) sorption on extracellular polymeric substances produced by *Rhodococcus opacus* and *Rhodococcus rhodochrous*. Bioresour. Technol., 225, 113–120

P4. Impact of steppe plowing on small mammal diversity

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In natural ecosystems, the diversity of small mammal species is determined by their trophic relationships and topical characteristics. Most species of small mammals are not inclined to migrate long distances. However, when conditions are favorable, thanks to their short life cycle, they reproduce quickly and spread to suitable nearby territories. Small mammals are very sensitive to habitat disturbances, which makes them good indicators of such disturbances and makes it possible to use them in monitoring studies.
Indicators of biodiversity are used to assess the degree of influence of negative factors on the environment. As a rule, when comparing these indicators, they are based on data on diversity in the conditions of natural landscapes of a certain type. The research was conducted in the south of Ukraine in the steppe zone (Mykolaiv and Kherson regions). The research covered both agricultural lands and territories of regional natural parks with preserved areas of steppe. Both diversity of small mammal species and density of their populations were evaluated. The results obtained were analyzed using various biocenotic and informative indices. For example, the Shannon index revealed considerable differences in the level of diversity in agrolandscapes and control areas (natural landscapes) (Fig. 1). It should be noted that the amplitude of the index values on each of the habitat types was quite significant (Fig. 1A). However, when considering the data averaged over the habitat types, we observe a pronounced tendency for the diversity to decrease towards the fields (Fig. 1B). The Shannon index often reached critically low values in the fields.

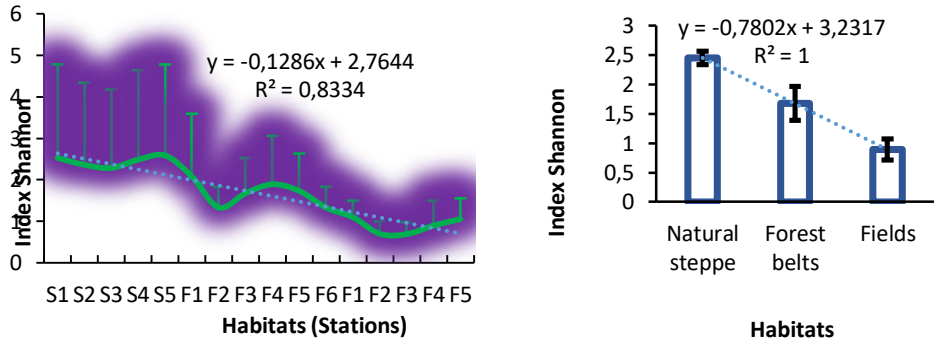

Figure 1. Shannon index value at the studied stations in the steppe zone of Ukraine. Designation of habitats (stations): S (1-5) – steppe, F (1-7) – forest belts, F (1-7) – fields.

P5. Topsoil amended with rice husk and supplemented with combination of organic and inorganic fertilizers influenced growth and yield of three genotypes of Carrot (*Daucus carota* L.) in pot

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Cultivable agricultural land is inadequate in cities and peri-urban. Container gardening portends excellent prospect for farming in such areas. Thus, topsoil supplemented with 30% by volume of rice husk was utilized as growth medium in 10-liter container. Three carrot genotypes (Safety Touchon France, Carotte Touchon AM and Carotte Touchon ETS) were evaluated in response to organic and inorganic fertilizer combinations (0, 20 t/ha poultry manure, 20 t/ha pig manure, 10 t/ha poultry manure + 200kg/ha NPK 15:15:15, 10t/ha pig manure + 200kg/ha NPK 15:15:15). The experiment was a 3 x 5 Split plot laid out in a Completely Randomized Design and replicated six times. Data collected on percent emergence, emergence quantity and quality, yield and yield components were subjected to analysis of variance. Results revealed that application of 20t/ha pig manure and usage of seeds of Safety Touchon France genotype had the highest seedling emergence across the days of evaluation. However, all yield components except root uniformity index, number of sorting group and harvest index, had highest values when 20t/ha poultry manure was applied. The genotype, Safety Touchon France, had the highest whole plant biomass yield, root yield, root uniformity, number of marketable roots, and percent marketable yield. Whole plant biomass yield and root yield were highest in Carotte Touchon AM that were grown with 20t/ha poultry manure. Experiment outcome supports recommending container planting for carrot.

Key words: Carrot, Containerization, Yield, Fertilizers, Genotype

P6. Optimizing water use for small plot organic fruit and vegetable production in the Palouse

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The establishment of small-scale irrigated farming such as in urban reclamation or heavily disturbed soils poses significant challenges that are often magnified by the inexperience of enthusiastic beginning farmers. We established a demonstration site near Moscow, ID with the intent of developing an irrigation prescription adaptable to regional farms. We estimated soil hydrology. We measured co-located bulk density (ρ_b) and quasi-saturated hydraulic conductivity (K_{fs}) paired with spatiotemporal data of electrical conductivity (ECa) and soil volumetric water content (θ_v) to evaluate irrigation effectiveness in a highly variable site. K_{fs} values ranged from near zero cm/hr in highly compacted sites, such as roadways, to over 200 cm/hr in less utilized areas. Bulk density values sampled from selected irrigation zones ranged from 1.1 g/cm^3 to 1.7 g/cm^3 with the average value of 1.4 g/cm^3. Preliminary volumetric water content results have shown a general negative trend with average values for 10cm and 30cm depths to be 0.25 cm^3/cm^3 and 0.26 cm^3/cm^3, respectively. Lastly, our electrical conductivity results reflected greatest variation within two irrigation zones. Data is still being collected to determine correlations between irrigation, water retention, and EC. The site selected for this study is not only representative to the Palouse region, but also due to its varied land use history, is an opportunity to monitor the effects of agricultural reclamation of urban landscapes. Understanding the effects of irrigation will enable local producers to maximize their vegetable or fruit production while limiting excessive water use.

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P7. Effects of fish cultivation on the trophic state of Staw Kardynalski reservoir

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Staw Kardynalski (104 ha), part of fish farm "Ślesin" (CGFP Sp. z o.o.) is used for cultivation of carp monoculture. The pond is feed by river water via Bydgoski Canal, and periodically desiccated for the winter time. Due to high trophy of the pond we started a project to evaluate its current state in terms of selected physico-chemical parameters. Canal water was characterized by slightly alkaline reaction, high EC (ca 2 mS/cm), rich in inorganic fractions of dissolved carbon (IC 25-54 mg/L) and poor in organic C fraction (TOC 7 mg/L). It was noted, however, that during the year the pool of TOC increased over the year to 37 mg/L. EC of sediments was mostly <500 µS/cm. The levels of TOC varied depending on sampling points (1 to 66%), while IC fraction was much lower (0-17%). The reaction of pond's water was alkaline (>8) in spring, followed by a gradual lowering in other seasons. pH of sediments was slightly alkaline except winter (water drown) when the symptoms of acidification were noted. Canal water was nutrient-poor (< 1 mg/l) with the exception of nitrates (V) which concentrations where very high (6.7 mg/l) after one year of monitoring. We recorded the highest peaks of nitrogen forms in sediments during summer indicating strong eutrophication. For phosphates high peaks were noted in various seasons indicating high pool of available P. Due to Ca addition, we recorded high Ca levels in sediments and water, especially at the end of the season. We have found that biogeochemical processes of main nutrients and related elements underwent seasonal fluctuations related to the way of reservoir usage more than effects of feeding water. Due to carp introduction together with its feeding and Ca addition the nutrient levels in surface water increased over the vegetation period. As a result water become turbid with high density of phytoplankton, the absence of floating macrophytes and high abundance of *Phragmites* sp. These conditions may be good for carp production, however, additional measures may be required to improve the ecological status of the pond.

Acknowledgments

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References

Karp Nakielski. CGFP Fish Farm "Ślesin". https://karpnakielski.pl/o-gospodarstwie/

P8. Macroaggregate stability investigation of some Hungarian soils

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Soil structure is an important feature influencing the soil hydrophysical properties. There is no accurately objective or generally applicable method to measure and describe the soil structure. It is a characteristically complex property the components that make up the aggregates are also different in size, shape and chemical composition. In addition to the coupling mechanisms of the hierarchical organization of soil aggregates (fine primary particles, micro- and macroaggregates) are different. Furthermore soil structure dynamically changes due to various internal and external reasons. There are numerous methods of soil structure characterization. One group of them investigates the persistence of soil structure under destructive forces. Aggregate stability indicates mechanical stability of soil. Most frequently the destructive action of water is measured with wet sieving or simulated rainfall. In an ongoing research characteristic Hungarian soils were sampled for soil structural and hydrophysical study. In this survey we investigated the macroaggregate stability (MaAS) of samples originated from the horizons of 30 Hungarian soil profiles, and its correlation with different soil physical and chemical parameters. We also took into account land use. Aggregate stability was determined by wet sieving method (Eijkelkamp device).
We found good correlation between aggregate stability and humus and Calcium content. While adsorbed Sodium content had a negative effect on the aggregate stability. There were great differences in the stability of topsoils and subsoils, as the most important determinant of macroaggregate stability was soil organic matter content. Grassland topsoil horizons showed larger aggregate stability than croplands.

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P9. CO2 emission from soils amended with different types of biochar

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Intensive use of soil for food production and depletion of soil organic matter is a global concern as soil C sequestration potential becomes limited and the contribution of agricultural soils to the global CO_2 emission is increasing rapidly over past few decades. In agricultural soils, soil organic matter conservation by reduced tillage practices, application of organic fertilizers and cover crops seems to be an efficient strategies for increasing soil C stocks. However this strategies might not be enough for the future predictions of CO_2 emission and it is necessary to develop new soil management strategies for reducing CO_2 emissions from agricultural soils. Application of raw biomass e.g. crop residues is not beneficial in long-term C sequestration, however thermal conversion of this biomass to highly stable and recalcitrant forms of carbon like biochar might be a good solution (Jung et al., 2019). For many researchers biochar offers significant tool to reduce CO_2 and GHG emission from soil. Biochar improves soil quality by soil C sequestration but is also able to capture CO_2 from atmosphere becoming an C sink (Dissanayake et al., 2020). However there is a knowledge gap how the initial properties of biochar impact the CO_2 emission, as there is a clear evidence that biochar can become a source of C for microbes in soil modifying soil microbial activity and C turnover. In the study six biochars derived from different feedstocks (pine wood chips, cereal straw, green grass, kitchen wastes, coffee grounds and sunflower husks) were applied to two soil types (sandy and loamy) and emission of CO_2 was measured. Soils with biochar were incubated under controlled conditions of light and temperature in glass jars equipped with rubber valves for gas collection. CO_2 concentration was measured with gas detector Alter GasHunter II after 1,5,10,20,30,40,50,60,70 days from biochar application and fluxes of CO_2 were estimated. Biochar application caused an significant increase of CO_2 emission in the first 10-14 days of the experiment compared with unamended soils. The highest CO_2 concentrations were measured in variants with kitchen wastes and coffee grounds biochars, the lowest for high lignocellulose materials like sunflower husks and pine wood chips biochar. Application of biochar to sandy soil caused more significant increases of CO_2 emission compared with loamy soil. The results of the study show that feedstock origin and the chemical composition of biochars derived from different waste biomass is an important factor when considering biochar potential for carbon sequestration in soil.

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References

Dissanayake P.D., You S., Igalavithana A.D., Xia Y., Bhatnagar A., Gupta S., Kua H.W., Kim S.,Kwon J.-H., Tsang D., Ok Y.S., (2020). Biochar-based adsorbents for carbon dioxide capture: A critical review.
Renewable and Sustainable Energy Reviews 119, 109582.

Jung S., Park, Y.-K., Kwon, E.E., 2019. Strategic use of biochar for CO_2 capture and sequestration. Journal of CO2 Utilization 32, 128–139.

Zimmerman A., Gao B., Ahn M., (2011). Positive and negative carbon mineralization priming effects among a variety of biochar-amended soils. Soil Biology and Biochemistry 43, 1169- 1179.

P10. Moisture meter for fiber flax straw

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Fibre flax is a waste-free crop because a wide range of products is produced from flax raw materials (flax fiber, seeds) and its waste (flax straw, shive). During flax harvesting, it is important to preserve the flax yield without losing and deteriorating quality properties. Fibre flax harvesting technology depends on different factors, such as the method of flax retting, the method of flax straw primary processing, the requirements for flax raw materials, and the weather conditions (Rostovtsev et al., 2020).

The quality of fibers obtained is dependent on the quality of the straw, which in turn is dependent on the duration of field drying process and variations of the moisture content in the straw swathes. The moisture content of the raw material is therefore, of special importance, as it is one of the properties that determine the selection of the raw material for a specific end-use product. In this regard, the monitoring and measuring of moisture content is critical operation (Dudarev I., 2020).

A device with a capacitance probe and oscillatory-type two-component complex permittivity transducer for simultaneous measuring moisture content and complex dielectric permittivity has been developed (Figure 1). When the probe pierces the fibre flax straw or bale the penetration resistance is determined by the built-in strain gauge with adjustment for the density variation of the measured material. It was shown that determined in laboratory moisture contents were in sufficiently good agreement with experimental data obtained under field conditions. A moisture meter directly measures the fibre flax, hay or hemp moisture in the field, collect and process data using a microcomputer, and display measured results with modern user-friendly interface.

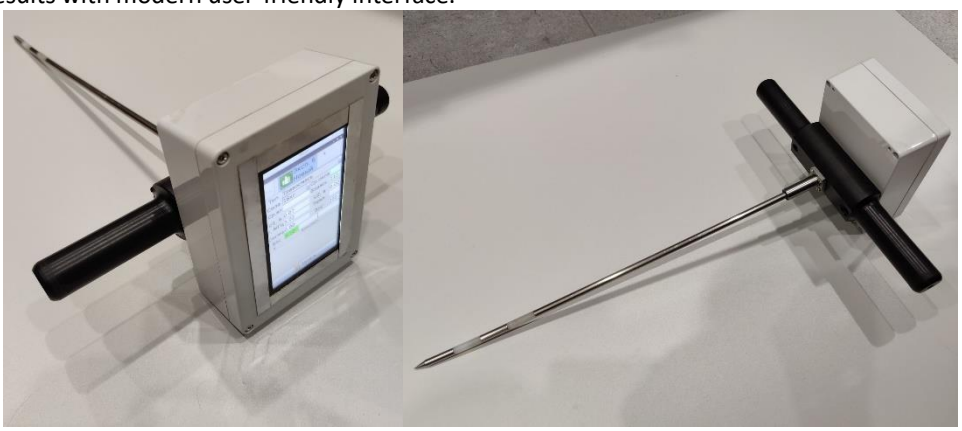

Figure 1. Fiber flax Moisture meter.

References

Rostovtsev R.A., Chernikov V.G., Ushchapovsky I.V., Popov R.A. (2020). The main problems of scientific support of flax GROWING Agricultural Machinery and Technologies, 14 (3), 45-52.

Dudarev I. (2020) A Review of Fibre Flax Harvesting: Conditions, Technologies, Processes and Machines, Journal of Natural Fibers. DOI: 10.1080/15440478.2020.1863296

P11. Nutraceutical, physical and organoleptic properties of wheat pasta fortified with parsley leaf powder

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The aim of the study was to evaluate nutraceutical, physical and organoleptic properties of durum wheat pasta fortified with parsley leaf powder (PLP). Varying levels of PLP (2.5, 5.0, 7.5, and 10.0%) were incorporated for development of fortified pasta and their effect on nutraceutical properties (total phenolic content and antioxidant activity), cooking quality (optimum cooking time water absorption capacity, cooking loss), texture (hardness, adhesiveness, extensibility at break, elongation at break), color and organoleptic attributes was assessed. The results showed that the amount of phenolic compounds increased significantly in the fortified pasta with the increase of the fortification level. Furthermore, the increase of these bioactive compounds in fortified pasta was accompanied by an increase of its antiradical ability and its reducing power. Moreover, the addition of PLP in pasta significantly reduced optimum cooking time, hardness, extensibility at break, elongation at break, lightness and yellowness. In contrast, the incorporation of PLP in pasta significantly increased water absorption capacity, cooking loss, adhesiveness and greenness. As regard organoleptic evaluation, all fortified pasta received acceptable scores in overall acceptability. Approximately 93% of the data variance was explained by the first two principal components PC1 (76.84%) and PC2 (16.72%) and significant correlations were noted between different properties of pasta. PLP can successfully be used (up to 5.0%) in nutritionally valuable pasta formulations.

P12. Effect of soil moisture on greenhouse gas emissions in strawberry cultivation

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Key words: soil moisture, gas emission, strawberry cultivation

The soil environment is an extremely important and often overlooked gas emitter. The conducted research was aimed at assessing the impact of soil moisture on the composition of soil air and the potential amount of greenhouse gas emissions from soil in strawberry cultivation (*Fragaria ananassa* Duch.).
The experiment was carried out in completely randomized design with one factor in ten replications. The research was carried out in the vegetation hall of the West Pomeranian University of Technology in Szczecin. Strawberries of the cv. Grandarosa were grown in optimal soil moisture conditions (ψW = -10 kPa) and conditions of water deficiency in the substrate (ψW = -45 kPa). A peat substrate was used for cultivation. Five gas emissions were measured in the research: ammonia, dinitrogen oxide, carbon dioxide, methane and water vapor. The gas concentration in the closed chamber was measured with an INNOVA 1412 field trace gas analyzer. Gas concentrations were recorded after 10 minutes of measurement. The obtained results were subjected to univariate analysis of variance. The significance of differences between the means was determined using Duncan's test, with the significance level of α=0.05.
In the conducted research, the humidity conditions had no effect on the emission of ammonia and nitrous oxide. Different moisture content in the substrate influence the amount of methane. Higher emission was found in dry conditions than in optimal moisture. Significantly greater amount of carbon dioxide was determined in the substrate with optimal moisture than in the substrate with drought stress. The concentration of water vapor ranged from 2.20% (in optimal substrate moisture) to 2.53% (substrate with water deficiency), and the difference between the means was statistically significant. According to many authors, coal mineralized from organic matter is the main factor influencing methane emissions. Even in poorly drained soils, CH_4 emissions are considered negligible. Many scientific publications have confirmed the effect of soil moistening and microbial activity on the increased release of CO_2. The increased concentration of carbon dioxide may also be caused by the greater weight of the roots of plants grown under optimal conditions.

References

Borken W., Xu Y.J., Brumme, R., Lamersdorf N. (1999). A climate change scenario for carbon dioxide and dissolved organic carbon fluxes from a temperate forest soil drought and rewetting effects. Soil Science Society of America Journal, 63, 1848-1855
Casals P., Romanya J., Cortina J., Bottner P., Couteaux M.M., Vallejo V.R. (2000). CO2 efflux from a Mediterranean semi-arid forest soil. I. Seasonality and effects of stoniness. Biogeochemistry, 48, 261–281
Oertel C., Matschullat J., Zurba K., Zimmermann F., Erasmi St. (2016). Greenhouse gas emissions from soils – a review. Geochemistry, 76, 327-352
Rastogi M., Singh S., Pathak H. (2002). Emission of carbon dioxide from soil. Current science, 82, 511-512
Thangarajan R., Bolan N.S., Tian G., Naidu R., Kunhikrishnan A. (2013). Role of organic amendment application on greenhouse gas emission from soil. Science of the Total Environment, 465, 72-96

P13. Green complexing agent - citric acid in the adsorption process

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Citric acid is a natural organic acid that has been known for a long time. It is ubiquitous in nature: large amounts can be found in plants, especially citrus fruits, and in living organisms. It acts as an intermediary in aerobic metabolism in the Krebs cycle in which it is isomerized to isocitric acid [1]. Generally it is regarded to be safe as approved by the Joint Food and Agriculture Organization and World Health Organization Expert Committee on Food Additives [2]. Citric acid is obtained from many sources, commercially by mycological fermentation using *Candida spp.* or by the solvent extraction process from the *Aspergillus niger* fermentation solution. Citric acid and its salt are used in many industrial fields, incl. the food, pharmaceutical and cosmetic industries as well as the chemical industry, due to the ability to form thermodynamically stable complexes with many metal ions, from alkali metals, through heavy metals, to lanthanides [3]. Its next great advantage is high biodegradability. These properties of citric acid become the basis for its use as a biodegradable and safe complexing agent in the metal adsorption process, which could be an alternative to the currently used synthetic compounds, such as EDTA (ethylenediaminetetraacetic acid) or DTPA (diethylenetriaminepentaacetic acid) which are characterized by poor biodegradability. The aim of this study was to evaluate the effect of citric acid on the adsorption process of rare earth elements (REE) representatives on selected adsorbents. In order to optimize the process, the influence of the REE(III): citric acid molar ratio, initial solution pH, phase contact time and initial concentration were studied using the batch technique. The kinetic parameters were determined using the pseudo-first order (PFO), pseudo-second order (PSO) and intraparticle diffusion models. The equations of Langmuir, Freundlich and Temkin isotherms were applied to determine the isotherm parameters. The desorption studies were also carried out to evaluate the regeneration abilities of the adsorbents.

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References

Dakanali M., Kefalas E.T., Raptopoulou C.P., Terzis A., Mavromoustakos T., Salifoglou A. (2003). Synthesis and spectroscopic and structural studies of a new cadmium(II)-citrate aqueous complex. Potential relevance to cadmium(II)-citrate speciation and links to cadmium toxicity. Inorganic Chemistry, 42, 2531–2537.

Soccol C.R., Vandenberghe L.P.S., Rodrigues C., Pandey A. (2006). New perspectives for citric acid production and application. Food Technology and Biotechnology, 44, 141–149.

Dhillon G.S., Brar S.K., Verma M., Tyagi R.D. (2011). Recent advances in citric acid bio-production and recovery. Food and Bioprocess Technology, 4, 505-529.

P14. The changes in maize rhizobiom composition occurring in the vegetation cycle

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Plant–microbiome interactions are significant determinants for plant growth, fitness, and productivity. The knowledge of structural and functional diversity within the plant microbiome could provide an opportunity to develop new, sustainable agricultural practices. Due to the selection of strains and their intended use, they can be used continuously or ad hoc, as a biofertilizer or biological control agent.
Maize (*Zea mays* L.), as a cultivated plant, is of great importance in the world, both in terms of utility and economics. This is due to the possibility of using virtually all of the plant's biomass as feed, food or industrial raw material. In the European Union, maize is the second-most cultivated crop after wheat. The aim of our research was to evaluate changes in the rhizobiome composition occurring in the maize vegetation cycle.
Rhizosphere soil samples were collected from 4 agricultural fields of maize located in Poland. All samples were collected in three periods of the vegetation cycle: before plant flowering, after flowering, and after harvest. Metagenomic DNA was isolated from the protected material using the Qiamp PowerFecal Pro Kit, Qiagen DNA isolation kit. DNA libraries were then prepared according to the 16S Metagenomic Sequencing Library Preparation Nextera XT protocol. Sequencing of the V3-V4 16S rRNA hypervariable regions was performed with the MiSeq Reagent Kit v2 with a reading length of 2x250 bp. The taxonomic classification of microorganisms was performed based on 16S rRNA amplicons using the Metagenomics program (Illumina). Statistical analysis and data visualization were performed using R Studio and MicrobiomeAnalyst software.
Comparative analysis of the taxonomic composition showed 4 species of bacteria common to all soil samples taken from the roots, ie *Gaiella occulta, Gemmatimonas aurantiaca, Nitrosomonas* sp. and *Sphingomonas* sp. In addition, 24 species of bacteria characteristic of maize roots were found, which are constantly present regardless of the vegetation stage of the plant. The highest values of the Shannon biodiversity index were observed among soil samples from maize roots after flowering (index value 2.2), while the lowest for soil samples from maize roots after harvest (index value 1.95). In all the tested soil samples, the percentage advantage of bacteria of the genus *Sphingomonas* and *Bradyrhizobium* was observed, which constituted 17-29% and 13-18% of all types in the sample, respectively.

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P15. Structural property analysis of bacterial cellulose-hemicellulose composites

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Cellulose-hemicellulose component of primary plant cell walls (PCW) is substantially responsible for fruit and vegetable texture and diseases resistance. Due to PCW sizes and difficulties with its isolation, use of its analogues is a promising ability to explore PCW vital processes. Bacterial cellulose (BC) is considered as a possible biomaterial for tailor-made biosystems due to its purity and mechanical properties. Thus, PCW analogues were discovered to explore its structural parameters and assess mechanical properties.
Binary cellulose-hemicellulose PCW analogues were grown for 10 days in hemicellulose-containing Hestrin-Schramm liquid medium with *Komagataeibacter xylinum* bacteria strain (Schramm, etal., 1957; Szymańska-Chargot et al., 2017). Four types of hemicelluloses (xyloglucan, xylan, arabinoxylan and glucomannan) at three concentrations (0.25 %, 0.5 % and 1 %) were used. Grown films were washed in distilled water for 4 days, then dried at 40 °C for further analysis. Images PCW analogues were captured with atomic force microscope (AFM), in order to estimate fibril diameters. Imaging was followed by nanoindentation, performed to measure Young`s modulus of PCW analogues. In addition to AFM measurements, FT-IR spectra of PCW analogues were collected to investigate their molecular structure (Yamamoto et al., 1996).
AFM image analysis showed diameters of fibrils to drastically increase with growing concentration of xyloglucan and glucomannan, compared to pure BC. Moderate impact on fibril diameter was observed for BC-xylan and BC-arabinoxylan composites. An increase in Young`s modulus was reported at 0.25% concentration for all types hemicelluloses used. Further addition of hemicellulose resulted in increase in Young`s modulus for xylan and arabinoxylan samples, while for xyloglucan and glucomannan modulus decreased. Analysis of cellulose Iα:Iβ ratio showed Iβ cellulose percentage content to increase by 4-5%, 2-4% and 1-2% with xylan, xyloglucan and arabinoxylan, and glucomannan addition, respectively. Observed data showed Iα:Iβ cellulose ratio to be almost independent of the hemicellulose concentration.

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References

Schramm, M., Gromet, Z., Hestrin, S. (1957). Synthesis of cellulose by Acetobacter Xylinum. 3. Substrates and inhibitors. Biochemical Journal, 67(4), 669-679.

Szymańska-Chargot, M., Chylińska, M., Cybulska, J., Kozioł, A., Pieczywek, P. M., Zdunek, A. (2017). Simultaneous influence of pectin and xyloglucan on structure and mechanical properties of bacterial cellulose composites. Carbohydrate polymers, 174, 970-979.

Yamamoto, H., Horii, F., & Hirai, A. (1996). In situ crystallization of bacterial cellulose II. Influences of different polymeric additives on the formation of celluloses I α and I β at the early stage of incubation. Cellulose, 3(1), 229-242.

P16. Nutraceutical potential of *Centaurea cyanus* L. flowers (*Cyani flos*)

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Centaurea cyanus L. represents the Asteraceae family and the Carduoideae subfamily. This species originates from the northern Mediterranean region. It occurs in Europe and Asia in the natural environment. In the Polish flora, this common field weed can be found on wastelands, roadsides, and fallows. It blooms from May to September. Its flowers are the herbal raw material (*Cyani flos*) used in the food, pharmaceutical, and cosmetic industries. Its edible flowers are used as a food colorant and are added to teas and desserts. They are used in phytotherapy due to their diuretic, choleretic, anti-inflammatory, antiseptic, antibacterial, antioxidant, antihypertensive, blood vessel sealing, and cytoprotective properties. In cosmetology, the biologically active *Cyani flos* compounds are used in products dedicated to couperose skin care, treatment of mycoses, and alleviation of allergic lesions and skin inflammations. Cyanidin contained in this raw material forming complexes with metal ions is a component of hair rinses, and anthocyanosides exert a photoprotective effect. The aim of the study was to determine the content of selected biologically active substances in *Centaurea cyanus* L. disc florets. The energy value, content of sugars, proteins, fatty compounds, vitamin C, and flavonoids, and the quantitative and qualitative composition of amino acids were determined in fresh *Cyani flos* raw material. The nitrogen content in the flowers was determined with the Kjeldahl method. The amino acid composition was determined with the Davies and Thomas method. The lipid content was assessed with the Soxhlet method, and vitamin C content was determined in accordance with the PN-EN 14130:2004 standard. The antioxidant activity of the flowers was assessed using the Folin method. The water content in the *C. cyanus* flowers was in the range of 40-45 g/100 g fw. The total protein concentration in this raw material was 1.6-2.2 g/100 g fw. In turn, the total fat content was in the range of 0.17-0.27 g/100 g fw. Aspartic and glutamic acids were the dominant amino acids. The content of vitamin C, flavonoids, and polyphenolic compounds indicates high antioxidant activity. The energy value of *Cyani flos* was in the range of 204-225 kcal/100 g fw. The content of biologically active chemical compounds in the tested raw material indicates its natural nutraceutical potential of dietary phytocompounds.

P17. An interaction of pear pectin with the materials of food packages – the physicochemical studies

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Pectin is a component of many food products (e.g. jams, jellies, desserts as well as fruit juices and nectars) mainly due to its thickening, emulsifying, stabilizing and gelling properties (Moslemi, 2021). Like other food ingredients, pectin is in a contact with the packaging materials such as glass, polypropylene or paper. Commercially used pectin is obtained from the apples or citrus fruit. However, the results of recent research have shown that also pectin extracted with the sodium carbonate solution (diluted alkali-soluble pectin – i.e. DASP) from the pear fruit reveals the structure-forming and gelling properties (Cieśla et al., 2021).
The aim of studies was to characterize interfacial properties of DASP sequentially extracted from the fruit of *Pyrus communis* L. cv. 'Conference'.
Chemical composition and behavior of the pear DASP in the water and salt (NaCl and $CaCl_2$) solutions have been studied in detail (Cieśla et al., 2021). The presented experiment was focused on the effect of DASP concentration on the surface tension (pendant drop method) of pectin dispersions, the wettability of different materials (glass, polypropylene, polyethylene terephthalate, low-density polyethylene, polystyrene and paper) by these dispersions (sessile drop method; Ramé-hart Goniometer with CCD camera and software; ramé-hart instrument co., Succasunna, NJ, USA) as well as the oil-holding capacity and emulsifying ability of DASP from pear fruit.
The pectin concentration and the dispersing medium used affected the wettability of different food packages by the DASP suspensions. The obtained information about interfacial properties of DASP can be important at the consideration of the pear pectin as a potential thickening and emulsifying agent.

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References

Moslemi, M. (2021). Reviewing the recent advances in application of pectin for technical and health promotion purposes: From laboratory to market. Carbohydrate Polymers, 254, 117324.

Cieśla, J., Koczańska, M., Pieczywek, P., Szymańska-Chargot, M., Cybulska, J., Zdunek, A. (2021). Structural properties of diluted alkali-soluble pectin from *Pyrus communis* L. in water and salt solutions. Carbohydrate Polymers, 273, 118598.

P18. Effect of superabsorbent dose on yield and chemical composition of pea seeds

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In the era of observed climatic changes contributing to the emergence of soil moisture deficiency, effective ways to retain and rationally manage water are being sought. One of the solutions to provide water for crops during periods without rain is the use of superabsorbent (hydrogel). The aim of the study was to identify the response of two cultivars of pea (*Pisum sativum* L.) - Hubal and Batuta to different doses of superabsorbent.

The study was carried out during 2016-2018, based on two-factor field experiment established in a split-block randomized design with 4 replications. The first factor was the dose of superabsorbent (SAP) (0, 20, 30 $kg \cdot ha^{-1}$), while the second – legume cultivar (Batuta and Hubal). The hydrogel was sown with the Amazone D9-30 seeder and mixed with the soil by means of a passive tilling set to a depth of 15 cm.

The results showed that the application of superabsorbent significantly increased the yield of pea in the two years of the research. The use of SAP20 resulted in a significant increase in the seed yield in 2017 (by 47.8%) compared to SAP0. In 2018, significant differences in relation to the control object were noted when using a dose of 30 kg of hydrogel per ha (yield increase by 13.7%). The genetic factor significantly differentiated the yield of pea seeds only in 2017. The Batuta variety yielded 9.8% better than Hubal. The biometric parameters of the legume species did not vary with the dose of superabsorbent. The chemical composition of seeds of the legume species varied only according to the genetic factor. Pea seeds of Batuta cultivar had a higher content of crude fat (by 14.4%), phosphorus (by 12.2%) and potassium (by 7.8%) compared to Hubal.

P19. Effect of superabsorbent dose on the parameters of chlorophyll fluorescence and the SPAD index in two pea cultivars

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The soil requirements of individual legume species vary, but all species grown in Poland are characterized by a significant demand for water. A disadvantageous feature of these plants is their uneven yielding caused by periodical shortages of rainfall, often lasting several weeks, which have become more and more frequent in recent years. One of the solutions aimed at providing water for crops during rainless periods is the use of a superabsorbent (hydrogel). The aim of the study was to identify the response of two cultivars of pea (*Pisum sativum* L.) - Hubal and Batuta to different doses of superabsorbent.

The study was carried out during 2016-2018 based on two-factor field experiments established in a split-block randomized design with 4 replications. The first factor was the dose of superabsorbent (SAP) (0, 20, 30 kg·ha^{-1}), while the second – legume cultivar (Batuta and Hubal). Measurements of chlorophyll direct fluorescence were made with the PocketPEA fluorimeter. Two indexes were assessed: Fv/Fm (maximum quantum yield of photosystem II) and PI (index of photosystem II functioning). Measurements were made after 20 minutes' dark adaptation of the leaf, in 9 replications. Leaf greenness index (SPAD) measurements were made using a SPAD - HYDRO N-TesterTM chlorophyllometer. Measurements were performed in 4 repetitions.

The results showed that chlorophyll fluorescence indices were generally significantly different between SAP doses. The mean value of the index describing the maximum quantum yield of PSII (Fv/Fm) significantly increased after application of the SAP dose of 30 kg·ha^{-1} in pea in 2018, and SAP doses of 20 kg·ha^{-1} in 2017. The mean value of functioning index of photosystem II (PI) was significantly higher after application of superabsorbent at a dose of 20 kg·ha^{-1} in pea in 2017, and at a dose of 30 kg·ha^{-1} in 2018. In general, the genetic factor significantly differentiated the value of chlorophyll fluorescence indices. The cultivar Hubal was characterized by a significantly higher value of the Fv/Fm and PI indexes compared to Batuta in all years of the study. The relative chlorophyll content in the leaves of the legume species did not vary with the hydrogel dose, but a significant effect of cultivar on this trait was demonstrated. Higher mean value of SPAD index was characterized by cultivar Hubal compared to Batuta, but significant differences were recorded in 2016 and 2017.

P20. Characterization of hydrogels as alternative materials for production micronutrient fertilizers with biodegradable complexing agent

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Hydrogels are innovative natural or synthetic polymer superabsorbents. The ability to absorb and retain large quantities of water or physicochemical fluids arises from hydrophilic cross-linked three dimensional network (Ahmed 2015, Ullah et al. 2015). Due to desirable features of hydrogels as a large sorption capacity, high rate of reversible fluid absorbing power, non-toxicity, mechanical strength, chemical resistance as well as mechanical resistance, mentioned materials are widely applied in many fields of industry. They are used, among others, in medicine, pharmacy, cosmetics, electronics, agriculture as well as in many branches of chemical industry (Ullah et al. 2015). Additionally numerous investigations have shown that hydrogels can help minimize irrigation water consumption, improve fertilizer retention in soil and increase plant growth rate (Chen at al. 2018).
Three commercially available acrylic-based superabsorbents - TerraHydrogel®Aqua (THA), Zeba®Hydrogel (ZH) and Agro®Hydrogel (AH) were firstly studied for assessment of physico-chemical properties by not only determination of swelling capacities and grain size, but also by recording Fourier transform infrared spectra (FTIR) and scanning electron microscopy (SEM) images. The main purpose of this study was investigation of the influence of chemical conditions on hydrogels, kinetic and adsorption behaviour towards Cu(II), Zn(II), Mn(II), Fe(III) in the presence of the chelating agent of a new generation called iminodisuccinic acid (IDHA). The research parameters including the sorbent dose, pH of the solution, initial concentration of Cu(II), Zn(II), Mn(II) and Fe(III) complexes with IDHA as well as phase contact time and temperature on the adsorption efficiency were studied by the static method. The experimental data were also characterized by kinetic and adsorption parameters obtained based on the Langmuir and Freundlich models of sorption.

References

Ahmed E.M. (2015). Hydrogel: preparation, characterization, and applications: A review. Journal of Advanced Research, 6, 105-121.

Ullah F., Othman M.B.H., Javed F., Ahmad Z., Akil H.M. (2015). Classification, processing and application of hydrogels: A review. Materials Science Engineering C, 57, 414-443.

Chen J., Lü S., Zhang Z., Zhao Z, Li X, Ning P., Liu M. (2018). Environmentally friendly fertilizers: A review of materials used and their effect on the environment. Science of the Total Environment, 613-614, 829-839.

P21. Assessment of the accuracy of chromium and nickel determination in organic and organic-mineral fertilizers using the ICP-OES technique

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The accuracy as important parameter of validation of analytical method, expresses the degree of agreement between the value found experimentally and a reference value (Bulska 2018, Teixeira et al. 2014, Souza et. Al 2014). Accuracy can be checked by analyzing certified reference materials with the specified content of examined constituent (Bulska 2018). Another method of accuracy assessment is comparison obtained results in proficiency testing. Therefore, participation in interlaboratory comparisons can confirm that these two intra-laboratory procedures are working satisfactorily or allow the identification of possible sources of systematic error during the measurement process (Thompson et al. 2006).
Content of chromium and nickel in organic and organic-mineral fertilizers were determined with inductively coupled plasma optical emission spectrometry (ICP-OES) according to the in-house developed analytical procedure. Due to the analysis of certified reference materials the accuracy was defined and expressed as recovery chromium and nickel. The quality control of the tests was carried out on the basis of RM Marsep 259 (compost), RM 275 (cow manure) producer Wepal and RM Q10 / 2018 (organic NPK fertilizer - lawn fertilizer) producer VDLUFA. In order to ensure measurement consistency and verify the competence, the Testing Laboratory participated in proficiency tests organized by National Chemical–Agricultural Station in Warsaw, covering the determination of Cr and Ni in organic fertilizer samples.

References

Bulska E. (2018). Metrology in Chemistry. Springer, 101, 87-113.

Teixeira L.S., Vieira H.P., Windmöller C.C., Nascentes C.C. (2014). Fast determination of trace elements in organic fertilizers using a cup-horn reactor for ultrasound-assisted extraction and fast sequential flame atomic absorption spectrometry. Talanta, 119, 232-239.

Souza S.O., Costa , Santos D.M., Pinto J.S., Garcia C.A.B., Alves J.P.H., Araujo R.G.O. (2014). Simultaneous determination of macronutrients, micronutrients and trace elements in mineral fertilizers by inductively coupled plasma optical emission spectrometry. Spectrochimica Acta Part B: Atomic Spectroscopy, 96, 1-7.

Thompson M., Ellison S.R.L., Wood R. (2006). The international harmonized protocol for the proficiency testing of analytical chemistry laboratories. Pure and Applied Chemistry, 78, 145-196.

P22. A fibre preparation from oat husk and bran: Antioxidant activity and interactions between phytochemicals

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Oat (*Avena sativa* L.) has a valuable nutrients composition and content of many bioactive compounds. Especially oat bran is a rich source of nondigestible fibre (β-glucans) with unique pro-health properties. Oat husk (hull) which represents on average 27% of grain, is a by-product obtained from oat processing. It is assumed that about 3.0 million tons of oat hull are generated every year as a by-product. Oat husk is rich in insoluble dietary fibre and has a similar level of polyphenols as oat bran. The aim of these studies was to determine the possibility of using micronized oat husk and bran as a component of fibre preparation. Especially the antioxidant capacity and the interactions between biologically active compounds were determined. The material for the study was the micronized (average particle size 20 μm) oat bran layer (BL) and oat husk (OH). The basic chemical composition and phenolic acids profile of BL and OH were determined. The mixtures of fibre preparation with different proportions BL to OH (0:1, 1:0, 1:9, 2:8, 3:7, 4:6, 5:5, 6:4, 7:3, 8:2 and 9:1) were prepared. The following antioxidant assays were performed: the ability to quench ABTS radicals, chelating power and inhibition of linoleic acid peroxidation. Moreover, the interaction analysis (isobolographic analysis) between the biologically active compounds was of OH and BL was performed. The obtained results showed the incorporation of OH into BL allows to obtain a fiber preparation with unique pro-helath properties. The optimal composition of the oat micronized preparation with the proportion of 60-70% OH and 30-40% of BL allows to obtain a fibre preparation characterized by 60-70% fiber content, above 3% β-glucans content, the high content of ferulic acid (about 400 μg/g d.m.) and with high antioxidant activity resulting both from the content of bioactive substances in the husk and bran, but also from their synergistic effect. A proposed preparation can be used as a valuable addition to various food products.

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P23. Thermal imaging applications in seed quality evaluation

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The last two decades have witnessed growing concerns about seed quality parameters because any investment on fertilizations, integrated pest management programs, water and other inputs without good seeds won't be worth. Detecting the variations among seed lots and among individual seeds within a seed lot has great importance for both seed industry and markets. Imaging-based techniques can be regarded as efficient tools to test and evaluate individual seeds to explore the imbibition process, to investigate the germination capacity and to discern vigor differences among seeds lots. In specific, thermal imaging has various applications in quality assessment of different agricultural products especially seeds. The technique has been moved from just an exploration method in engineering and astronomy into an effective tool in many fields for forming unambiguous images called thermograms eventuated from the temperature and thermal properties of the target objects. The system depends on converting the invisible infrared radiation emitted by the tested seeds into visible diagrams called thermograms. Analyzing these thermograms resulted in useful information about the extrinsic and intrinsic properties. This work shed some light on theoretical background of the system, the modern configurations, and most recent research endeavors carried out for estimating various quality traits of different seeds. The study comprehensively describes how thermal imaging systems were successfully implemented in estimating seed viability, detection of fungal and insect infestation, detection of seed damage and impurities, seed classification and variety identification.

Keywords: Thermal imaging, Thermography, Seed, Grain, Quality

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References

Belin, É., Rousseau, D., Rojas-Varela, J., Demilly, D., Wagner, M.-H., Cathala, M.-H., & Dürr, C. (2011). Thermography as non invasive functional imaging for monitoring seedling growth. Computers and Electronics in Agriculture, 79(2), 236-240.

ElMasry G., ElGamal R., Mandour N., Gou P., Al-Rejaie S., Belin E., & Rousseau D. (2020). Emerging thermal imaging techniques for seed quality evaluation: Principles and applications. Food Research International, 131, 109025.

Rahman, A., & Cho, B.-K. (2016). Assessment of seed quality using non-destructive measurement techniques: A review. Seed Science Research, 26(4), 285-305.

P24. Synthesis of eco-friendly biopolymer alginate-based composite for rare earth elements adsorption

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Alginates are anionic and natural biopolymers usually extracted from marine brown algae. These polymers are characterized by numerous unique features, mainly biocompatibility, biodegradability, mild gelation conditions and also easy modifications enabling alginate derivatives production with new, attractive properties. Due to these valuable properties, alginates are used in many fields: food, textile, medical, pharmaceutical industries, as well as environmental protection. Alginate-based biosorbents have been used for several years to remove toxic heavy metal ions and dyes from aqueous solutions [1,2]. There are also increasing attempts to use them in the recovery of critical raw materials – rare earth elements. Efficient recovery of La(III), Ce(III), Pr(III), and Nd(III) from aqueous solutions is considered to be a fundamental point of view. Natural hydrogel biopolymers based on alginate and cellulose (eco-friendly and cost-effective) were successfully prepared, characterized, and applied in this study. A new kind of composites of different ratios of alginate (ALG) and cellulose (C) (i.e. 5:1, 2:1, 1:1, 1:2, and 1:5) were synthetized. These composites were produced by ionotropic gelation using $CaCl_2$ as a crosslinking agent. The composite sorption abilities are studied by the effect of pH, biosorbent mass, interaction time, initial metal ions concentrations, and temperature. The composite with the 5:1 ratios of alginate and cellulose was the most effective for La(III), Ce(III), Pr(III), and Nd(III) ions removal. Uptake kinetics was well fitted by the pseudo-second-order model. The Langmuir model fitted better the adsorption isotherms compared to the Freundlich and Temkin ones. The saturation time of the composite was dependent on the metal ion concentration. Moreover, the results revealed that the optimum conditions for the rare earth elements sorption are at a temperature of 333 K and pH 5, with a biosorbent mass of 0.05 g. The metal loaded composite recycling was performed through the series of sorption desorption cycles. As a final step, the sorption properties of the formed composite were compared to alginate and cellulose as the reference materials. Enhanced sorption capacity of cellulose was proved in the newly synthetized composite. The developed environmentally friendly alginate-based biopolymer composite showed high rare earth elements recovery and possibilities of prospective application.

Acknowledgments

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References

1. Wang, S., Vincent, T., Faur, C., Guibal, E. (2016). Alginate and algal-based beads for the sorption of metal cations: Cu(II) and Pb(II). International Journal of Molecular Sciences, 17, 1453-1478.

2. Asadi, S., Eris, S., Azizian, S. (2018). Alginate-based hydrogel beads as a biocompatible and efficient adsorbent for dye removal from aqueous solutions. ACS Omega, 3, 15140-15148.

P25. Effect of biochar hydrophobicity / hydrophilicity on the hydrophysical soil properties (preliminary experimental data)

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The aim of the study was to evaluate the effect of agricultural surfactant on the biochar properties. Two experiments were conducted from June to September 2021. The small-plot field experiment was set up on the territory of the biological station «Kuchak» on sod-podzolic soil of loamy texture and the fifty-six-day laboratory experiment was carried out at the University. The same soil was used both in the field and the laboratory experiments. The treatments in both experiments were identical and arranged in a randomized order: «a» - mineral fertilizer N16P16K16, 0,075 t·ha-1, «b» - hydrophobic biochar, 20 t·ha-1, «c» - hydrophobic biochar, 20 t·ha-1 + mineral fertilizer N16P16K16, 0,075 t·ha-1, «d» - hydrophilic biochar, 20 t·ha-1, «e» - hydrophilic biochar, 20 t·ha-1 + mineral fertilizer N16P16K16, 0,075 t·ha-1, «f» - control soil. The hydrophilic biochar was obtained by treating the initial hydrophobic biochar with a solution of an agricultural surfactant for 24 hours. The size of biochar particles applied to the soil was 0.5-1.0 cm. Biochar was applied to the top 10-cm soil layer. Spring wheat of Iren variety was used as a crop.

At the time of contact with a drop of water, the hydrophilic biochar had an edge wettability angle equal to 27.4 degrees and hydrophobic biochar – 73.5 degrees. In 10 seconds after water application, hydrophilic and hydrophobic biochar had an edge wettability angle equal to 15.3° and 62.4°, respectively. Water absorption capacity of biochar treated with the agricultural surfactant solution was 43% higher than that of the initial biochar. During the field experiment it was found that soil water content in a 0-10 cm layer was 20% lower in the treatment with hydrophobic biochar («b») compared to the treatment with hydrophilic biochar («d»). The soil water content in the laboratory experiment was maintained at the level of 70-75% of the field capacity (18.8 ± 0.6%). In the laboratory experiment the highest amount of water necessary to maintain the water content at the same level was used in the control soil («f»). The most economical water consumption was observed in the treatment with the combined application of biochar (hydrophobic and hydrophilic) and fertilizer («c» and «e»), it was 20% lower compared to the control treatment.

The results obtained are preliminary experimental data of assessing biochar hydrophobic and hydrophilic properties on the hydrophysical parameters of soils.

P26. Biogas efficiency from silkworm waste under mesophilic conditions

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In view of the increasing demand of organic agriculture, utilization of waste and environmental protection, sericulture focuses not only on the cocoon production, but also on other ways that can benefit the farm's economy. It is necessary to find new sources of income for small-scale farmers not only through cocoon selling, but also by the multiple uses of by-products. Insect farming technology provides a cheap source of biomass, which may be a good material in biogas production.
The studies showed that the examined substrates, both silkworm breeding waste and caterpillar excreta, generate a biogas yield comparable to other substrates of agricultural origin, such as cattle, pig and chicken manures. Fermentation of silkworm excreta under mesophilic conditions produces 167.32 m^3/Mg TS of methane and 331.97 m^3/Mg TS of biogas, while fermentation of silkworm breeding waste yields 256.59 m^3/Mg TS of methane and 489.24 m^3/Mg TS of biogas. Moreover, the chemical composition of these raw materials was analyzed (Łochyńska and Frankowski, 2018).

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References

Łochyńska M., Frankowski, J. (2018). The biogas production potential from silkworm waste. Waste Management, 79, 564-570.

P27. The influence of shoots and rhizomes extracts from *Reynoutria japonica* on taxonomic composition of soil fungal communities

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Invasive *Reynoutria japonica* may considerably modify the microbiome and mycobiome of soil microbial communities. The aim of the study was to determine the differences in the composition of the mycobiome in the soil after addition of the *Reynoutria japonica* shoots and rhizomes extracts.
The laboratory experiment was performed to evaluate the influence of knotweed extracts on soil fungal communities' composition. Two types of extracts: *R. japonica* shoots and *R. japonica* rhizomes were added in four concentrations (control – no extract, low – extract diluted 100 times, medium – extract diluted 10 times, and high – undiluted extract) to soil collected from under native plant species. The mycobiome biodiversity and composition was determined using the Next Generation Sequencing (NGS) after DNA extraction with the FastDNA SPIN Kit for Feces® in a Fast-Prep-24 homogenizer. Metagenomic analysis of the fungal population was performed on the basis of the ITS1 hypervariable region. The specific sequences of the ITS1FI2 and 5.8S primers [1,2] were used to amplify the selected region and prepare the libraries. The PCR reaction was performed with a Q5 Hot Start High-Fidelity 2X Master Mix according to the manufacturer's protocol. Sequencing was performed on the MiSeq platform, in paired-end (PE) technology, 2x250nt, using the Illumina v2 kit.
The research allowed for metagenomic recognition of the soil fungal biodiversity after knotweed extracts application. The taxonomic composition of fungi in the soil changes after the use of knotweed shoots and rhizome extracts. In general, these extracts decrease the occurrence of Mortierellomycota and Basidiomycota types representatives. The results indicated that among the fungi assigned to individual taxa, the Ascomycota type predominate in soil mycobiotic communities, the relative abundance of which increases after the use of knotweed extracts. The soil with extracts of knotweed rhizomes was characterized by the greatest biodiversity of mycobiota.

References

Schmidt, P.A.; Bálint, M.; Greshake, B.; Bandowa, C.; Römbke, J.; Schmitt, I. Illumina metabarcoding of a soil fungal community. Soil Biol. Biochem. 2013, 65, 128–132.
Vilgalys Mycology Lab—Duke University. Available online:
https://sites.duke.edu/vilgalyslab/rdna_primers_for_fungi.

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P28. How does the taxonomic composition of fungi change in the soil profile of Mollic Stagnic Gleyosols?

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Despite the fact that soil microbes affect the biogeochemical processes throughout the entire soil profile, it is known little about biodiversity of microbes, especially fungal communities in the deeper soil horizons. Most studies of soil properties in agricultural soils have been restricted to the upper 30 cm layer, which has been subjected to repeated agricultural treatments and is influenced by different natural factors, and that has the greatest microbial concentration. This not only restricts the identification of the composition of the microbial communities and changes its functionality, but also the understanding of the common processes of the transformation of soil compounds.

The aim of the study was to determine the differences in the composition of the mycobiome in the soil profile of Mollic Stagnic Gleyosols with the five soil layers: Ap (0-30 cm) – A2 (30-53 cm) – 2ACgg 53-70 cm) – 3G1 (70-110 cm) – 3G2 (110-150 cm) under lucerne cultivation.

The diversity and composition of fungal communities was determined by using the method based on Next Generation Sequencing (NGS) after DNA isolation and ITS1 marker gene amplification. The DNA isolation from the environmental samples, with the FastDNA SPIN Kit for Feces® in a Fast-Prep-24 homogenizer (6 m/s, 40 s). The sequencing of ITS1 marker was performed with Illumina MiSeq platform, and QIIME2 environment was used for processing of the data.

The identification of the following classes of fungi were found in the Ap layer: Sordariomycetes (~28%), Leotiomycetes (~14%), Eurotiomycetes (~13%) and Mortierellomycetes (~12%). The mycobiome of A2 was dominated by Mortierellomycetes (~61%) classes. Representatives of Leotiomycetes (~28%), Sordariomycetes (~25%) and Mortierellomycetes (~13%) prevailed in 2ACgg soil layer. What is more the same classes, but with completely different opposite proportion (11%, 25% and 35%, respectively) were detected in 3G1 between 70 cm and 110 cm of soil depth. In the deepest part of soil profile (110-150 cm) determined as 3G2 layer, the most abundant was fungi belonging to Eurotiomycetes class (~31%), the next one were Mortierellomycetes (~21%) and Sordariomycetes (~14%) representtives.

The results indicated that fungal community composition is changing through the soil depth profile of Mollic Stagnic Gleyosols. The data interpretation and comparison with the other results will permit to expend the knowledge concerning the significance of the diversity and composition of mycobiome participating in the transformation and stabilization of soil organic matter in the soil horizon.

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P29. Living mulches as a chance to improve orchard biodiversity and suistainability – DOMINO and BioHortiTech projects

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Organic management is based on practices that are supposed to enhance biodiversity. However, specialization of intensive organic orchards has resulted in a conventional-like approach and increased use of external inputs. Enhancing the functional biodiversity of both above and below ground communities can be achieved by increasing crop species diversity e.g. by using living mulches.
In 2018, as a part of DOMINO project, an experiment in already existing eight-year-old apple orchard was established (Malus × domestica Borkh., cv. Gala on M9 rootstock) to assess the impact of innovative orchard floor management practices using different living mulch species on the orchard biodiversity. The orchard was drip irrigated, trees were managed according to organic farming rules and localized fertilization was provided with organic fertilizers (dry bovine manure and stillage), with a total of 12 g N/tree. During the whole project several different living mulch species were tested to maintain the soil on the tree row: pumpkin, garden violet, wild strawberry, lady's mantle, peppermint, marigold and nasturtium. Some of these plants have potential in soil phytoremediation, others were meant to improve weed and soil-borne pests' control or be used as secondary cash crops. The impact of the living mulches was assessed on both aboveground (insects and weed populations) and belowground (microorganisms and nematodes) populations as well as on the apple trees and soil nutritional level and fruit yield. Data will be presented for a selected set of parameters which pointed to a varied effect of the different species, but with a general positive impact on biodiversity. The assessment is now continued as a part of BioHortiTech project on the most promising living mulch species (peppermint, lady's mantle and wild strawberry) to evaluate the long-term effect of the studied orchard floor management practice.

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References

Mia J.M., Furmanczyk E.M., Golian J., Kwiatkowska J., Malusá E., Neri D. (2021) Living mulch with selected herbs for soil management in organic apple orchards. Horticulturae, 7, 59.

P30. Effect of simulated flooding on the diversity of selected bacteria important for soil fertility

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The aim of this research was to analyse the abundance of agriculturally important bacteria in riverine soils and to evaluate changes in their populations as a result of a simulated flood.
The research material consisted of three Fluvisols collected in the form of soil blocks (~ 900 cm^3) from meadows located in Wojszyn (medium Fluvisols - F1) and Janowiec (light Fluvisols - F2 and very light Fluvisols - F3) in the Lublin Voivodeship. Fluvisols were placed in containers and then flooded with river water taken from the Vistula River to the height of 5 cm above the soil surface. The flooding conditions were maintained for 2 weeks (Furtak et al., 2020). For analyses, fresh soils were taken after 7 and 14 days of water stagnation and 56 days after soil drying.
The bacterial community structure was analysed using next-generation sequencing (Miseq, Illumina). Searching for information in worldwide literature, it was determined which sequences belong to microorganisms important for plant cultivation (NCBI database).
Changes in the abundance of bacteria involved in the nitrogen, carbon and phosphorus cycles were observed, but their abundance varied according to both the stage of the experiment and the Fluvisols. For example, bacteria of the genus *Cellulomonas* (carbon cycle) in the F1 and F3 soils multiplied after 7 days of flooding. Bacteria of the genus *Arthrobacter* (phosphorus cycle) decreased in abundance following 7 days of flooding in all the Fluvisols, but increased in F2 and F3 after 14 days of flooding. Bacteria of the genus *Flavobacterium* (nitrogen cycle) multiplied after 7 days of flooding in all Fluvisols, but in F1 and F2 their abundance decreased after 14 days of flooding and in F3 it increased.
The results indicate that the effect of simulated flooding on soil bacteria varies and is determined by soil type, structure and vegetation.

Acknowledgments

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References

Furtak K., Grządziel J., Gałązka A., Niedźwiecki J. (2020). Prevalence of unclassified bacteria in the soil bacterial community from floodplain meadows (fluvisols) under simulated flood conditions revealed by a metataxonomic approach. Catena, 188, 104448.

National Center for Biotechnology Information, NCBI database. https://www.ncbi.nlm.nih.gov/ (accessed 10 July 2019).

P31. Microbiome and metabolic potential of the rhizosphere microorganisms of black alder (*Alnus glutinosa*), silver birch (*Betula pendula*) and scots pine (*Pinus sylvestris*)

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A forest habitat is defined as a set of relatively persistent climatic, topographic, water and soil factors creating conditions for forest life. It is a complex of external conditions, such as climate, soil, land morphology with a geological structure, in which a given phyto- and zoocenosis functions [1]. The external image of the habitat is represented by plants, both undergrowth and tree species and their valuation features (valuation). In forests deformed by man, undergrowth vegetation often does not reflect the potential possibilities of habitats, but only the possibilities of surface soil levels, not taking into account their deeper layers, which are accessible to tree roots [2]. The aim of the study was to determine the structural and functional biodiversity of soil microorganisms inhabiting the rhizosphere of three selected tree species: *Alnus glutinosa*, *Betula pendula* and *Pinus sylvestris*. Soil samples were collected in 2019 and 2020 from a mixed forest located near the Agricultural Experimental Station IUNG-PIB in Osiny, Poland. Samples were taken from tree root layers. Each sample was collected in three biological replicates every August from selected tree species. The basic physical and chemical parameters of soils were determined, as well as the determination of enzymatic activity and the assessment of the metabolic profile of soils (Biolog EcoPlates and FFPlates). The highest metabolic activity on EcoPlates plates was observed in soil collected from under black alder and warty birch. In turn, the soil collected from under Scots pine was characterized by a much lower biological activity and a lower metabolic potential. The results obtained on the FFPlate also showed the highest metabolic potential of fungi in samples taken from the root zone of the black alder. The best metabolized compound was L-Phenylalanine, L-Asparagine, D-Mannitol and g-Hydroxy-Butyric Acid.

Acknowledgments

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References

Insam, H., and Goberna, M. (2004). Use of Biolog® for Community Level Physiological Proffiling (CLPP) of Environmental Samples. In Molecular Microbial Ecology Manual, 2nd Ed.; Kluwer Academic: Dordrecht, The Netherlands, 853–860.

Pawlik Ł., Buma B., Šamonil P., Kvaček J., Gałązka A., Kohout P., Malik I. (2020). Impact of trees and forests on the Devonian landscape and weathering processes with implications to the global Earth's system properties - A critical review. Earth-Science Reviews DOI: 10.1016/j.earscirev.2020.103200Doran J.W. and Zeiss M.R. 2000. Soil health and sustainability: managing the biotic component of soil quality. Applied Soil Ecology 15: 3-11.

P32. Microbiological activity under trees as an indicator of potential biological weathering and soil formation – towards a better understanding of the Earth system dynamics

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Forest ecosystems differ significantly from agricultural ones. One of the key elements of both forest and agricultural soil are soil microorganisms. Microorganisms are an integral part of the soil environment and perform a number of positive functions in it [1]. They affect the functioning of ecosystems, plant health, and soil structure and productivity. In forest and agricultural ecosystems, edaphic conditions, plants and soil microorganisms are closely related. The formation of specific features of forest habitats is determined by the physical, chemical and biological properties of the soil [2].
The aim of the study was to answer one of the big questions in the Earth sciences, i.e., how biological agents, as the critical interface between the biosphere and the abiotic environment, shape soil and landscape evolution? Within the present study we ask what is the level of microbiological activity within root systems of trees and how it can influence biological weathering. The area of interest (AOI) was in the Poprad River gorge in the southern part of the Beskidy mountains. The mountain range belongs to the Outer Westen Carpathians and is predominantly built of flysch rocks consisting sandstones, mudstones and conglomerates. The area is still neotectonically active. The study site is on a steep north-facing valley side; approximately 250 m from the Poprad River. Soil samples were collected in 2021. The basic physical and chemical parameters of soils were determined, as well as the determination of structural diversity of bacteria and fungi (NGS) and the assessment of the metabolic profile of soils (Biolog EcoPlates and FFPlates).

Acknowledgments

The research was carried out as part of the implementation of the project: NCN 2019/33/B/ST10/01009

References

Insam, H., and Goberna, M. (2004). Use of Biolog® for Community Level Physiological Proffiling (CLPP) of Environmental Samples. In Molecular Microbial Ecology Manual, 2nd Ed.; Kluwer Academic: Dordrecht, The Netherlands, 853–860.

Pawlik Ł., Buma B., Šamonil P., Kvaček J., Gałązka A., Kohout P., Malik I. (2020). Impact of trees and forests on the Devonian landscape and weathering processes with implications to the global Earth's system properties - A critical review. Earth-Science Reviews DOI: 10.1016/j.earscirev.2020.103200Doran J.W. and Zeiss M.R. 2000. Soil health and sustainability: managing the biotic component of soil quality. Applied Soil Ecology 15: 3-11.

P33. Review of farmers land use systems and their evaluation based on chemical, physical and microbiological properties of Indian Solonetz soils

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Land use system has a great impact on soil properties. Soils are intricately linked to climate change through biogeochemical and hydrological cycles. Land use practices may affect these cycles contributing to climate changes. Altered climate like elevated temperature and changes in precipitation influence soil processes and properties which results in soil degradation and in extreme conditions land abandonment. The effect of land use on soil chemical (organic carbon, pH, electrical conductivity, avN, AL-P_2O_5, AL-K_2O, avMg^{2+}, avCa^{2+} and avNa^{+}), microbiological properties (BSR, MBC, DHA and alkaline phosphatase activity) and soil moisture of salt-affected soils was investigated in India. The main goal of the study was to evaluate the farmer's decision for deciding the land use system based on soil physical, chemical and microbiological properties, and the contribution in maintaining soil quality. Soil samples were collected from Solonetz soils under different land uses such as arable land (SnA), bare land (SnB) and pasture land (SnP). Results of the study showed that all three sites were statistically different from each other in chemical and microbiological properties. Based on soil chemical and soil moisture, more than 86% of total variance was determined by the principal component analysis (PCA) whereas least discriminant analysis (LDA) showed great variations in soil microbial properties. The values of microbiological properties were the highest in SnA, intermediate in SnP and the lowest in case of SnB. Overall, it was concluded that arable land (SnA) had more favorable chemical properties and it has been microbiologically more active in investigated salt affected (Solonetz) soils and results of this study favours farmer's decision on land use systems. Moreover, soil conservation and amelioration practices are suggested in bare land and pasture land to prevent further degradation and to improve the soil quality of the investigated salt affected areas.

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P34. Biochar as soil additive

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Crop cultivation is essential for the functioning of the entire world economy. The farmland is sown with different plants each year, which impoverishes the soil and makes necessary to fertilize it. Artificial fertilizers solve the problem of the lack of substances required for plant life in the ground only seasonally, however, in the long run, they enhance the soil degradation. Therefore, it is mandatory to look for solutions to reduce soil depletion in the long term, and one of them is the addition of biochar to the soil.
Biocarbon by itself does not provide nutrients to the ground, but improves their properties through increased adsorption, reduced losses nutrients by leaching and increasing the organic carbon content [1, 2]. The porous structure of biochar is an ideal habitat for microorganisms, which have a positive effect on the soil quality.
Soil impoverishment is not the only problem of agriculture facing today. The constantly increasing pollution of the environment also has a negative impact on crops. Toxic substances present in the soil may limit the growth of plants or build into their structure. Due to its highly developed specific surface, biochar is a very good adsorbent. It is possible to "trap" heavy metals on it, as well as some organic substances. Because of the binding of pollutants on the surface of biochar, their availability to plants is reduced, which has a positive effect on the quantity and quality of crops [3].
Additionally, biochar as a substance of natural origin, is an environmentally friendly adsorbent. It is obtained from biomass that has been previously used by humans and is a waste material that poses problems related to its storage, as well as the processes of decay. The latter result in uncontrolled emissions of greenhouse gases such as carbon dioxide and methane. The process of anaerobic carbonization of biomass leads to the binding of elemental carbon into a stable structure that does not generate greenhouse gases. Therefore, the processing of biomass into biochar enables the effective management of a whole range of various troublesome wastes.

References

McHenry M. P., (2009). Agricultural bio-char production, renewable energy generation and farm car-bon sequestration in Western Australia: Certainty, uncertainty and risk. Agriculture, Ecosystems and Environment, 129, 1-7.

Wu W., Yang M., Feng Q., McGrouther K., Wang H., Lu H., Chen Y., (2012). Chemical characterization of rice straw-derived biochar for soil amendment. Biomass and Bioenergy, 47, 268-276.

Beesley L., Moreno-Jimenez E., Gomez-Eyles J. L., (2010) Effects of biochar and greenwaste compost amendments on mobility, availability and toxicity of inorganic and organic contaminants in a multi-element polluted soil. Environmental Pollution, 158, 6, 2282-2287.

P35. Application of the extrusion technique in the food industry

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In food production, the extrusion technique has been around for more than 70 years. The use of an extruder was noted in 1946. [1] Due to the appropriate construction of screws and barrels, the extrusion technique is still structurally evolving, giving new possibilities for treatment. The physicochemical changes in the raw material are determined by the equipment used, the thermomechanical effect including the processing of raw materials through hydro-baro-thermic treatment and finally giving the appropriate texture and shape to the product leaving the extruder under high pressure. [2] The division of single, double and multi-screw extruders has been presented. Their structure and influence on technological parameters, and thus on the properties of products, are discussed. [3]

References

Harper J.M., 1981. Extrusion of Foods. CRC Press, Boca Raton FL

Frame N.D., 1994. The Technology of Extrusion Cooking. Springer Science + Business Media, Dordrecht

Wójtowicz A., 2018. Zeszyty Problemowe Postępów Nauk Rolniczych nr 595, 2018, 131–144

P36. Evaluation of the effectiveness of biological reclamation in the Iharkút-Németbánya bauxite mine area based on changes in soil properties

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The more than 30 years long intense mining of bauxite reserves around Bakonyjákó-Iharkút and Németbánya ended in 2005. Reclamation of the exhausted mining areas started partly in parallel with the activity, then continued in two main phases, 15 and 30 years after abandonment of mining.
The aim of our research was to investigate to what extent the reclamation of the Iharkút-Németbánya bauxite mining areas (landscaping, reforestation and lawn care) can be considered successful and effective. Parameters indicative of initial soil formation processes beginning with the recultivation were observed. Physical, chemical and microbiological characteristics of seven soil profiles, opened in grassland and forest stands of different ages and composition, were compared. The results were used to evaluate (a) how the layering, plasticity (KA), texture, pH, carbonate-, organic carbon and humus content of the artificial mine soils changed with age; b) how these indicators and humus quality (E4/E6), as well as total hydrolytic enzyme activity (FDA) vary with depth (0-10, 10-20, 20-30 cm) and with stand age; c) the correlation and strength of soil properties, and f) and the effect of land use type and tree species composition of forest stands on soils.
Our results show that soils of both grassland and forest stands, 15 years after reclamation, show a slight humification process, with an initial stage of progress (decomposition activity and small-scale humus formation). Enzyme activity and humus content decreased with depth, but increased with time, and the improving humus quality over time also indicate that after 30 years the humification and mineralisation processes are approaching a first stage equilibrium. No significant differences were found between grassland and woodland in terms of the effectiveness of reclamation at this stage, but in general it can be concluded that initial changes are more advanced in areas where the tree species diversity is generally higher, either through planted species or species that spontaneously colonise from natural stands. Factors limiting soil formation processes (e.g. rock fragment and calcium-carbonate content) play an important role in their expression, and their effects may outweigh those of positive factors in a cascade of interactions.

P37. Spatial distribution of enzyme activities in the rhizosphere of various wheat varieties under drought condition

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Previous studies showed that plants in response to different abiotic stress such as drought modify the spatial distribution of enzyme activities in their rhizosphere through modulation of root system architecture, interaction with beneficial microorganisms and release enzymes and exudates. However, the spatial distribution of enzyme activities in rhizosphere of wheat varieties with different tolerances to drought remains unknown. For this purpose, we used *in situ* zymography to determine spatial distribution of β-glucosidase, acid phosphatase, and leucine aminopeptidase in rhizosphere of three wheat varieties (Baran (rainfed wheat), Sirvan (drought tolerant wheat), and Marvdasht (drought sensitive wheat)). The results showed that the hotspots percentage of three tested enzymes in rhizosphere of Baran were significantly higher than those in the rhizosphere of two other varieties. Furthermore, the normalized hotspot percentage (the hotspots area of enzyme activity divided by the root surface area) of acid phosphatase and leucine aminopeptidase were higher in Baran rhizosphere in compare to Siravn and Marvdasht. The highest mean of β-glucosidase activity in the hotspots also was related to Baran which was significantly higher than two other varieties. However, the highest mean of acid phosphatase and leucine aminopeptidase activities were related to Baran and Sirvan. The rhizosphere extent of enzyme activities in each wheat varieties was different. The rhizosphere extent and also the normalized rhizosphere extent (The rhizosphere extent of enzyme divided by the root radius) of enzyme activities in Baran were broader than two other varieties. Also, the rhizosphere extent of acid phosphatase and leucine aminopeptidase in Sirvan were broader than those in Marvdasht. The analysis of root traits showed that root system of Baran and Sirvan were more effective than Marvdasht because they had higher root surface, length, and volume in compare to the Marvdasht. Also, the shoot dry biomass of different wheat varieties arranged in the following order: Baran> Sirvan> Marvdasht. According to these results, Baran as a rainfed wheat through developing root system architecture and also increasing the hotspots area and the rhizosphere extent of enzyme activities had higher tolerance to drought stress than two other varieties.

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References

Bilyera, N., Zhang, X., Duddek, P., Fan, L., Banfield, C. C., Schlüter, S., ... & Razavi, B. S. (2021). Maize genotype-specific exudation strategies: an adaptive mechanism to increase microbial activity in the rhizosphere. Soil Biology and Biochemistry, 108426.

P38. Physicochemical properties of Camelina sativa oil pressed from the seeds of different varieties

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Camelina oil has recently been used for many purposes as food, biofuel, cosmetics and pharmaceuticals. Therefore, the aim of the study was to characterize the physicochemical properties of camelina oil pressed from the seeds of different varieties (Luna, Śmiłowska, Omega). Different methods for comprehensive characteristics of camelina oils have been applied i.e. differential scanning calorimetry (DSC); color measurement L* a* b*, Fourier transform infrared (FTIR) spectroscopy and fatty acids determination by gas chromatography (GC). Thermal behavior during phase transition (melting, crystallization) of the oils was investigated by DSC using various scanning rates (1, 2, 5 °C/min). DSC analysis revealed that the crystallization process was manifested with one single peak and temperature of phase transition was influenced by cooling rate, for 1 °C/min mean peak temperature was -47.6 °C while for the rate 2 °C/min -52.5 °C. In the melting profiles two peaks were detected, one exothermic and one endothermic, with peak temperatures at around -38 and -15 °C (for heating rate 1, 2 °C/min) and around -34 and -12 °C (for heating rate 5 °C/min). The shape of crystallization and melting profiles was repeatable for various camelina varieties. In the case of color measurement, the significant differences ($p \leq 0,05$) were observed between camelina varieties for the parameters of L*a*b*. The lightness L * varied between 81.7 and 89.9, parameters of a* between -3.2 and 0.8 and parameter of b* between 45.9 and 96.1. The differences between varieties were also observed in fatty acid composition. The most abundant fatty acid in all camelina oils was α-linolenic fatty acid (C18:3, n-3), which content varied between 30.3 and 37.2 % , next was the linoleic acid (C18:2), which yielded between 15.3 and 21 %, whilst gadoleic acid (C20:1) also exhibited noticeable presence between 13% to 15%. FTIR spectra measured in the range of 400 and 4000 cm^{-1} showed no differences between camelina varieties.

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P39. Reaction of camelina (*Camelina sativa* (L.) Crantz) to different foliar fertilization

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Camelina (*Camelina sativa* (L.) Crantz) is an oil plant that can increase farmland biodiversity in many parts of the world. In addition to food importance, it is a good alternative in biofuel production. In recent years, interest in the cultivation of this species has increased. This is due to the high tolerance of camelina to unfavorable environmental conditions and the possibility of versatile crop utilization [Zanetti et al. 2017, Kurasiak-Popowska et al. 2019]. According to Román-Figueroa et al. [2017], a special feature of this plant is its easy adaptation to various soil and climatic conditions. Both spring and winter varieties of this species are cultivated [Righini et al. 2019, Wittenberg et al. 2019]. The aim of the experiment was to evaluate the response of camelina, the variety 'Smiłowska' (spring form), to various foliar fertilization. The combined application of three fertilizers had the most positive effect on the tested features and economic result: urea (46% N), magnesium sulfate (16% MgO + 32% SO_3), and Plonvit R (multi-component fertilizer). The obtained increase in seed yield after the application of the above variant was 0.54 $t \cdot ha^{-1}$, i.e., 37.5% compared to the control. The remaining fertilization combinations did not have a significant effect on seed yield, which amounted on average to 1.66 $t \cdot ha^{-1}$. The yield of fat and protein amounted to 0.68 $t \cdot ha^{-1}$ and 0.42 $t \cdot ha^{-1}$, respectively, and was strongly correlated with seed yield. The yielding of the variety ´Smiłowska' was stable over the years of the study. The combined use of three foliar fertilizers (Urea + Magnesium Sulfate heptahydrate + Plonvit R) increased the SPAD (soil plant analysis development) and LAI (leaf area index) values compared to the control. The application of urea alone reduced crude fat content in the seeds.

Acknowledgments

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References

Zanetti F., Eynck C., Christou M., Krzyżaniak M., Righini D., Alexopoulou E., Stolarski M.J., Van Loo E.N., Puttick D., Monti A. (2017). Agronomic performance and seed quality attributes of Camelina (*Camelina sativa* L. Crantz) in multi-environment trials across Europe and Canada. Ind. Crop. Prod., 107, 602-608.

Kurasiak-Popowska D., Ryńska B., Kurasiak-Popowska D. (2019). Analysis of distribution of selected bioactive compounds in *Camelina sativa* from seeds to pomace and oil. Agronomy, 9, 168.

Román-Figueroa C., Padilla R., Uribe J.M. Paneque M. (2017). Land suitability assessment for Camelina (*Camelina sativa* L.) development in Chile. Sustainability, 9, 154.

Righini D., Zanetti F., Martínez-Force E., Mandrioli M., Toschi T.G., Monti A. (2019). Shifting sowing of Camelina from spring to autumn enhances the oil quality for bio-based applications in response to temperature and seed carbon stock. Ind. Crop. Prod., 137, 66-73.

Wittenberg A., Anderson J.V., Berti M.T. (2019). Winter and summer annual biotypes of camelina have different morphology and seed characteristics. Ind. Crop. Prod., 135, 230-237.

P40. Emission of CO_2 caused by eucariota in wastewater treatment process in relation to the whose emission

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Carbon dioxide (CO_2) is one of the gases that increase the greenhouse effect. Direct emissions of CO_2 from wastewater treatment plants (WWTP) are caused by organisms found in the wastewater purification process, mainly prokaryotes and eukaryotes.
In presented results, we aimed to quantify the contribution of eukaryotes in the direct emission of CO_2.
The emission of CO_2 was monitored over a year (taking into account subsequent seasons) in model sequencing batch reactors (SBR).
The contribution of eukaryotes to the total CO_2 emissions is of the order of several or more ppm and changes with the seasons.

Table 1. The share of eukaryotes in the total CO_2 emission.

Season	Share [ppm]
Summer	9.92
Autumn	3.32
Winter	1.44
Spring	2.86

As could be expected, the emissions caused by eukaryotic organisms were small in relation to the total CO_2 emissions (Tab. 1) but measurable and quantified for the first time.
Our results of the contribution of CO_2 produced by different components of activated sludge in SBR can improve the estimation of emissions of GHGs in this area of human activity and fill the gap in the knowledge of this topic.

References

Jaromin-Gleń K., Babko R., Kuzmina T., Danko Y., Łagód G., Polakowski C., Szulżyk-Cieplak J., Bieganowski A. (2020). Contribution of prokaryotes and eukaryotes to CO_2 emissions in the wastewater treatment process. PeerJ, 17, 8:e9325.

P41. Strip-till one-pass: environmentally friendly tillage and crop cultivation technology

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Modern agriculture aims not only to produce food, but also to attend to environmental care. Therefore, the area of agricultural land cultivated in accordance with conservation agriculture principles is growing (Kassam et al. 2019). One even more simplified crop production technology involves loosening narrow strips of soil and simultaneously applying mineral fertilizers and sowing seeds in a single pass of a machine – i.e. strip-till one-pass (Benincasa et al. 2017). A research project under way since 2018 is working on the hypothesis that zonal loosening tillage, fertilization and sowing by strip-till one-pass will have a less negative environmental impact than conventional tillage involving several processes. The technology for winter plants involved determining: seedbed soil moisture immediately after sowing by gravimetric method; soil moisture during the autumn vegetation period by Time Domain Reflectometry technique; soil respiration during soil preparation for sowing and immediately after sowing by EGM-4 PP System; and CO_2 emissions resulting from fuel consumption.

The industrial research and development works revealed that, using strip-till one-pass, soil moisture in the seedbed immediately after sowing winter oilseed rape in a period without rainfall was 5.1%, which is 1.8 percentage points higher than in soil that had previously been ploughed. The higher humidity in the surface soil layers of the soil was maintained down to depths of 7.5 cm, 12 cm and 20 cm throughout the entire autumn growing season. After the end of the vegetation of winter plants grown by strip-till technology, the average soil moisture content in the 0–12 cm layer was 16.6%. In the unloosened inter-rows, moisture was 1.6 percentage points higher than in the loosened strips. Under conventional tillage, soil moisture was 13.6%. Meanwhile, in this period, the average respiration of unloosened soil under strip-till one-pass was 81 mg CO_2 m^{-2} h^{-1} – i.e. 17% lower than after ploughing. The lower CO_2 emissions due to the lower fuel consumption (38.8 L ha^{-1}) amounted to a reduction of 102.4 kg CO_2 ha^{-1}.

Acknowledgments

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References

Benincasa P., Zorzi A., Panella F., Tosti G., Trevini M. (2017). Strip tillage and sowing: is precision planting indispensable in silage maize? International Journal of Plant Production, 11, 577-588.

Kassam A., Friedrich T., Derpsch R. (2019). Global spread of conservation agriculture. International Journal of Environmental Studies, 76, 29-51.

P42. Phytotoxicity and respiratory activity of soil in the first year of fertilization with spent mushroom substrate

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The economic and living activity of man is associated with the generation of huge amounts of various types of waste, characteristic for a given form of human activity. One of such waste is the substrate left over from mushroom cultivation. According to the latest data, Poland is a leader in the mushroom industry in Europe (1). The aim of the research was to assess the phytotoxicity and respiration of soil subjected to annual fertilization with spent mushroom substrate and manure.
The research was carried out on a model of a field experiment in which individual objects were fertilized with: mushroom waste, manure, mushroom waste together with NPK mineral fertilization applied in two doses. All plots were sown with *Lolium multiflorum*. The non-fertilized soil was the control. In the first year based on the analysis of parameters related to the initial stage of development of the plant, the number of seeds germinated in the soil and the weight of sprouts that make up the growth index were examined (2), root length, germination in soil solution, respiratory activity were analysed.
The applied methods of fertilization did not show any significant effect on the germination. Fertilization did not have a positive effect on the length of the root. The inhibition of the root growth measured after 2 and 4 days in the fertilized soil as compared to the control soil was observed throughout the entire study period. The least favorable for this analyzed parameter turned out to be the addition of manure and mushroom substrate with fertilization at the N2P2K2 level. The applied methods of fertilization resulted in the stimulation of the growth index, which was most pronounced in spring and summer. The most beneficial for the development of the test plant turned out to be the application of the mushroom substrate together with mineral fertilization at the level of N2P2K2. A decrease was recorded only in autumn in the object with mineral fertilization at the level of N1P1K1. All methods of fertilization stimulated respiration. This effect was most pronounced in spring in objects with mushroom waste, including mineral fertilization on both levels.

References

Czop M., Kłapcia E. (2015). Evaluation of the suitability to organic recycling of the base coming from champignon mushroom farming. Archives of Waste Management and Environmental Protection, 17, 139-150.

Masciandaro G., Ceccanti B., Garcia C. (1997). Soil agro-ecological managment: fertirrigation and vermikompost treatments. Bioresource Technology, 59, 199-206.

P43. *In vitro* study on the nanostructure of the covalently linked pectins in cell walls: comparison of apple (*Malus domestica* Borkh.) and carrot (*Daucus carota* subsp. *sativus*) pectins

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Plant cell walls are composed of carbohydrates, phenolic compounds, structural and enzymatic proteins, ionically and covalently bound minerals, glycoproteins and lignin, present in secondary cell walls (Carpita & Gibeaut, 1993; Höfte & Voxeur, 2017). Among the carbohydrates, next to cellulose and hemicelluloses, pectins are the major component of primary cell wall and the middle lamella in higher plants (Posé et al., 2012). Pectin is a complex of several polysaccharides, rich in galactruronic acid which comprises up to 60-65% of pectin. Our studies of pectic polysaccharides showed characteristic structures observed when diluted alkali soluble fraction of pectin (DASP) was deposited on mica. It was hypothesized these structures originated from a single rhamnose residues interspersed within the homogalacturonan chains.

In this study we investigate structural properties of DASP pectin fraction extracted from apple (*Malus domestica* Borkh.) and carrot (*Daucus carota* subsp. *sativus*). Studies of atomic force microscopy topological images of DASP deposited on mica were supported by chemical characterization of pectin samples, carried out by means of FT-IR and HPLC. Collected data revealed statistically significant differences between pectin from both sources with respect to the number of branches per molecule as well as length of observed polysaccharides. Bending stiffness of pectic polymers was quantified by their persistence length calculated from AFM images, and showed no statistically significant differences between DASP extracted from apples and carrots. Finally, experimental studies were supplemented by numerical simulations of rhamnose interspersions within the homogalacturonan chains leading to formation of spatial kinked rods-resemble structures. It is suspected that this regular structure has a great importance for cell wall integrity and therefore texture and firmness of the whole fruits and vegetables.

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References

Carpita, N. C., & Gibeaut, D. M. (1993). Structural models of primary cell walls in flowering plants: Consistency of molecular structure with the physical properties of the walls during growth. Plant Journal, 3(1), 1–30.

Höfte, H., & Voxeur, A. (2017). Plant cell walls. Current Biology, 27(17), R865–R870.

Posé, S., Kirby, A. R., Mercado, J. A., Morris, V. J., & Quesada, M. A. (2012). Structural characterization of cell wall pectin fractions in ripe strawberry fruits using AFM. Carbohydrate Polymers, 88(3), 882–890.

P44. The usage of *Hermetia illucens* and *Tenebrio molitor* larvae as a way for biovalorization of digested sewage sludge

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Municipal sewage sludge after methane fermentation is a type of waste difficult to any further manage. It can be applied as fertilizer for agricultural lands, but due to its contamination or elevated levels of heavy metals it may cause a threat to the environment if used without the caution (Heimersson et al. 2017). In order to find another way to deal with the excess of digested sewage sludge, an experiment based on entomoremediation approach was conducted (Bulak et al. 2018). The aim of the experiment was to test the possibility of biovalorization of the sludge by the larvae of two insect species, the fly *Hermetia illucens* and the beetle *Tenebrio molitor* as well as to determine the optimal dose of sludge dry matter per larva. For this purpose, 6 variants of sludge doses (25, 50, 75, 100, 500, 1000 mg dry weight (DW)) for both insect species were set in three replicates. The results showed that both species of the insects can survive on the digested sewage sludge as the only source of food. The biomass of the insect increased, which indicates the possibility of biovalorization of the sludge with the insects. In the case of *H. illucens* larvae the highest utilization rate was obtained for 500 and 1000 mg DW doses and was 14.6 $\pm$ 0.5% and 21.1 $\pm$ 5.4%, respectively. *T. molitor* larvae, in contrast to the fly larvae, obtained the highest utilization rate at the 25 mg DW dose and it was as high as 82.1 $\pm$ 1.9%.

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References

Heimersson S., Svanström M., Cederberg C., Peters G. 2017. Improved life cycle modelling of benefits from sewage sludge anaerobic digestion and land application. Resources, Conservation and Recycling, 122, 126-134.

Bulak P., Polakowiski C., Nowak K., Waśko A., Wiącek D., Bieganowski A. 2018. Hermetia illucens as a new and promising species for use in entomoremediation. Science of the Total Environment, 633, 912-919.

P45. Testing the feasibility of detecting soil contamination using dielectric sensors

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Soil contamination often causes irreversible environmental degradation, such as death of plants, small animals and soil micro-organisms, as well as groundwater pollution. Some of the most environmentally degrading pollutants are petroleum-based substances, such as used engine oil. These pollutants are often the consequence of negligence, such as leaky lubrication systems in agricultural machinery, improper storage or even deliberate dumping of used engine oil in the soil. Engine oil has a high viscosity index and therefore adheres strongly to soil particles. Moreover, it takes tens or even hundreds of years to decompose and remains in the soil for a very long time, causing soil depletion.
It is important to be able to detect even small amounts of such contaminants in soil. In this work, the possibility of detecting soil contamination by engine oil was tested using three different dielectric probes connected to a vector network analyzer. Sand containing several different levels of 15W40 motor oil contamination was used in the measurements.

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References

Soto-Cabán S. (2012). A Simple Coaxial Waveguide Fixture Designed for the Measurement of Dielectric Properties of Contaminated Soil. International Journal of Engineering Research and Development, vol 4, nr 3,s. 40-45

P46. Application of natural antioxidants in meat and meat products

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Meat is rich source of proteins, lipids, vitamins and minerals. Meat products are spoiled by two major causes: microbial growth and chemical deterioration. The most common form of chemical deterioration is oxidative rancidity. Lipid oxidation is responsible for reduction in nutritional quality, as well as changes in flavour and colour, which can precipitate health hazards and economic losses in terms of inferior product quality. Synthetic antioxidants have been used to retard or minimize oxidative deterioration of foods. Currently, the awareness of the possible health implications of the extended use of synthetic antioxidants has promoted consumer - driven demands supporting the use of natural antioxidant compounds. The objective of this paper is to review the recent published literature on plant based natural antioxidants used in meat and meat products. Many herbs, spices, and their extracts have been reported as having high antioxidant capacity. In the meat industry, fresh or dried and ground herbal leaves are primarily used. They can also be replaced by herbal extracts and essential oils. The concentration of biologically active substances contained therein is approximately 30-fold higher than in fresh and dried spices. Thyme (*Thymus vulgaris* L.), rosemary *Rosmarinus officinalis* L.), sage (*Salvia officinalis* L.), marjoram (*Origanum majorana* L.), oregano (*Origanum vulgare* L.), basil (*Ocimum basilicum* L.) are the most popular herbal spices added to meat and its products. Their role in meat processing can be considered in several aspects. They have antioxidant and bactericidal properties and improve organoleptic properties, giving meat products a specific flavour, aroma, and desirable appearance. Polyphenols inhibit the development of undesirable microflora and limit oxidative changes in fats and proteins contained in muscle tissue and meat products, thereby extending the shelf life of raw meat material during storage. Including natural antioxidants in the diet has beneficial effects on human health because they protect the biologically important cellular components (DNA, proteins, and membrane lipids) from reactive oxygen species (ROS) attacks. Additionally, herbs exert a positive effect on the physiological and biochemical processes in the human organism, stimulate appetite, improve metabolism, digestibility of nutrients, and gastrointestinal function, prevent cancer and strengthen immunity.

P47. Modelling of thermal properties of fine and medium textured soils amended with different additives

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The effect of additives with different composition and origin - non-organic (microplastics), organic (vermicompost) and mineral (zeolite) on thermal properties of two soil varieties was studied. The soil samples were taken from the 0-20 cm layer of non-cultivated clay Deluvial-meadow soil, from the experimental field Gorni Lozen and of cultivated loam Haplic Cambisol, from the experimental station of potatoes in Samokov. The concentrations of the additives were 10% per mass of the sample.
The samples were analyzed for particle size distribution, mineralogical composition by XRD, soil organic carbon content, and water retention properties. The soil thermal conductivity, thermal diffusivity and volumetric heat capacity were measured with SH1 sensor of KD2Pro device (Decagon Devices) during the process of drainage at different matric potential in laboratory conditions. The received experimental data for thermal properties as a function of soil water content were used for validation of de Vries model (1963). The results showed that thermal properties of the mixtures with microplastics and zeolite were close to the control variant (soil) and decreased in the variants with vermicompost.

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References

de Vries D. A. (1963). Thermal properties of soils. In: W. R. Van Wijk (Ed.) Physics of Plant Environment North-Holand, Amsterdam, 210-235.

P48. Physical and physicochemical characteristics of soil polluted with heavy metals

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The aim of this study was to determine the influence of heavy metal pollution on the physical and physicochemical characteristics of medium textured Aluvial-deluvial soil. The undisturbed and disturbed soil samples were taken from two soil profiles under grass located at different distance from the Copper smelter in Pirdop. The disturbed soil samples were used for determining: particle size distribution, particle density, mineralogical composition by XRD, soil organic carbon content, cation exchange properties, surface charge by potentiometric titration by Titrino Metrohm 702SM apparatus, content of As, Cd, Cu, Pb and Zn by ICP Optical Emission Spectrometer Series 715-ES after preparing extracts with aqua regia. The undisturbed soil cores were used for determining the soil bulk density, soil water retention curves by suction plate apparatus, soil thermal conductivity, thermal diffusivity and volumetric heat capacity by KD2Pro device (Decagon Devices) during the process of drainage at different matric potential. The content of Pb, Cu, As, and Cd was above the maximum permissible level (Atanassov, 2008) in the humic horizon and decreased with depth and with distance from the Copper smelter. The negative surface charge in profile 1 (close to the smelter) did not varied significantly with depth while in profile 2 the charge decreases with depth. The physical properties of both profiles were similar. The soil structure characteristics and soil thermal properties changed significantly below the upper 0-5 cm soil layer. The water stability of soil aggregates was low below 0-5 cm which can be attributed to lack of biological activity due to the soil pollution.

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References

Atanassov, I., 2008. New Bulgarian soil pollution standards. Bulg. J. Agric. Sci., 14: 68-75

P49. Diversity in agrolandscapes of the steppe zone based on insect

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Today, one of the environmental problems is the global reduction of animal and plant species diversity (Ceballos et al., 2015). A significant reduction in the species diversity of insects is caused, among other things, by the intensification of agriculture and the use of new insecticides. The action of insecticides is not selective and, as a result, beneficial insects, including pollinators, die in masse.

Among arthropods, one of the groups used as indicators for assessing environmental quality are ground beetles (Coleoptera, Carabidae). These insects are extremely sensitive to changes in environmental quality in both natural and artificial ecosystems. The diversity and density of populations of these insects in each type of habitat is determined by many factors: microclimatic, edaphic, etc. In many cases, the diversity of beetles in agricultural landscapes is determined by the distance to, the area of, and the level of diversity within non-transformed natural landscapes. Insects were studied in the south of Ukraine in the Mykolaiv and Kherson regions. The material was collected by analysis of soil samples from an area of 0.25 m^2 (50 cm × 50 cm) to a depth of 10 cm and subsequent sieving of the soil through sieves of different diameters. The dynamic density of insects was established using soil traps. Transects from 25 traps were installed in each type of habitats at a distance of 10 m. Material sampling was performed daily. Aspects of insect diversity in natural landscapes and on the territories of fields and forest belts are considered in the work. The influence of agriculture is expressed in a tendency towards a decrease in diversity in all seasons (Fig. 1).

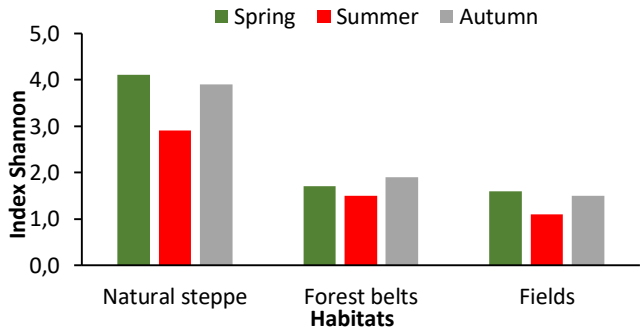

Figure 1. Seasonal changes values of the Shannon index in the studied habitats on the territory of the projected Dnipro wind farm and the natural steppe.

References

Ceballos G., Ehrlich P.R., Barnosky A.D., García A., Pringle R.M., Palmer T.M. (2015). Accelerated modern human-induced species losses: Entering the sixth mass extinction. Science Advances, 1, e1400253s

P50. Changes in agricultural soils affected by pollutants from poultry rearing – preliminary research

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Animal production, e.g. poultry farming, can pose serious problems to both surrounding environment and human health. Contaminants from poultry farms can have adverse effects on soil quality as a result of improper waste management and direct emission of organic dust or volatile odorous compounds from poultry houses. The studies conducted so far have mainly analysed the use of poultry wastes for fertilization purposes and its beneficial effects on soil properties and crop yield. However, the main environmental risk associated with animal wastes is the introduction of considerable amount of contaminants such as pathogens, pesticide residues, potentially harmful elements and a spectrum of emerging pollutants (veterinary pharmaceuticals, antibiotic resistance genes or steroid hormones). Therefore, there is an urgent need to assess the changes in soil quality and the potential risk in the areas of intensive animal production.

The aim of this preliminary research was to assess the changes in soil environment in the surroundings of a poultry house where the intensive broiler breeding was carried out. Soil samples were collected in March 2019 on the farm area, located in the north-eastern part of Poland, from the surface soil layer (0-20 cm) at a distance of 1, 10 and 50 m from poultry house. Soils were characterized with respect to their basic physicochemical properties (texture, pH, total C and N content). An ion chromatographic method with conductivity detection was used for determination of anions (F^-, Cl^-, NO_2^-, Br^-, NO_3^-, SO_4^{2-}, PO_4^{3-}) in soil extracts. Dehydrogenases activity (DH) and nitrification (NIT) were applied as biological indicators of soil quality. In order to assess potential risk, several trace elements and pharmaceuticals were determined in soil samples.

The study revealed that the concentration of trace elements was relatively low and did not exceed the limits specified in Polish Soil Quality Standards. Higher concentrations of Cu, As and Zn (used as nutritional additives to increase the efficiency of poultry feeding) were recorded in the closest distance from the poultry house. Generally, for determined inorganic anions a similar spatial distribution pattern was noticed. Variability in DH and NIT activity was also observed. Moreover, pharmaceutical residues such as metoclopramide (in all samples) or trimethoprim, sulfamethazine, carbamazepine (in single samples) were found. The results revealed that more extensive studies on the impact of intensive poultry farming on soil quality, are still required.

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P51. Changes in the secondary and tertiary structure of gluten network influenced by ferulic and caffeic acid supplementation

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Polyphenols are frequently added to wheat-based foods for potential health advantages or as an unintentional by-product of another ingredient such as bran or fruit fragments. Monomeric polyphenols, such as phenolic acids, can decrease gluten strength by reducing disulphide bridges. This attribute could be exploited in products that do not benefit from significant gluten growth but demand high mechanical energy inputs (Girard & Awika, 2020). Vibrational techniques such as Raman spectroscopy appear to be a suitable analytical approach to study the structure of gluten proteins as they do not require any expensive reagents or equipment (Kłosok et al., 2021).

The aim of the research was to examine the effect of caffeic and ferulic acids supplementation on the structure of gluten network. These phenolic acids were added to the model flour in concentration 0.05%, 0.1% and 0.2% (w/w). Model flour is consisting of commercially available wheat starch and wheat gluten in proportions 80:15 (w/w). After mixing, gluten was washed out, frozen, lyophilized and pulverized. Secondary and tertiary structures were determined by analysis of the amide I band, aromatic amino acid microenvironment and disulphide bridges conformation. Additionally, quantification of free SH groups and total SS groups was performed according to procedure of Wang et al. (2016).

The formation of β-sheet-like structures from α-helices and β-turn structures is the most significant structural modification detected in the amide I band. Addition of these phenolic acids did not cause considerable changes in the SS conformation. When compared to the control sample, both the SS and free SH groups increased following supplementation. Tyrosine doublet was increased in all samples following supplementation, and tyrosine residue was exposed. The intensity of the tryptophan band increased following ferulic acid supplementation, resulting in more buried tryptophan residue. However, the intensity dropped in samples supplemented with higher caffeic acid contents, which lead to more exposed tryptophan residue. Obtained results indicate that caffeic and ferulic acids can be incorporated into gluten network or be enclosed in hydrophobic pockets.

Acknowledgments

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References

Girard, A. L., Awika, J. M. (2020). Effects of edible plant polyphenols on gluten protein functionality and potential applications of polyphenol–gluten interactions. Comprehensive Reviews in Food Science and Food Safety, 19(4), 2164–2199.

Kłosok, K., Welc, R., Fornal, E., Nawrocka, A. (2021). Effects of Physical and Chemical Factors on the Structure of Gluten, Gliadins and Glutenins as Studied with Spectroscopic Methods. Molecules, 26(2), 508.

Wang, X.-Y., Guo, X.-N., Zhu, K.-X. (2016). Polymerization of wheat gluten and the changes of glutenin macropolymer (GMP) during the production of Chinese steamed bread. Food Chemistry, 201, 275–283.

P52. Agronomical benefit of pulse as cover crops

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All the benefits of conservation practices increased farmers' interest in the cultivation of cover crops. Cover crops have a positive effect on agroecosystems by: 1) reducing soil erosion and nitrate leaching, 2) increasing water infiltration and maintaining soil moisture, 3) suppressing weeds and reducing the occurrence of pests, nematodes and soil pathogens, 4) improving soil quality by increasing the content of organic matter and the availability of nutrients.

Among the cover crops, pulses play a significant role. They improve soil quality and provide more favorable conditions for the growth and development of successive crops, as well as contribute to the reduction of weed infestation. Therefore it is important to improve our knowledge on pulse cover crops cultivation, including their importance in protecting crops against weeds, and their effect on nitrogen and organic matter content in the soil, biological properties of the soil, and its erosion.

Pulses as cover crops (e.g. *Medicago lupulina* L., *M. sativa* L., *Trifolium pratense* L., *T. repens* L., *T. incarnatum* L., *T. subterraneum* L., *Vicia villosa* Roth., *V. sativa* L.) might be a beneficial agronomic solution for the different crops, especially when apart from improving or maintaining agricultural production at a high level, one of the additional aims is to protect natural resources. However, it may be difficult to adapt the cultivation strategy to the different species of pulse due to their different agrotechnical requirements, as well as phenological, morphological, and physiological features that can affect the productivity of the main crop. Therefore, using multi-species cover crops mixes that include pulses seems to be a good solution, in which different species can complement each other or act synergistically.

Pulse cover crops as living mulch inhibit the development of weeds through niche pre-emption, and their residues inhibit or delay weed emergence and growth by creating a physical and chemical barrier (allelopathic effect). In addition, they also may reduce compaction and erosion of the soil, and increase the content of organic matter and activity of soil microorganisms as well as its nitrogen content due to symbiotic N2 fixing. So, a wider use of pulse cover crops is needed in crops, especially in those with limited use of pesticides and mineral fertilizers.

P53. Agrophysical bases of the formation of complex agrochemicals on a polymer matrix

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A variety of agrochemicals are widely known, providing plant nutrition at the expense of the main macroelements (nitrogen, phosphorus, potassium) and a wide range of microelements that make up their composition. They, together with the formed soil fertility, constitute the main basis of the harvest of cultivated crops. Corrective methods of using various agrochemicals are also known, including both root and foliar fertilizers. In this case, foliar dressing can be carried out at certain phases of the growth processes of the vegetative mass of plants and are the most operational. At present, in addition to agrochemical methods, various compositional means for controlling the growth and development of plants on an agrophysical basis are being developed. The aim of the study was to develop an agrophysical basis for the formation of complex agrochemicals. The objects of research were new complex agrochemicals of the KAA series (Komarov A.A., Komarov A.A., 2018). At the same time, their main basis was a polymer matrix, on which both nutrients and other means of controlling the growth and development of plants (enzymes, hormones, humates, amino acids, etc.) were fixed. The basis of the polymer matrix contained fragments of carboxylic acids (up to 30-93 wt%), fragments of unsaturated carboxylic acids, which were selected from the following group of monomers: glutamic, methacrylic, acrylic, alginic, maleic, fumaric, lactic acids (up to 1.0 -32.5 wt.%), N-vinylamide, and also contained 0.7-62.7 wt.% Salts (Patent No.2401824). Significant differences between these fertilizers consisted in the fact that it was possible to introduce into the polymer matrix (without harm to plants) significant amounts of nitrogen (up to 25%), phosphorus (up to 25%) and potassium (up to 15%), as well as trace elements that were fixed in it. in the form of organomineral complexes. In addition, the organic polymer, which is the basis of fertilizers, having surface-active and adhesive properties with respect to the surface of the leaf plate, shoot, stem, is able to deposit and then prolonged supply of nutrients to a vegetative plant. The polymer itself (after using all the nutrients from it) decomposed into simple components in the form of H_2O and CO_2. The polymer and its decomposition products did not pollute or poison the environment, which made it possible to use it in organic farming. Research was carried out were carried out both in laboratory and in the field in various agro-climatic zones of Russia and Kazakhstan from 2009 to 2021.

According to the results of the research, the high efficiency of such polymer composites as "Aquadon-Micro", "Zelenit", "Cora" and "Vitanoll" was revealed. For example, the action of the applied wetting agent in these composites made it possible to ensure the distribution of fertilizers over the surface of the sheet with an even thin layer covering the entire surface of the sheet with a film, which ensured their high resistance to insolation and washout. The use of polymer fertilizers as a means of foliar feeding made it possible to create rational systems of mineral nutrition, sharply increase the resistance of the productive phytocenosis to adverse weather conditions, significantly reduce the amount of applied mineral fertilizers, and improve the quality and quantity of fertilizers. crops, and significantly increase the profitability of agricultural production. The use of polymer fertilizers as part of foliar dressing provided a yield correction in the system of precision farming and precision plant growing. In this case, the decisive factor was the factor of the optimal time of exposure of the correcting agent to the growing plant in the critical phases of growth and development of the cultivated crop. This is especially important when switching the physiological mechanisms of plant nutrition, when instead of accumulating biophilic elements in the organs of by-products (leaves, stems, etc.), nutrients were reused in the organs of storage and reproduction (grain, tubers, fruits). In the practical application of these drugs, a synergistic effect was repeatedly observed, especially when used together with plant growth regulators. Thus, the use of "Vitanoll" provided an improvement in the quality of crop production and an increase in the yield of grain, industrial, vegetable, spicy-aromatic crops and medicinal plants by 10-50%; the average economic efficiency of foliar fertilization has reached more than 10 euros per 1 euro of costs.

References

Komarov A.A., Komarov A.A. (2018). Prospects of the use complex agrochemicals for differentiated its introduction as a means of growth management and plant development, Agrochemical Bulletin, 6, 37-41.
Patent No. 2401824 (2010). Russia.

P54. A complex of agrophysical and physiological-biochemical principles in the fight against drought

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The main limiting factor limiting the growth and development of plants in the arid zone is the lack of moisture. It is known [1] that in agricultural practice, moisture-swelling polymer materials in the form of hydrogels, hydrophilic polymers of a network structure, are used as a means to improve the water regime of the soil and the moisture supply of plants. These polymers, upon contact with water, quickly absorb and keep it in their volume for a long time. When introduced into the soil, hydrogels are able to accumulate a large amount of moisture, providing a significant increase in moisture in the soil and creating favorable conditions for plant development. Taking into account the agrophysical features of hydrogel polymers, which ensure the preservation of moisture in the soil, it seemed very important to use them in drought conditions [2]. Thus, hydrogels based on acrylamide and acrylic acid are capable of fixing 270 ml of water per 1 g of hydrogel [3]. However, despite their unique properties, hydrogels are still not widely used in plant growing. This is due to the fact that hydrogels are introduced into the soil in large doses, 400 kg or more [4]. Considering the high cost of hydrogels - up to 10 euros / kg, their use when applying the soil is not economically profitable. Therefore, to use the potentially valuable properties of the hydrogel, it is necessary to search for other methods of its application.

The purpose of the research is to develop a method for activating the development of the root system of plants in drought conditions. This goal was achieved through comprehensive measures combining both agrophysical and physiological and biochemical principles in the fight against drought using polymer hydrogels and physiological activators of growth processes.

Model laboratory and field experiments were carried out at the A. I. Baraev from 2019 to 2021. The research was carried out in the arid Akmola region of Kazakhstan on chernozem soils with the following agrochemical parameters: pH 8.2-8.4 (GOST 26423-85); Humus 3.6-3.8% (GOST 26213-91), N-NO_3 4-6 mg/kg (GOST 26951-86); K_2O 670-723 mg/kg (GOST 26205-91); P_2O_5 20-30 mg/kg (GOST 26205-91). In the experiments we used the «Ritin-10» hydrogel, which was kindly provided by T.N. Danilova[5]. The experiments used hormonal preparations of the auxin type (heteroauxin) at concentrations of 10^{-5} and 10^{-9} M and humic fertilizer «Stimulife» [6] at concentrations of 10^{-1} and 10^{-3}%. Statistical processing of the results of field and laboratory experiments was carried out using the Stat program.

Research results. A new method for activating the development of the root system of plants under drought conditions has been developed. A patent was obtained confirming the novelty of research [7]. The new method was implemented through complex measures that combine both agrophysical and physiological and biochemical principles in the fight against drought. The method included the use of polymer hydrogels of any composition with moisture-swelling ability with high moisture absorption rates.Before sowing, the seeds were soaked in solutions of activators of growth and development of the root system of plants in strictly specified concentrations. Then the seeds were encrusted with dry powder of finely ground hydrogel. The seeds prepared in this way were sown into the soil according to the usual technology using standard seeders. Phytohormones of the auxin type (for example, indolylacetic acid) at a concentration of 10^{-8}...10^{-9} M and humic preparations (for example, «Stimulife») at a concentration of 10^{-3}...10^{-5}% which stimulated the development of the root system of plants. This ensured the penetration of roots from the upper arid ones into the deeper and better provided with moisture horizons of the soil. This, in turn, contributed to better plant nutrition, reduced stress, increased plant productivity and quality.

References

Patent No. 2189382 RU (1998). Moisture-swellable soil conditioner and the method of obtaining it.

Okolelova A.A., Zheltobryukhov V.F., Egorova G.S., Rakhimova N.A., Kasterina N.G., Zaikina V.N., Shcherbakova L.F. (2016). Application of a hydrogel in soils. Volgograd.

Naumova P.V., Shcherbakova L.F., Okolelova A.A. (2011). Optimization of soil moisture supply using polymer hydrogels. Izvestiya Nizhnevolzhsky Agrouniversity Complex, 4 (24), 1-5.

Agafonov O.M., Revenko V.Yu. (2018). Possibilities of polymeric hydrogel as storage of soil moisture in the zone of unstable moistening in the krasnodar region. International Journal of Humanities and Natural Sciences, 10, 35-38.

Danilova T.N. (2018). Influence of polymer gels "Ritin-10" and "V-415K" on water supply of grain crops in conditions of soil drought. Agrophysics, 1,1-9.

Komarov A., Petropavlovsky A., Yakushev V. (2010). Perspectives of humic preparation «Stimullife®» in Target Inflluence Technology. 15th International Humic Substances Society Meeting (IHSS15), "Humic Substances and the Maintenance of Ecosystem Services".

Patent №35226 KZ (2021). Method to activate the development of root system of plant in conditions of drought.

P55. Study of chlorpyrifos residues in apples and citrus fruits

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Chlorpyrifos and chlorpyrifos-methyl are two insecticides that have not been renewed by the European Commission. According to the opinion of the European Food Safety Authority (EFSA), these substances are genotoxic and neurotoxic to human health, especially children, causing brain damage. The deadline for the use of these insecticides in the European Union expired on April 16, 2020. The aim of the study was to investigate whether the selected fruits contain chlorpyrifos residues. The experiment compared 2011, when the use of chlorpyrifos was allowed, and 2019, which was the penultimate year of use of this pesticide in the European Union. The presence of chlorpyrifos residues in fruits makes it possible to assess the trend of fruit producers' compliance with the relevant legal regulations. The study covered apples (15 samples) and citrus fruits (oranges, grapefruits and lemons - a total of 12 samples), which came from the 2011 and 2019 seasonal harvests. The peel, flesh and whole fruit were sampled from apples, while in the case of citrus fruits, the peel and flesh were tested. The pesticide content was assessed using the QuEChERS method and the HPLC chromatographic technique with an MS/MS detector according to the previously described procedure [1].
In apple skins from the 2011 harvest, chlorpyrifos was detected in 44% of the tested samples - on average 0.131 mg/kg, from 0.023 to 0.269 mg/kg (MRL 0.05 mg/kg). In 30% of samples of whole apples and pulp, the presence of chlorpyrifos was found, respectively: 0.029 mg/kg, 0.016 to 0.049 mg/kg, and 0.014 mg/kg, 0.008 to 0.024 mg/kg, respectively. No chlorpyrifos was found in the apple samples from the 2019 harvest. In 2011, chlorpyrifos was found in all the tested citrus fruit peel samples (100%): on average 0.315 mg/kg, from 0.030 to 1.135 mg/kg compared to 2019, when the number of contaminated samples decreased by 50% (on average 0.111 mg/kg, from 0.074 to 0.138 mg/kg). In 2011, 30% of citrus fruit pulp samples showed the presence of chlorpyrifos: on average 0.006 mg/kg, from 0.005 to 0.007 mg/kg (MRL 0.3 mg/kg), while in 2019 no chlorpyrifos was found in the analyzed citrus pulp samples. Summarizing the study, one can clearly notice the limitation of the use of chlorpyrifos in the protection of apple and citrus trees.

References

Kowalska G. (2020). Pesticide Residues in Some Polish Herbs. Agriculture, 10(5):154. https://doi.org/10.3390/agriculture10050154

P56. Problems related to the quality of soils in rural areas in Poland – based on questionnaire surveys

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Soil is a non-renewable natural resource, one of the most important components of the natural environment. It is primarily important as a means of crop production, producer and absorber of gases, natural environment for a huge number of organisms which break down organic matter, providing nutrients for plants. At the same time, it is one of those natural resources which are easily degraded, thereby leading to deterioration of the biological activity of the environment, with particular emphasis on agricultural production, ecological and sanitary conditions effecting plants, animals and humans, as well as landscape values. In order to maintain the proper quality of the soil, it is very important for farmers to be ecologically aware of the causes of soil degradation and the methods of its improvement. To a greater extent than before, the responsibility for soil care rests with the people who use the soil on a daily basis.

The presented study is based on the results of a survey conducted among the participants of training courses organized within the project „Protection of soil biodiversity as a condition of health of present and future generations" No. POIS.02.04.00-00-0082/16 in 2018–2019. The aim of the survey was to assess the environmental awareness of the respondents in terms of the quality and productivity of cultivated soils in Poland and methods of their protection. The questionnaire included questions about problems related to soil, fertilization, protection of plants and climate change. The analysis of the results was based on 307 completed questionnaires.

It was found that the users of agricultural soils in Poland take a conscious approach to soil management. They recognize serious problems related to maintenance of proper soil moisture and structure, protection against diseases and pests, use of proper fertilization and crop rotation. Irrigation was identified as the main problem faced by producers in cultivating crops, followed by the protection of plants against pests and diseases. Many of them also have problems with determining the proper fertilization, because they do not perform chemical analyses of the soil or are unable to determine the dosage of fertilizers on the basis of the obtained results of the analysis. Therefore, for farmers, it is important to provide substantive support by qualified experts as well as assistance in the form of training and specialist advice.

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P57. Changes in the structure of gluten proteins caused by supplementation of the model wheat dough with selected flavonoids and their glycosides

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Polyphenols are compounds commonly found in plants. Among them, two large groups of compounds were distinguished: phenolic acids and flavonoids. Due to their antioxidant properties, these compounds can have a positive effect on the human body. Therefore, they can be an appropriate supplement to wheat bread, which is part of the daily diet for many people (Dziki et al., 2014).

The quality of bread is greatly influenced by the physicochemical properties of gluten proteins (gliadins and glutenins). These proteins affect the quality of the wheat flour and therefore also the quality of the wheat dough. Glutenins and gliadins are able to form a macromolecular complex in the presence of water (gluten). The gluten has the form of a viscoelastic mass, which in molecular terms is composed of polypeptide chains. Adding phenolic compounds to the dough may disrupt the proper structure of the gluten network (Krekora et al., 2021).

The aim of the research is to determine the effect of selected polyphenols from the group of flavonoids (quercetin, hesperetin) and their glycosides (rutin, hesperidin) on the structure of gluten proteins in the model wheat dough using FTIR spectroscopy.

Analysis of the difference spectra in the amide I band showed that all spectra can be divided into two spectral regions. The range from 1570 to 1650 cm^{-1} with negative bands and the range from 1650 to 1720 cm^{-1} with positive bands. A similar arrangement of the bands in the positive range, related to β-sheets and anti-parallel β-sheets after the addition of quercetin and their glycoside (rutin), indicates that these compounds react with gluten proteins with the OH group present at the B ring. However, a different arrangement of the bands in the case of hesperetin and its glycoside, can be connected with an additional OCH3 functional group present in the structure of these compounds.

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References

Dziki, D., Różyło, R., Gawlik-Dziki, U., & Świeca, M. (2014). Current trends in the enhancement of antioxidant activity of wheat bread by the addition of plant materials rich in phenolic compounds. Trends in Food Science & Technology, 40(1), 48–61.

Krekora, M., Miś, A., & Nawrocka, A. (2021). Molecular interactions between gluten network and phenolic acids studied during overmixing process with application of FT-IR spectroscopy. Journal of Cereal Science, 99, 103203.

P58. Influence of the phenolic acids addition on the structure and properties of microfibrillar cellulose and nanocellulose-based composites

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Phenolic acids are a group of organic chemical compounds naturally occurring in plants. They have antioxidant capacity but this compounds out of plant tissue are easily oxidized. This makes difficult to use properties of polyphenols in the food industry without a stabilizer [1]. Cellulose has high mechanical strength and relatively low density provides possibility to produce completely biodegradable, durable and safe food packaging [2]. Our research provides to use cellulose or nanocellulose as a biocompatibility matrix material to enabling the adsorption on surface phenolic acid and stabilized it. Our composites are based on cellulose produced from vegetable and fruit post-production waste as additional advantage for the food industry [3]. Phenolic acids adsorbed on the surface allow to create and improve composites with antioxidant properties and changes some other properties of plant cellulose films. The amount of absorbed phenolic acids, antioxidant capacity, molecular structure, hydrophobicity and thermal properties were measured. Generally phenolic acids retained their antioxidant properties and composite with gallic acid had the highest antioxidant properties. The Raman spectra showed that the larger molecule like chlorogenic acid better adheres to the cellulose/nanocellulose surface than smaller like gallic acid. The addition of phenolic acids improved hydrophobic properties and the composites containing phenolic acids were stiffer than cellulose alone.

Acknowledgments

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References

1. Anh Dao T. Phan, Gabriele Netzel, Dongjie Wang, Bernadine M. Flanagan, Bruce R. D'Arcy, Michael J. Gidley (2015). Binding of dietary polyphenols to cellulose: Structural and nutritional aspects, Food Chemistry, Volume 171, Pages 388-396.
2. Renard C., Watrelot A., Bourvellec C. (2017) Interactions between polyphenols and polysaccharides: Mechanisms and consequences in food processing and digestion. Trends in Food Science and Technology, volume 60, 43-51.
3. Szymańska-Chargot M., Chylińska M., Gdula K. (2018). Characterization of cellulose isolated from fruit and vegetable pomaces, World Polymers Congres MACRO 2018, Cairns, Austria, 1-5.07.2018 r., str. 354

P59. Potato and raspberry stem biochars as a tool to reduce greenhouse gases emission

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Climate changes strongly affect the ecosystems and put agriculture in the face of new challenges. One of the major issues, which could prevent the negative changes is the reduction of greenhouse gases (GHGs) emission, such as CH_4 and CO_2. Of particular importance is the reduction of GHG emissions from soil due to the large-scale of this process. Soil enrichment with biochar was proposed as a means of carbon sequestration and mitigation of GHGs emission [1]. Modern agriculture also is looking for ways of beneficial management of post-harvest plant biomass. Biochar production from plant waste could be helpful in both matters. For this reason, biochars produced from widely available waste materials with useful qualities are still being sought.

The aim of our study was to determine the potential of CH_4 uptake and CO_2 production by selected biochars prepared from plant waste materials (wood offcuts, sunflower husk, raspberry and potato stems). In our experiment, the consumption of 1% CH_4 and CO_2 emission of selected biochars incubated at 60 and 100% water holding capacity (WHC) with the addition of 1% CH_4 (v/v) were investigated for 28 days at 25°C. New biochars from potato and raspberry stems showed highest potential for CH_4 uptake in both moisture levels. Moreover, these biochars produced significantly less CO_2 than wood offcuts biochar. Consequently, we obtained negative net GWP calculated for new biochars from potato and raspberry stems [2].

Since the potato is one of the main global crops (ca. 17.5 million ha in 2018, FAOSTAT), the amount of potato stems as a plant waste is considerable. Raspberry crops are less widespread but still they have a local significance (e.g. in Europe). It should also be noted that the stems are often a habitat for parasites and pathogens so for this reason they should be disposed of properly [2]. Those facts could be the environmental and economic justification for the application of newly prepared biochars from potato and raspberry stems as a tool to reduce GHGs emission, improvement of soil physicochemical properties and limitation of plant diseases and pests.

Acknowledgments

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References

Kammann, C., Ippolito, J., Hagemann, N., Borchard, N., Cayuela, M.L., Estavillo, J.M., Fuertes-Mendizabal, T., Jeffery, S., Kern, J., Novak, J., Rasse, D., Saarnio, S., Schmidt, H.P., Spokas, K., Wrage-Mönnig, N. 2017. Biochar as a tool to reduce the agricultural greenhouse-gas burden–knowns, unknowns and future research needs. J. Environ. Eng. Landsc. Manag., 25, 114–139.

Kubaczyński A., Walkiewicz A., Pytlak A., Brzezińska M. 2020. New biochars from raspberry and potato stems absorb more methane than wood offcuts and sunflower husk biochars. Int. Agrophys., 34, 355-364.

P60. Soil CO_2 emissions, induced by different tillage operations

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Crop production is a source of greenhouse gas emissions due to soil disturbance by tillage, improper management of crop residues, fertilization and the use of machinery. Tillage is a basic practice for growing crops, but intensive treatments lead to mineralization of soil organic matter and carbon dioxide fluxes.

A study on soil short-term CO_2 emissions, induced by the application of some technological operations, which are an integral part of conventional and soil protection technologies, was conducted. The applied treatments were: slitting, operation, which is part of technology for minimum tillage and conventional - disking and shallow tine cultivation on plowed area, disking on plowed area, stubble disking and uncultivated stubble. For their implementation were used: the special device for slitting, in this case applied on stubble, as well as general-purpose machines: disc harrow, shallow tine cultivator.

The study was conducted on calcic chernozem during the fall. CO_2 emissions were measured after chambers incubation with CO_2 gas analyzer and recorded during the first hour, the second hour, on the fourth and the tenth day.

In the first hour, after the operations and in the second, the highest CO_2 emissions were obtained. Stubble emissions were the lowest (0.35 kg ha^{-1} h^{-1}). The highest fluxes were measured in the variant with shallow tine cultivation and disking of plowed area, which were 2.08 kg ha^{-1} h^{-1} and 1.07 kg ha^{-1} h^{-1}, respectively, during the first hour and 0.47 kg $^{-1}$ h^{-1} CO_2 in the application of slitting on the stubble. The difference between CO_2 emissions of the tilled and untilled areas decreases by the tenth day.

The results of the study indicate that the lower intensity of tillage leads to lower levels of carbon dioxide emissions. The development of technological operations and machines that lead to conservation of soil organic matter are essential for modern crop production, whose main objectives are the soil carbon sequestration and reducing the amount of greenhouse gases from the agricultural sector.

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P61. Thermal behavior of pellets during pyrolysis

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Contribution deals with thermal behavior study of the pellets during pyrolysis. The sample of the pellets from dried grasses and another biological waste from cleaning grain. A simple kinetic thermal decomposition samples was investigation with isoconversional methods, such as Kisinger - Akahira - Sunose and Flyn - Ozawa - Wall model. The goal of this research is to description of the thermal behavior of the pellets during pyrolysis using thermogravimetric analysis (TGA), that allow obtaining more precise information in the characterization of biological waste in pellets forms. Basic composition of sample is cellulose, hemicellulose and lignin therefore maximal weight loss observed in temperature range from 180 °C to 450 °C. Minimally mass loss is evident for too initially and final area of the thermal decomposition to 100 °C and 900 °C, respectively. Activation energy was calculated in the range from 67 kJ.mol^{-1} to 683 kJ.mol^{-1}. The increase of activation energy and rate constant is observed with increasing mass loss to conversion 0.8 and in both models for all heating rate. Flyn - Ozawa - Wall model shows higher activation energy for smaller conversions. The final decomposition temperature of the individual components of the sample was determined via differential thermal analysis (DTA) curve in the temperature range from 300 °C to 350 °C.

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References

Anca-Couce A., Berger A., Zobel N. (2014). How to determine consistent biomass pyrolysis kinetics in a parallel reaction scheme. Fuel, 123, 230-240.
Sonobe T., Worasuwannarak N. (2008). Kinetic analyses of biomass pyrolysis using the distributed activation energy model. Fuel, 87, 414-421.
Guo F., He Y., Hassanpour A., Garby J., Zong Z. (2020). Thermogravimetric analysis on the co-combustion of biomass pellets with lignite and bituminous coal. Energy, 197, 117-127.
Onsree T., Tippaywong N., Zheng A., Li H. (2018). Pyrolysis behavior and kinetics of corn residue pellets and eucalyptus wood chips in a macro thermogravimetric analyzer. Case Studies in Thermal Engineering, 12, 546-556.

P62. Functional composition in the bacterial core microbome of soil microorganisms during the growth of the subsequent crop

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Microorganisms play an essential role in numerous processes in the soil ecosystem. Recently, the determination of core microbiome in agroecosystems is received significant attention with a main objective being to maximize utilization of microbiome function. The aim of this study was to determine both, composition and functional features of the soil core microbiome during the growth of the subsequent wheat cultivars (Tytanika, Nordcap, Hondia, Rotax). Bulk soil samples from a 0–20 cm depth layer were collected (autumn time), during the growth of the subsequent wheat (after legume and wheat forecrop). Bacterial microbiome was analyzed by Next Generation Sequencing (NGS) and Community Level Physiological Profiling (CLPP) techniques.
We overall observed no differences in bacterial activity (Average Well Color Development, AWCD) in terms of the use of different groups of carbon substrates in soil samples from the cultivation of four wheat varieties and different fore crops. However, the microorganisms inhabiting the rhizosphere of the studied wheat cultivars with different forecrop were characterized by a different use of individual carbon substrates. This fact was reflected in the functional determination of the bacterial core microbiome of the soil. The differences in bacterial core microbiome were determined using FAPROTAX database. We found that bacterial core microbiome found in soil after wheat forecrop has dominant functions compared to bacterial core microbiome in soil after legume forecrop. The differences in the bacterial microbiome were noted regarding in the group function microorganisms of: methanotrophy, methanol oxidation, methylotrophy, aerobic ammonia oxidation, aerobic nitrite oxidation, nitrification, nitrogen fixation fermentation, aromatic hydrocarbon degradation, predatory or exoparasitic, intracellular parasites and aerobic chemoheterotrophy. It is noteworthy much lower relative abundance of the taxa with the intracellular parasites function in the microbiome of the soil with the legume forecrop. Similar results were obtained by Siczek and coworkers (2020), who indicates some protective role against pathogens in the soil after faba bean, which may result in lower fungicide requirements.

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References

Siczek A.; Frąc M.; Gryta A. Forecrop (2020). Effects on Abundance and Diversity of Soil Microorganisms during the Growth of the Subsequent Crop. Agronomy, 10, 1971.

P63. Investigation of microaggregate stability of different soils as a function of characteristic soil properties

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Soils consist of structural elements and aggregates of various shapes, sizes and organizations, which are formed by the arrangement of different soil components. The shape, size, and spatial arrangement of aggregates determine the size and relationship of pores to a number of physical, chemical, and biological processes (transport and storage of heat, gas, water, and dissolved nutrients). The structure of the soil can be described in several ways: in terms of the shape, size and stability of its aggregates. Stability expresses the degree of resistance to various degradation effects (e.g. water erosion) as a function of time. The aggregate stability of soils can be affected by many factors: mineral and organic binders, and external factors independent of the soil (e.g. environmental, agricultural impacts). According to general theories, microaggregates (<250 µm) are predominantly stabilized by organic-mineral complexes, which are relatively stable and are not easily degraded by changes in soil organic matter content as a result of land use and cultivation.
In our study, we searched for a quantifiable relationship between microaggregate stability and different soil properties. We examined 56 complete soil profiles in Hungary, which were selected based on their varied parameters. Microaggregate stability was determined by laser diffractometric method (LDM), with Malvern Mastersizer 3000 device, using Hydro LV dispersion unit, as the ratio of dispersed to non-dispersed clay content.
The measured data were arranged in a database and correlation and regression analysis were performed between each measured soil property and the microaggregate stability. Results show that there is a good correlation between microaggregate stability and calcium carbonate, humus content, pH, and soil type. A clear relationship can also be observed between cultivated and uncultivated soil horizons

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Supported by the ÚNKP-20-3 New National Excellence Program of the Ministry for Innovation and Technology from the source of the National Research, Development and Innovation Fund."

P64. Modified expression of prolyl 4 hydroxylases (P4Hs) revealed the effect of arabinogalactan proteins (AGPs) on cell wall changes during fruit ripening process

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Arabinogalactan proteins (AGPs) as cell wall-plasma membrane continuum components are implicated in numerous physiological events in all aspects of plant development (Showalter 2001). Despite the huge interest, no detailed research has been done so far on AGPs found in fruit during ripening process. Thus, the aim of this research was to examine presence, molecular characterization and spatial-temporal localization of AGPs in tomato fruit tissue in which prolyl 4 hydroxylases (P4Hs) are up/down-regulated. Using transgenic lines - fruit with altered AGP structure lead to the discovery of general functional aspects of AGPs in fruit ripening. For these reasons, tomato lines with silencing and overexpression of P4Hs genes at different stages of ripening were the research material. For precise characterization of AGP features*, in-* and *ex-planta*, extraction proteins, SDS-PAGE, Western blot, immunofluorescence labelling with CLSM were used.
In tomato of RNAi lines at green stage, AGPs with various molecular mass are detected - 50-150kDa (JIM13), 80-200kDa (LM1), 80-120kDa (LM2). With the progress of ripening of RNAi lines, the molecular mass of AGP recognized by JIM13 increases significantly, in comparison to wild type. In case of OEX lines, in the green stage, no differences were found between AGPs derived from transgenic lines and unmodified plants. AGP epitope recognized by JIM13 alternates in the OEX#1 and OEX#2 lines at the red ripe stage. On the other hand, the part of the AGP bound by LM2 undergoes modifications already at the breaker stage, and the molecular mass of AGP from modified fruit significantly increases compared to AGPs from wild type fruit.
The obtained results indicate the effect of P4Hs on AGPs glycosylation (JIM13, LM1, LM2, MAC207 epitopes) and cellular distribution in tomato tissue. In tomato fruit from all analysed transgenic lines, changes in presence and in molecular features of AGPs are observed. Moreover, described changes are correlated with specific stages of ripening process.

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References

Showalter A.M. (2001). Arabinogalactan-proteins: structure, expression and function. CMLS, 58, 1399-1417.

P65. Organic fertilization effect on hemp seed and biomass yield

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In conventional growing systems where synthetic fertilizers and agrochemicals are used many of the threats of soil nutrient depletion, weeds, pests, and diseases are easily overcome. That is why the organic fertilization and ecological farming is getting popular and required. In this article organic farming of hemp (*Cannabis sativa* L.) is presented. Studies of this kind have not been carried out so far. One of the possibilities of organic fertilizer is the mulberry silkworm (*Bombyx mori* L.) breeding waste. This insect breeding is a cheap source waste, which gives very positive results on the plants yield.
In this research 3 repetition pots were prepared: with silkworm fertilizer 15 t/ha, 30 t/ha and pots without fertilization (control). The amounts of 3 yields: total, straw and seed were measured. Moreover, chemical composition of silkworm waste, soil and hemp material was tested. The best results of fertilization were obtained in silkworms manure fertilization in dose 30t/ha (Łochyńska and Frankowski, 2019).

Acknowledgments

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References

Łochyńska M., Frankowski, J. (2019). Impact of Silkworm Excrement Organic Fertilizer on Hemp Biomass Yield and Composition. Journal of Ecological Engineering, 20, 63-71.

P66. Relevance and biodiversity of *Neosartorya* spp. fungi in fruits production

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As Poland is also a market leader of berry production in the EU and the world, this position requires the producers and processors of fruits to monitor the quality of their raw materials. Fruits can be settling or contaminated by various microorganisms, including fungi, that developed various adaptations allowing them to survive in the environment as a result of their exposure to fungicides and climate change. Initially, these were mainly adaptations for protection against the harmful effects of various natural environmental stressors. With regards to evolution, fungi have developed additional mechanisms of response to temperature, light, humidity, oxygen, or the presence of chemical compounds, which allowed them to effectively adapt to changing environmental conditions, including resistance to high temperatures. Therefore, inside the kingdom of fungi, we can observe high biodiversity and vast adaptation mechanisms. Most fungal species grow and develop best in warmer temperatures. However, there are many kinds of fungal organisms exhibiting unique resistance to heat, which enables them to thrive in otherwise adverse conditions. Especially, representatives of filamentous fungi belonging to the *Neosartorya* genus forming ascospores, which occurs naturally in soil and plant debris, can be resistant to high temperatures. These fungi are mostly associated with contamination of canned fruit products, juices and raw fruit product, causing enormous financial losses during production and transport stages of manufacture.

Despite ever-developing technologies of food preservation, many species of thermo-resistant fungi can withstand popular preservation techniques, such as pasteurisation. Because of this, merely increasing the temperature during production isn't always the correct tactic, as it may impair food quality and help in the cultivation of fungal pollutants that are already present on produce due to the previous contact with soil. This occurrence may lead to food spoilage by the growth of mould and accumulation of mycotoxins, directly responsible for causing diseases.

The metabolic, morphological and genetic properties of *Neosartorya* spp. fungi are changing and thus can be important in their resistance to preservatives, chemicals and natural plant extracts. Various species of this genus can create ascospores with different shapes, structures and resistance to temperature, chemicals and other factors. Some studies focused on conditions affecting the growth of *Neosartorya* fungi have been carried out already, with most of them examining the link between temperature, pH, presence of sugar and organic acids. However, there are no conclusive results, especially ones that can be used in modifying the stages of large-scale crop and food production. Thus, further research on both the nature of *Neosartorya* spp. and alternative control of these fungi is needed.

Acknowledgments

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P67. Measurement of soil moisture by the TDR method with the use of a dagger probe

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There are many types of soil moisture probes on the market. These probes differ in design and application. In case of laboratory probes, the sensitivity zone of the probe is important. However, in the case of field tests, an important parameter is the appropriate mechanical strength of the probe, due to soil heterogeneity and presence of potential obstacles such as plant roots or stones.
This paper presents a prototype of a dagger probe for soil moisture measurement using the TDR method. The probe works with a vector network analyzer. The frequency range from 3.75 MHz to 3 GHz with a 3.75 MHz step was used. In addition to measuring the soil dielectric permittivity, from which soil moisture is indirectly determined, the probe is used to measure the electrical conductivity of soil.
At first, the probe was evaluated with the use of numerical simulations and laboratory tests. The design of the probe was simulated in Ansys HFSS software. Laboratory measurements included reference materials such as aqueous KCl solutions of various electrical conductivity and moist sand. Afterwards, field tests were conducted. The obtained results obtained show that the proposed probe design is suitable for field measurements in the full moisture range, from dry to saturated soils. Additionally, due to its design, it is suitable for mobile devices for soil moisture measurement.

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References

Majcher J., Kafarski M., Wilczek A., Szypłowska A., Lewandowski A., Woszczyk A., Skierucha W.(2021). Application of a dagger probe for soil dielectric permittivity measurement by TDR, Measurement, vol. 178, s. 1-13

P68. Methodological comparison of particle size distribution data on a nationally representative soil database in Hungary

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Worldwide more and more soil scientist and practical soil consultant are taking a stand for or against the use of laser diffraction method for particle size distribution determination (LDM PSD) in soil physics. The poor agreement of LDM PSD test data with the results of conventional (standard) sedimentation tests, which also depends on the properties of the soil samples, is attempted to be resolved by some by specifying and standardizing the LDM PSD measurement methodology, others by clarifying the evaluation methods. In order to find the right measurement and evaluation methodology, it is essential to have a large number of results from samples with a wide range of soil properties, which can be organized into a database for statistical analysis.

In the course of our research work, we explored about 60 soil profiles that are representative of the Hungarian soil conditions, sampled the different genetic horizons of the profiles (about 250) and determined the most important soil properties of the collected samples. The LDM PSD data of the samples were measured (Malvern Mastersizer 3000, Hydro LV dispersion unit) and the PSD data were also determined using the standard Hungarian sedimentation (sieve-pipette) method (MSZ PSD). The results of our measurements were organized in a database and this database was used to investigate the conversion potential of the PSD determination methods.

Through the application of the usual size limits at the laser diffraction method, the clay fraction was under- and the silt fraction was overestimated compared to the MSZ PSD results, and subsequently the soil texture classes were determined according to the results of both methods also differed significantly from each other. Based on our previous experience on a smaller sample size, local scale dataset (MAKÓ et. al., 2019), we extended the upper size limit of the clay fraction from 2 µm to 7 µm. This size limit change greatly improved the comparability of MSZ PSD and LDM PSD results, resulting in a better correspondence between the texture classes derived from the PSDs.

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References

Makó, A., Szabó, B., Rajkai, K., Szabó, J., Bakacsi, Zs., Labancz, V., Hernádi, H., Barna, Gy. (2019). Evaluation of soil texture determination using soil fraction data resulting from laser diffraction method. International Agrophysics, 33, 445-454.

P69. The metabolic and genetic differences in soil bacteria communities between forest and agricultural ecosystems

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Natural forest ecosystems are multi-layered plant communities, in which trees are the dominant formation. Because of the many functions that forests have, it is important to maintain their diverse species composition. One of the fundamental elements of forest ecosystems is the soil, which one of the key elements are microorganisms, inseparable part of environment which perform a number of positive functions in it. Due to more intensive human activity in agroecosystems, as compared to slight activity in forest ecosystems, the former have a much lower diversity of living organisms.
The aim of the study was the functional and genetic characterization of bacteria in forest and agricultural soils, and a comparison of these environments in terms of biological activity. The material for the study consisted of soil samples collected from a forest and an agricultural field attached to it. The assessment of the functional diversity of soil microbial communities (microbial functional diversity) was carried out using the Biolog system (EcoPlates), while the genetic biodiversity was determined using NGS techniques.
The higher microbial activity and diversity was observed in cultivation field samples compared to forest ones. There were observed the highest percent of unclassified and unknown sequenced in forest samples. Forest samples could be the source of new, unknown bacteria and proteins with previously unexplored functions.

The research was carried out within the statutory subject 1.27 of IUNG-PIB "Structural and functional characterization of soil microorganisms biodiversity in forest and agricultural ecosystems".

P70. Seasonal dynamics of bacterial functional diversity in degraded soil amended with phosphorus biofertilizer

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Research on the functional diversity of microbial communities inhabiting arable and degraded soils constitutes one aspect of scientific work towards the development of sustainable and organic agriculture. It goes without saying that monitoring changes in the belowground environment under the influence of different agrotechnical practices allows to evaluate the stability of agroecosystems and the profitableness of a particular method [1].
The aim of the study was to determine the seasonal variations in bacterial functional profile in chemically degraded soil amended with phosphorus mineral fertilizer enriched with strains of beneficial microorganisms.
The field experiment comprised of the following treatments: FC-optimal dose of fertilizer without microbial enrichment, FA100-optimal dose containing microorganisms, FA60-dose of fertilizer reduced by 40% and microbiologically enriched. Soil samples were taken in autumn 2018 (A18), summer 2019 (S19) and autumn 2019 (A19). Predictive functional profiling of bacterial communities were conducted using next generation sequencing (NGS), PICRUSt software [2] and KEGG online database [3].
The majority of obtained operational taxonomic units (OTUs) was associated with metabolism (~54%). Among metabolism-related pathways the highest number of predicted OTUs was assigned to amino acids and carbohydrates transformations. The clear separation of treatments according to soil sampling time was observed in PCA analysis. It was also observed that A19 treatments were characterized by the greatest number of sequences throughout the experimental period.

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References

Wang J., Liu L., Gao X., Hao J., Wang M. (2021) Elucidating the effect of biofertilizers on bacterial diversity in maize rhizosphere soil. PLoS ONE, 16(4), e0249834.

Langille M.G.I., Zaneveld J., Caporaso J.G., McDonald D., Knights D., Reyes J.A., Clemente J.C., Burkepile D.E., ThurberR.L.V., Knight R., Beiko R.G., Huttenhower C. (2013). Predicitve functional profiling of microbial communities using 16S rRNA marker gene sequences. Nature Biotechnology, 31, 814-821.

Kanehisa M., Goto S. (2000) KEGG: Kyoto Encyclopedia of Genes and Genomes. Nucleic Acids Research, 28(1), 27-30.

P71. Zeolites Na-X and Na-P1 as materials improving soil sorption capacity relative to zinc and lead ions

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Due to the increasing environmental pollution caused by human activity, such as mining, oil and gas quarrying, it is necessary to look for materials enabling the removal or immobilization of undesirable substances. Synthetic zeolites, formed during the hydrothermal reaction of aqueous sodium hydroxide and a by-product of conventional hard coal combustion - high carbon fly ash, may be the answer to this need.
In this study, the selected zeolites (Na-X, Na-P1) were characterized by: X-Ray diffraction, scanning electron microscopy and X-ray energy dispersive spectroscopy, transmission electron microscopy, porosimetry, microelectrophoresis phenomenon and potentiometric titration. Their adsorption capacity relative to lead(II) and zinc(II) ions was determined in the single adsorbate systems. Desorption measurements were also performed to establish the strength of heavy metals binding to zeolites.
The obtained results showed that Na-P1 zeolite had the largest adsorption capacity relative to lead(II) ions (407 mg/g). In turn, Na-X zeolite was characterized by better adsorption properties towards zinc(II) ions (656 mg/g). The highest level of heavy metal desorption was observed with hydrochloric acid. The results of the conducted research led to the conclusion that both adsorbents can be applied as effective soil additives enhancing immobilization of toxic metals and thus limiting their bioavailability.

Acknowledgments

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References

Liu, X.B., Zhang, X.Y., Wang, Y.X., Sui, Y.Y., Zhang, S.L., Herbert, S.J., Ding, G. (2010) Soil degradation: A problem threatening the sustainable development of agriculture in Northeast China. Plant Soil and Environment, 56, 87–97.

Sahoo, T.R., Prelot, B. (2020) Adsorption processes for the removal of contaminants from wastewater. Nanomaterials for the Detection and Removal of Wastewater Pollutants, 161–222.

P72. Effect of coapplication of poultry litter biochar and mineral fertilisers on soil ecotoxicity – 7 years field study

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The application of organic materials, such as poultry litter or poultry litter biochar, may lead to major changes in chemical properties of soil as well as in the structural and functional diversity of microbial populations. On the other hand the decomposition of biochar in soil may directly result in the appearance of various amounts of intermediate decomposition products in the environment. For this reason, the assessment of soil quality on the basis of the reactions of living organisms (bioindicators) can provide a lot of valuable information about the potential environmental risk associated with the application of this type of material. The understanding of the relationship between microorganisms and environment is crucial to assess the effect of organic materials after thermal transformation on soil. Therefore, the research was to evaluate the influence of the addition of poultry litter and poultry litter biochar on soil ecotoxicity. A micro-plot field experiment was established on an Eutric Cambisol in 2014 with five treatments: soil without fertilisation (control), mineral fertilisation (NPK), NPK + poultry litter at a rate of 5 t ha^{-1} DM (PL), NPK + poultry litter biochar at a rate of 2.25 t ha^{-1} DM (PLBI) and NPK + poultry litter biochar at a rate of 5 t ha^{-1} DM (PLBII). Given the need to create comparable conditions, the following rates of mineral fertilisers were used in the experiment (every year): 100 kg ha^{-1} N, 40 kg ha^{-1} P and 120 kg ha^{-1} K. In 2014–2020, soil samples were analysed for changes in ecotoxicological and chemical properties. Annual biomass production of pasture grass mixture was determined at three harvests per year. The biochar-amended soil was toxic to *Vibrio fischeri* in 2014-2019 years, non-toxic in 2020 year and exhibited low toxicity to *Heterocypris incongruens* throughout the research period. Over 7 years of research the soil with the addition of 2.25 t DM ha^{-1} of PLBI was the more toxic for *V. fischeri* but the soil with the addition of 5 t DM ha^{-1} of PLBII was the more toxic *for H. incongruens.* Poultry litter biochar had a more adverse effect on soil ecotoxicity to *H. incongruens* and *V. fischeri* than PL, but significantly increased the grass crop yield. Regardless of the type of organic material, the tested soils were generally classified as II (20% ≤ PE <50%) (slight acute toxicity) and III (50% ≤ PE <100%) (acute toxicity) of the toxicity class according to the test reaction (Persoone et al. 2003).

Acknowledgments

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References

Persoone G., Marsalek B., Blinova I., Törökne A., Zarina D., Manusadzianas L., Nałecz-Jawecki G., Tofan L., Stepanova N., Tothova L., Kolar B. 2003. A practical and user-friendly toxicity classification system with microbiotests for natural waters and wastewaters. Environ. Toxicol. 18(6), 395-402.

P73. Effect of inoculation of PGPR Bacillus sp. 2026 on the productivity of early maturing varieties and lines of spring bread wheat

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The plant growth promotion strain of bacterium was isolated from wheat rhizosphere and identified as Bacillus sp. 2026. The study of the effects Bacillus sp. 2026 was carried out in hydroponic and pot experiments under controlled conditions when growing wheat plants of early ripening varieties Sonora 64, Leningradskaya and ultra-early maturing lines AFI177, and AFI91 (Rudakova et al., 2016). 14-day-old seedlings, (growing on Knop solution) and inoculated with Bacillus sp. 2026 were characterized by an increased growth, total chlorophyll and carotenoids contents, catalase and peroxidase activities. Opposite, lipid peroxidation activity decreased in inoculated plants compared to noninoculated ones. Varietal differences in the reaction of wheat plants to bacterial inoculation have been established. The greatest visible effect on seedlings biomass increasing was noted in wheat cv. Leningradskaya (by 17%) and line AFI177 (by 21%). A significant change in biochemical parameters was observed in ultra-early maturing line AFI91. Inoculation with bacterium led to a significant increase in the number of grains per plant by 17-58% and grains mass per plant from 33% to 62% in pot experiments. Bacillus sp. 2026 increased the number of productive shoots (from 15% to 27%) and the number of grains per ear (from 9% to 21%). A significant increase in the grain mass of the main spike was established, which is associated with the revealed increase in the ratio of the productive and unproductive parts of the spike (up to 41%). It was found that the bacterium stimulated the uptake of macro- and microelements by plants and increased the protein content in the grains up to 20%. Inoculation with Bacillus sp. 2026 led to a reducing both tillering duration and early stem elongation by 2 days for Sonora 64, AFI177, AFI91 and by 3 days for Leningradskaya cv. Thus, PGPR Bacillus sp. 2026 may be used as biological inoculant when growing early ripening varieties.

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References

Rudakova A.S., Rudakov S.V., Davydova N.V., Mirskaya G.V., Zhuravleva E.V., Chesnokov Yu.V. (2016) Isozymic analysis of esterases in mature seeds of hexaploid soft wheat (Triticum aestivum L.). Agricultural Biology, 51(3), 327-334.

P74. Water migration between gluten and fibre components of dough during mixing

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Assessment of the water migration dynamics was performed with farinograph mixing tests using three-component starch-gluten-fibre dough and a regression model describing dough consistency as a function of gluten hydration level. The gluten hydration exerts a dominant influence on the rheological behavior of the bread dough. The direction of water migration between gluten component and others (i.e. hydration or dehydration of gluten) determines decreasing or increasing dough consistency at a given phase of mixing. The developed model (Miś et al., 2020) assumes the presence of differences between components in terms of hydration capacity and chemical reactivity as two mechanisms of the water migration process, named as physical and chemical redistribution, respectively.

Six commercial dietary fibres of various botanical origin were applied as air-dried and pre-hydrated preparations in the amounts of 3, 6, and 9 %. The study results demonstrated that both types of water redistribution caused significant decreases in the gluten hydration level. At the maximum fibre addition, they ranged from -0.05 (chokeberry fibre) to -0.22 (carrot fibre) and from -0.02 (carrot fibre) to -0.31 (oat fibre), for the physical and chemical redistribution, respectively. The gluten dehydration resulted in deterioration of the mixing properties of the supplemented doughs. Most of the examined fibres exerted a destructive effect, i.e. they reduced the consistency of the dough even by half (oat and carob fibres). The fibre pre-hydration treatment significantly mitigated this effect.

The chemical dehydration, in terms of intensity, equals physical dehydration, however, it proceeds at a later mixing time. The TGA results reported by Nawrocka et al. (2016) indicated that chemical interactions between gluten proteins and reactive compounds of the fibre supplement lead to folding or aggregation of gluten proteins. According to the cited results, the fibre supplements, in terms of folding/aggregation power, were sorted in the descending order: chokeberry > carob > cacao > carrot (flax and oat fibres were not classified). This ordering is in line with the ranking of the fibers due to the level of chemical dehydration of gluten and dough mechanical destruction they cause. These facts may prove a direct relationship of the chemical dehydration intensity with the aggregation degree of gluten proteins and, as a consequence, the susceptibility of the dough structure to the destructive action of the mixing increases.

References

Nawrocka, A., Szymańska-Chargot, M., Miś A., Wilczewska A.Z., Markiewicz K.H. (2016). Dietary fibre-induced changes in the structure and thermal properties of gluten proteins studied by Fourier transform-Raman spectroscopy and thermogravimetry. J. Agric. Food Chem. 64, 2094–2104.

Miś A., Krekora M., Niewiadomski Z., Dziki D., Nawrocka A. (2020). Water redistribution between model bread dough components during mixing. Journal of Cereal Science, 95, 103035.

P75. Information support of field experiments in precision agriculture

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Modern precision agriculture (PA) research and approaches are based on interdisciplinary sciences and use large amounts of heterogeneous geo-referenced data, including remote sensing (RS) data. The PA system implies the use of information technology to obtain and process data from multiple sources for decision-making in crop production. Since 2003, during of numerous field experiments in various research PA problems on the basis of the Agrophysical Research Institute (ARI) biopolygon located in the Leningrad Region, a large amount of heterogeneous geospatial data has been accumulated. In recent years, research with the RS data has also been intensively developing. Thus, it became necessary to develop a set of approaches and tools for obtaining and processing RS data, as well as storing and organizing experimental data. During the solving of this problem, first of all, the algorithm for collecting satellite and aerial photographs was worked out, the tools were selected and tested, which allow automatically obtaining satellite images of the selected area. For aerial photography, the unmanned aerial system Geoscan-401 is used, respectively, algorithms for the preparation and implementation of flights based on requests from researchers, as well as images preprocessing, including the construction of an orthophotomap and a digital terrain model, have been developed. In addition, a geospatial database was created, which provided systematization, storage and access to experimental data. Open and free software was used for information support, for example, PostgreSQL, PostGIS, GeoServer, SAGA GIS, QGis, etc. At this stage, the database is being filled, now it contains more than 10,000 items. Simple and complex queries have been worked out to ensure convenient search and access to the necessary information. Work in progress to develop graphical interface for further implementation and user work with the database. As a result, the problem solution made it possible to promptly provide the ARI researchers with experimental preprocessed georeferenced information, systematize and store the data. Thanks to the information support of field experiments, the quality of scientific work has increased.

References

Bure V.M., Mitrofanov E.P., Mitrofanova O.A., Petrushin A.F. (2018). Selection of homogeneous zones of agricultural field for laying of experiments using unmanned aerial vehicle. Vestnik of Saint Petersburg university. Applied mathematics. Computer science. Control processes, 14 (2), 145-150.

Yakushev V.P., Kanash E.V., Yakushev V.V., Matveenko D.A., Rusakov D.V., Blokhina S.Y., Petrushin A.F., Mitrofanov E.P. (2019). Advanced features of automated detection of within-field variability based on hyperspectral images and optical criteria. Sovremennye problemy distantsionnogo zondirovaniya Zemli iz kosmosa, 16 (3), 24-32.

P76. Determination of the priority agrotechnology for fertilization using geostatistics and remote sensing data

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Among the more perspective agrotechnologies for fertilization, intensive and precision agriculture (PA) technologies stand out. Differentiated agrochemical use in the PA system can significantly save resources, increase yields and product quality, while reducing the harmful impact on the environment. However, it is not always advisable to use this approach. Thereby, the task of perspectives determining for the transition to PA technology in an agricultural territory appears. At the Agrophysical Research Institute, an approach based on geostatistics and remote sensing data is proposed to solve this problem. The basis is a geostatistical model of agricultural field heterogeneity, which is an indicator of within-field variability and is presented as a sum of three components: macro-, meso- and microcomponents, which reflect global variations (for example, caused by landscape features), variability within the field scale, as well as random variations, respectively. During the study, a variogram analysis of the statistical structure of agroecological parameters was carried out, the level of within-field variability was estimated based on the analysis of the normalized variogram value and analytical characteristics (including the nugget to sill ratio). At the same time, the plants color characteristics and the NDVI (vegetation index) values obtained using satellite and aerial photographs were used as the initial data. A set of computational experiments have been carried out. For example, aerial photographs of an agricultural field located in the Leningrad Region were analyzed before and after differentiated fertilization. As a result, it was possible to confirm that the within-field variability had a high level before agrotechnology, and after that, the proportion of random variations increased, and, consequently, the level of internal heterogeneity decreased. The use of geostatistical methods for analyzing satellite and aerial photographs will significantly reduce the cost, as well as improve the quality and increase the scale of information support for crop production.

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References

Yakushev V.P., Bure V.M., Mitrofanova O.A., Mitrofanov E.P. (2020). The use of geostatistical methods to analyze the transition feasibility to the differential application of agrochemicals technologies. Vestnik of Saint Petersburg university. Applied mathematics. Computer science. Control Processes, 16 (1), 51-76.

Yakushev V.P., Zhukovskii E.E., Petrushin A.F., Yakushev V.V. (2010). A variogram analysis of the spatial heterogeneity of agricultural fields for precision agriculture. Toolkit. St. Petersburg: ARI, 52.

Van Meirvenne M. (2003). Is the soil variability within the small fields of flanders structured enough to allow precision agriculture? Precision Agriculture, 4 (2), 193-201.

P77. The influence of biopreparations on yields and fungi infestation of strawberry (*Fragaria x ananasa Duch*) in the organic system

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The growing ecological awareness of the society, as well as the increasing demands of consumers regarding the quality of food, are important reasons for the development of organic farming (Zydlik and Zydlik, 2016). Cultivation of strawberry in the organic system excludes the use of chemical plant protection products, so it is necessary to look for new solutions and biopreparations to pathogens control.
The aim of the research conducted within the EcoFruits project was to determine the effect of new biopreparations on the yield and health of strawberry fruit grown in the organic system. The research was conducted at the Agricultural Experimental Station of IUNG-PIB in Grabów (Mazowieckie Voivodeship) on a certified plantation (23 a) established in 2019. The experimental factors were combinations of solid and liquid biopreparations with beneficial microorganisms and plant extracts: 1a - control, 1b - control+carriers, 2 - solid preparation, 3 - solid preparation + liquid I, 4 - solid preparation + liquid II, 5 - solid preparation + liquid I + liquid II, 6 - liquid preparations I + II, and 3 strawberry cultivars with different susceptibility to fungal pathogens: Honeoye, Vibrant and Rumba.
In 2020, the highest fruit yields were obtained with the solid+liquid II biopreparations combination, on average 14,4 $t \cdot ha^{-1}$ (by 15,2% more than the control). The tested microbiological preparations reduced the incidence of grey mould (*Botrytis cinerea)* on strawberry fruit, most effectively in the combination of two liquid preparations I + II (by 30,6% in comparison with the control). Liquid preparations reduced fruit infestation by *Colletotrichum acutatum* only in the case of the Rumba cultivar (by 30,6% compared to the control treatment). Three investigated strawberry cultivars responded differently to the applied biopreparations, which requires further study.

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References

Zydlik P., Zydlik Z. (2016). Horticultural ecological crops in Poland – The dynamics of changes and perspectives for development. Nauka Przyr. Technol.,10, 2 #25. DOI: 10.17306/J.NPT.2016.2.25

P78. Role of extracellular polymeric substances in the remediation of contaminated soils

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Microbial extracellular polymeric substances (EPS) as well as organic, and inorganic pollutants coexist in the environment. The EPS compounds secreted by microorganisms are a complex mixture of macromolecules including polysaccharides, and proteins that can reduce mobility and, simultaneously, transform the oxidation states of impurities in soils. Microbial EPS can immobilize environmental pollutants by increasing soil reaction, organic matter content, and decreasing soil acidity or improving microbial enzymatic activity, biodiversity, and adsorption capacity relative to heavy metals.

Due to the wide variety of functional groups present in the EPS macromolecules, they affect the bioavailability of environmental pollutions based on different mechanisms. The EPS functional groups like OH^- play an important role in soil pH amelioration through neutralizing H^+ ions. The constituents of EPS containing multipolar moieties provide plenty of charged sites for the accumulation of toxic trace metals. The protonated chains of amino acids can form hydrogen bonds with impurities. In turn, hemiacetal, tyrosine and tryptophan, and aromatic rings can be involved in pollutant degradation. The bonding between EPS with environmental pollutants is not limited to covalent bonding. Hydrophilic moieties of EPS like $-NH_2$, -COOH present in aromatic rings tend to bind to organic pollutants, e.g. PAHs, via non-covalent bonding. All interactions between pollutants and EPS moieties leading to complexation or sorption contribute to the less availability of hazardous substances for plants and animals.

Therefore, due to great abilities to reduce mobility and enhance the transformation/degradation of environmental pollutants in terrestrial environments, microbial EPS can play a significant role in the remediation technologies applied for contaminated soils.

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P79. Quantitative Changes in the Population of Soil Microorganisms After the Co-inoculation of a White Lupine (*Lupinus albus* L.) Plantation

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The aim of the study was to assess how the co-inoculation (simultaneous inoculation) of white lupine plants with endophytic bacteria of the *Bacillus subtilis* or *Pseudomonas fluorescens* species and rhizobia of the *Bradyrhizobium* genus influenced changes in the population of soil microorganisms.

Between 2017 and 2019 field experiments were conducted at the Złotniki Research and Education Institute, Poznań University of Life Sciences (52°29'35" N; 16°50'41" E). In each year of the study a one-factor experiment was started in four replications with nine levels of the factor: 1. Uninoculated seeds (the control variant); 2. Seeds treated with the Nitragina inoculant; 3. Seeds treated with the Nitroflora inoculant; 4. Seeds inoculated with the *Pseudomonas fluorescens* strain; 5. Seeds inoculated with the *Bacillus subtilis* strain; 6. Seeds co-inoculated with *Bradyrhizobium* sp. from the Nitragina inoculant + *Pseudomonas fluorescens*; 7. Seeds co-inoculated with *Bradyrhizobium* sp. from the Nitragina inoculant + *Bacillus subtilis*; 8. Seeds co-inoculated with *Bradyrhizobium* sp. from the Nitroflora inoculant + *Pseudomonas fluorescens*; 9. Seeds co-inoculated with *Bradyrhizobium* sp. from the Nitroflora inoculant + *Bacillus subtilis*. White lupine seeds were treated with commercially available Nitragina and Nitroflora inoculants containing nitrogen-fixing bacteria.

At the end of the growing season soil samples were collected for molecular analysis in order to determine quantitative changes in the populations of soil microorganisms. The method described by Zhou (1996) was used to isolate the DNA from the soil samples.

Specific primers, including *α-Proteobacteria*, *β-Proteobacteria*, *Archaea*, and fungi on a genomic DNA template isolated from soil samples from different variants of the experiment, were used for polymerase chain reactions carried out at identical DNA concentrations of all purified preparations (10 ng/µl). The equal concentrations of the DNA templates in the PCRs enabled determination of the relative intensity of the amplified PCR products of α-*Proteobacteria* and *β-Proteobacteria* as well as the kingdoms of *Archaea* and fungi in different variants of the experiment after electrophoretic separation.

The relative intensity of the amplified PCR products showed that in comparison with the control variant, the co-inoculation of white lupine seeds with the Nitroflora inoculant and *Pseudomonas fluorescens* endophyte as well as the co-inoculation of the seeds with the Nitroflora inoculant and the endophyte of the *Bacillus subtilis* species increased the counts of bacteria of the *β-Proteobacteria* phylum as well as the counts of microorganisms of the kingdoms of *Archaea* and fungi.

In the other variants of the experiment the counts of the microorganisms under analysis was lower than in the control variant.

P80. Responses of Soil Bacteria to Wood ash and Nitrogen Fertilization: A microcosm study

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Bacteria are a major class of microorganisms that carry out different ecosystem functioning to keep soils healthy and productive. Changes in bacteria community composition can thus affect soil functioning and quality. In tropical agriculture, the integration of organic amendments and mineral fertilization is often adopted for effective soil management towards counteracting acidity and recycling trace elements. However, the short term responses of bacteria communities to these combinations particularly wood ash and N-fertilizer are under presented in literature. A microcosm study was conducted to determine the responses of soil bacteria to wood ash and N-fertilizer combinations. Surface soil samples were collected from an agricultural cropland and treatments were arranged in a completely randomised design in four replicates following this order: Control, N-fertilizer 90 kg ha^{-1}, N-fertilizer 90 kg ha^{-1} + 5% wood ash (w/w), N-fertilizer 90 kg ha^{-1} + 10% wood ash (w/w) and N-fertilizer 90 kg ha^{-1} + 20% wood ash (w/w) and incubated for 60 days. Using traditional/conventional culture media, results showed that Bacteria population increased with increasing amendment dosage after 60 days of incubation. On the other hand, Bacteria diversity and specie richness reduced with increased amendments dosage and incubation time. The relative abundance of bacteria showed a stable trend initially at day 0 of incubation with three important phyla (Proteobacteria, Firmicutes, and Actinobacteria) dominating all samples. However, the phylum Firmicutes remained the only dominant phylum in all treatments after 60 days of incubation. The results of this study revealed that the amendment of soil with wood ash in combination with nitrogen fertilizer at varying doses had an effect on soil bacteria population thereby altering the bacteria community composition, and all of these changes may be attributed to changes in soil pH and nutrient availability induced by amendment.

References

Barnard, R. L., Osborne, C. A., Firestone, M. K. (2013). Responses of soil bacterial and fungal communities to extreme desiccation and rewetting. *ISME Journal*. 7(11): 2229- 2241.

Bougnom, B.P., Knapp, B.A., Etoa, F-X., and Insam, H. (2011). Possible use of wood ash and compost for improving acid tropical soils. In: Insam, H., and Knapp B.A (eds.) Recycling of biomass ashes. Springer-Verlag, Berlin Heidelberg. Pp. 87 - 105.

P81. Anaerobic digestion of high-protein and rigid cell wall microalgal biomasses

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Microalgal biomass is a valuable substrate for biogas production, due to the fast growth rate and the lack of competition with food and feed production. Unfortunately, the high protein content in such biomass and the rigid cell wall may cause disturbances in the methane fermentation process.

The work investigated the differences in biogas yield between two microalgal species: *Chlorella vulgaris* characterized by high-content of proteins and *Parachlorella kessleri* characterized by rigid cell wall. Moreover, the influence of ultrasonic pretreatment of biomass on their suitability for biogas production was studied. The ultrasonication effect was evaluated using Fourier transform infrared spectroscopy (FT-IR) of total biomasses, as well as the fraction of neutral detergent fibre (NDF) isolated from them.

The results showed that the ultrasonic pretreatment of carbohydrate-rich biomass of *P.kessleri* caused a significant decrease in the content of structural complex carbohydrates. The reduction of the degree of polymerization evaluated based on the ratio of A1150/A1050, which was the ratio of the band associated to β(1–4)glycosidic linkage between monomers of the polysaccharide unit (A1150) and the band associated to the ether bond (-C-O-C-) in the ring of monomers (A1050) was observed. It was directly reflected in positive changes in the course of the methane fermentation process. On the contrary, the pretreatment of high-protein biomass of *C. vulgaris* negatively influenced its methane fermentation. After the ultrasonic treatment, almost complete disappearance of the amide II band (1545 cm^{-1}) and appearance of the band at 1590 cm^{-1} attributed to the NH_2 group were observed. The formation of a free NH_2 group under the influence of ultrasound may have been the cause of the ammonia inhibition during the methane fermentation process.

In view of the above, it can be concluded that the ultrasonic pretreatment of the carbohydrate-rich biomass is a good way to improve its suitability for biomass production, due to significant decrease in the content of structural carbohydrates and degree of their polymerization, but pretreatment of the high-protein biomass did not exert a positive impact due to the risk of the aggregation of proteins and the formation of ammonia and contribute to ammonia inhibition.

References

Oleszek M., Krzemińska I. (2021). Biogas production from high-protein and rigid cell wall microalgal biomasses: Ultrasonication and FT-IR evaluation of pretreatment effects. Fuel, 296, 120676.

P82. Antifungal and antioxidant activity of phytochemicals obtained from apple pomace

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Apples are one of the crops with the largest annual production. Poland is one of the major producers of apples, with ca. 3.6 million metric tons of apples produced every year. At the same time, apple residues consist of apple peel, seeds, and pulp, which represent about 25% of a fruit's fresh weight, are rich in biologically active compounds, and may become the important raw materials for obtaining various valuable by-products. The main bioactive compounds of apple processing by-products are, in particular, flavonoids (phloretin and quercetin glycosides, flavone derivatives, and catechins), as well as organic acids. Their applications have been addressed to exploit antioxidant and pharmacological properties.
The study aimed to determine the antifungal and antioxidant properties of raw and purified apple pomace extracts, as well as fractions obtained from gel permeation chromatography, and to evaluate their suitability as a source of natural bio-fungicides against pathogens of crops: *Botrytis* sp., *Fusarium oxysporum*, *Petriella setifera* and *Neosartorya fischeri*. For antifungal activity determination, a new, fast and simple instrumental method using BIOLOG MT2 Plates® was applied and optimized in the place of the conventional hole-plate method. The phytochemical composition of the studied objects was determined employing ultra-high performance liquid chromatography-photodiode array detection-mass spectrometry (UHPLC-PDA-MS) and compared with the spectra of in-house prepared and commercially available standards.
The results confirmed that the phytochemical constituents of the tested objects were mainly represented by phloridzin and quercetin derivatives. The fraction containing quercetin pentosides possessed the highest antioxidant activity, while the fraction containing phloridzin exhibited the strongest antifungal activity. Furthermore, sugar moieties differentiated the antifungal activity of quercetin glycosides. Quercetin hexosides possessed stronger antifungal activity than quercetin pentosides. It can be concluded that apple pomace could be a good source of natural bio-fungicides, due to the inhibition of mycotoxigenic fungal growth.

References

Oleszek M., Pecio Ł., Kozachok S., Lachowska-Filipiuk Ż., Oszust K., Frąc M. (2019). Phytochemicals of apple pomace as prospect bio-fungicide agents against mycotoxigenic fungal species—in vitro experiments. *Toxins*, *11*(6), 361.

P83. How do the *Trichoderma*-based naturalization strategies influence raspberry`s microbiota facing pathogens occurrence? A statement on functional response

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Fungal pathogens infections occurrence and the intensification of agricultural production, that has occurred in recent years, have led to farmers becoming dependent on chemical methods of plant protection as these methods were reliable and easy to use. In contrast, as it was proven chemical methods cause negative effects, i.e., the elicitation of pathogen resistance and a decrease in microbial diversity.
The reversal of this situation is sought in the eco-friendly targeted solutions. The bioproducts based on beneficial and antagonistic microorganisms are in line with the long-term policy of the European Green Deal and the EU Biodiversity Strategy for 2030. The EU implementing regulations currently prohibit the use of fungicides, one by one. Therefore, the naturalization concept fits very well here filling the gap in protection against pathogens. The crops naturalization approach is namely the soil or/and aboveground application of very carefully selected microorganisms obtained from natural and possibly local counterpart habitats. Here we present the work on the effect of the *Trichoderma*-based naturalization strategies on raspberry plants facing fungal pathogens occurrence.
Raspberry pot experiment in phytotron controlled condition was set up considering the following pathosystems: *Botrytis*, *Verticillium*, *Colletotrichum*, *Phytophthora*, and all pathogens (*Botrytis–Verticillium–Colletotrichum–Phytophthora*) and no pathogens included, within different *Trichoderma*-naturalization strategies: no naturalization, root inoculations, root inoculations and watering, watering [1].
We focused on plant-associated (rhizosphere soil and leaves) microbiota evaluation, namely the functional response. This was determined using the Biolog® System ECO MicroPlates and expressed as respiratory activity and biomass production of the microbial communities in the presence of particular substrates. The data was compiled in the form of the substrate stress index (SST) followed by cluster analysis.
A certain correspondence of the naturalization strategy and the type of pathogen on functional response was noted. More active were soil communities, than the leaves ones. For the raspberry leaves' community, we noted the three separate clusters, for soil the two, indicating similar functional responses inside each one.

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References

[1] Oszust K, Pylak M, Frąc M. *Trichoderma*-Based Biopreparation with Prebiotics Supplementation for the Naturalization of Raspberry Plant Rhizosphere. International journal of molecular sciences. 2021;22(12). doi: 10.3390/ijms22126356.

P84. How drought changes mycobiome composition of selected potato cultivars?

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Potato belongs to the most commonly cultivated and most important plants in the world. Climate changes are commonly associated with raising temperature and in connection drought is getting more frequent and intensive in last years. That is why studies toward finding drought-resistant cultivars of potato are important.
Aim of the study was to determine the drought induced changes in mycobiome composition of selected potato cultivars. Rhizosphere samples of 13 selected cultivars characterized by similar mycobiome profile were collected after 19 weeks of growth in pots. DNA was isolated and after amplification ITS2 region was sequenced using Illumina MiSeq platform with 2x300bp v3 sequencing reagents. Bioinformatics analyses, denoising, amplicon sequence variants (ASV) calling and taxonomic classifying to UNITE database were performed with QIIME2 environment, while statistical analyses were performed with R environment.
General trend was observed - composition of samples treated with drought drifted towards composition of bulk soil microorganisms. However such cultivars as: Pasja pomorska, Kama or Tewadi were found to be resistant to mycobiome composition changes despite infliction of drought.
Mycobiome composition of studied potato rhizosphere inducted with drought drifted towards composition of microorganisms detected in bulk soil. However cultivars relatively resistant to mycobiome changes due to induction of drought were observed. Such cultivars may possibly be considered as target of further studies towards finding drought-resistant cultivars and find place in agriculture altered by climate changes.

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P85. Imaging the cell wall composition at plasmodesmata using immunolocalization and Raman Spectroscopy

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Tomato, *Solanum lycopersicum*, is one of the most cultivated fruits (1). Understanding the biological components and processes that affect the quality and structure of tomato fruits during the ripening, is essential to design new strategies for plant breeding. Plasmodesmata may play an important role in fruit development, because the symplasmic pathway regulates the phloem transport and unloading of sugars, hormones and other molecules that control fruit initiation and development (2). Plasmodesmata are embedded in a specific cell wall domain enriched in (1,3)-beta-glucan (callose) polymer (3). Very little is known about other cell walls components at plasmodesmata or their role in fruit development. We apply Raman spectroscopy to complement immunolocalization studies on cell wall composition at these microdomains. Cellulose, homogalacturonan (HG) and ramnogalacturonan (RG) side chains and modifications were detected using dyes and a set of plant probes antibodies. Raman imaging and principal component analysis (PCA) showed a possible "pit field fingerprint" in the PC3. PC3 exhibits negative value at 1112cm^{-1} and 1090cm^{-1}, bands characteristic for cellulose; and an enrichment in hemicellulose (CH stretching band of pyranoid ring carbons is shifted) and proteins (Amide III and phenylalaline peak at 1003 cm^{-1}). The results indicate correlations between the Raman profile and immuno-labelling at pit field. These approaches can be used to screen tomato varieties or recombinant populations aiming to identify new markers for improvement of fruit growth, yield, or other traits relevant to agriculture.

Acknowledgments

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References

Food and Agricultural Organisation of the United Nations. Available online: http://www.fao.org/faostat/en/
Schulz A (2018): Role of Plasmodesmata in Solute Loading and Unloading. In *Annual Plant Reviews online*. 135-161.
Amsbury S, Kirk P, Benitez-Alfonso Y (2017): Emerging models on the regulation of intercellular transport by plasmodesmata-associated callose. J Exp Bot, 69,105-115.
Schulz A (2018): Role of Plasmodesmata in Solute Loading and Unloading. In *Annual Plant Reviews online*. 135-161.

P86. About the influence of film-forming silica sols nanocompositions on plants

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The elaboration of environmental friendly high efficient technologies and means of increasing the plants resistance to stressful conditions at the early development stages remains a urgent and demanded task of modern science. We have proposed a method for creating a nanoporous silica film (NSF) on the seeds surface using sols based on hydrolyzed tetraethoxysilane (TEOS). This films elaboration different from pelleting method by submicron thickness and at the same time ensuring the preservation of substances useful for plants. Synthesis of silica sols (Ss) based on 0.1 wt.% - 30 wt.% TEOS-$Si(OEt)_4$, pH 2-3 or pH 7-8 with the addition of a charge of detonation nanodiamond (CDND), detonation nanodiamond (DND), titanium dioxide in the form of anatase (TiO_2), solutions of macro- and microelements, etc., as well the treatment of seeds with Ss were carried out according to the original methods (Shilova et al., 2018).

Obtained data of the influence on plants of created Ss nanocompositions in the established concentration ratios indicate their complex positive effects in the treatment of plant seeds of grain and vegetable crops, namely: the formation on the seeds of a protective NSF, which regulates the composition of epiphytic microorganisms on the seeds surface, stimulates the plants germination, increases the growth rates, development and productivity, improves the quality of the plant production, (suggest change the plant production by plant products), increases plants resistance to damage by phytopathogens. Among the created Ss, 20 wt% TEOS pH 7-8 with 0.1 wt% TiO_2, as well as 1 wt% and 20 wt% TEOS (pH 2-3 or 7-8) exhibit a higher growth-stimulating ability in relation to plants, alloyed with 0.1 wt.% charge of CDND with boron; while 20 wt. % TEOS pH 7-8 with 2.5 wt% DND and 1 wt% TEOS pH 2-3 with 0.1 wt% TiO_2 or CDND with B – phytoprotective ability (Panova et al., 2018; Shilova et al., 2018; 2020). The above mentioned in complex testifies to the prospects of further continuation of research in the direction of improving the created Ss nanocompositions and developing a technology for their using in combination with fungicides and other nanopreparations to enhance and stabilize the positive effect on agricultural plants.

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References: Panova G.G., Semenov K.N., Shilova O.A., Kornyuhin D.L., Shpanev A.M., Anikina L.M., Hamova T.V., Artemyeva A.M., Kanash E.V., Charykov N.A., Udalova O.R., Galushko A.S., Zhuravleva A.S., Filippova P.S., Kudryavcev D.V., Blohina S. Yu. Impact of carbon and silica sol nanostructures on spring barley resistance to the root rot infestation // Agrophysica, 2018. № 3. pp. 48–58. DOI: 10.25695/AGRPH.2018.03.09; Shilova O.A., Khamova T.V., Panova G.G., Anikina L.M., Artemyeva A.M., Kornyukhin D.L. Using the sol–gel technology for the treatment of barley seeds // Glass Physics and Chemistry. 2018. T. 44. № 1. C. 26–32. https://doi.org/10.1134/S108765961801011X; Shilova O.A., Khamova T.V., Panova G.G., Kornyukhin D.L., Anikina L.M., Artemyeva A.M., Udalova O.R., Galushko A.S., Baranchikov A.E. Synthesis and research of functional layers based on titanium dioxide nanoparticles and silica sols formed on the surface of seeds of chinese cabbage // Russian Journal of Applied Chemistry. 2020. T. 93. № 1. C. 25–34 https://doi.org/10.1134/S1070427220010036

P87. Experiments and DEM simulations of spherical particles discharge from a cylindrical bin

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Numerous investigations have been made to predict the behavior of granular materials during discharge from a silo. Past experiments of Beverloo on emptying a silo of sand have shown that the discharge rate is dependent on the size of the discharge opening. They found that the flow rate of grains through a large orifice is dependent on its diameter to a 5/2 power law. The Beverloo law, or other models based on it, gives a reasonable estimation of the mass flow rate of particles with various PSD and particle shapes. However, they lack prediction when the size of the opening is less than about six particle diameters. It is an unresolved problem regarding discharge flow conditions for undisturbed flow and the shape of the arch (or dome) of stagnant material above the outlet after flow arrest.
A series of DEM simulations and laboratory experiments of the outflow of wooden spheres from a flat bottomed container was conducted, considering the maximum diameter to arrest the flow. The aims of the project were: a) check the ability of DEM to model real experiments, b) analyze the influence of material properties on flow rate and jam of the storage materials, c) to explain the mechanism of flow commencement and flow arrest.
The results of the laboratory determination of the mass flow rate of spheres have shown fairly close agreement with the results of simulations. The real particles of wood were not perfectly spherical, their properties were anisotropic, and their frictional properties were non-homogenously distributed on the surface; however, these deviations from ideal conditions did not produce a considerable discrepancy in the results. The shape of the dome formed above the outlet was found to vary in the replications of simulations. It resulted from the impossibility of exactly reproducing the assembly's fabric in a static state and its transient response to discharge initiation. The shape of the dome is pretty irregular but can be described by a surface that is not more complex than a paraboloid.

References

Beverloo, W. A.; Leniger, H. A.; De Velde, J. V. The flow of granular solids through orifices. Chem. Eng. Sci. 1961, 15, 260-269.

P88. Development an easy method to detect the presence of the pathogens fungi on soil and leaves from strawberry plantation

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The cultivation of strawberry has become globally important. At the level of the EU especially the Poland, from 2018 to 2019, has the highest harvesting area (49900 ha) and the second-largest strawberry production at the level of the 28th EU countries (185400 t) (FAOSTAT 23.09.2021). The Poland farm needs to have a quick and easy method to detect the presence of the four principal fungal pathogens of the strawberry plant i.e. *Botrytis cinerea*, *Colletotrichum acutatum*, *Phytophthora* sp., and *Verticillium* sp.. These fungal pathogens are responsible for the loss during the harvesting of the strawberry cultivation (Malarczyk D.G. et al. 2020). In this study, we analysed the effect of three different bacterial biopreparations applied on the Honeoye strawberry cultivar of strawberry to eradicate these fungal pathogens from cultivation. From soil and leaves samples, we detected the presence of these pathogens through PCR analysis with the utilisation of a specific primer to detect the presence of the pathogens and the effectiveness of tested biopreparations. We can observe a difference between the source of the sample and the analysed treatments. The important observation was that tested biopreparations were more effective in the control of pathogens in leaves than in the soil samples, and inside the leave only the *Verticillium* sp. was not eradicated, finding it in all analysed leave samples. For the soil samples, the presence of *Botrytis cinerea* has been influenced by the use of tested biopreparations. These very preliminary findings show that the developed biopreparations, are effective against all pathogenic fungi (apart from *Verticillium* sp.) and do not allow soil-borne pathogens to infect the plant. This is a good result as it shows us that we are on the right track with the application of these bacterial biopreparations, safeguarding the health and therefore the production inside the strawberries plantation.

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References

Malarczyk D.G., Panek J., Frąc M. (2020) Triplex Real-Time PCR approach for the detection of crucial fungal berry pathogens – *Botrytis* spp., *Colletotrichum* spp. and *Verticillium* spp. International Journal of Molecular Sciences, 21.

P89. Interactions between non-cellulosic polysaccharides and microfibrillar cellulose in the plant cell wall

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The plant cell wall architecture is a remarkable nature creation. It is composed mainly of polysaccharides, lignin and proteins. The common model of the plant cell wall shows that cellulose microfibrils form a three-dimensional network with hemicelluloses located in a heterogeneous matrix of pectins and proteins (Cosgrove, 2005). Moreover, this unique composite and its properties depends on the stage of growth, environmental factors and many more. The knowledge of interactions of polymers in the plant cell wall is very important, because allows for a better understanding of its structure and its influence on the mechanical properties of plant.

One of the methods used for the study on interactions of non-cellulosic polysaccharides with microfibrillar cellulose is the adsorption experiment. We present the results of this technique which showed that glucomannan, xyloglucan, ß-D-glucan and xylan interact with cellulose. Whereas arabinoxylan had just a little ability to bind to microfibrillar cellulose. What is more, it was shown that pectins, arabinan, galactan, arabinogalactan, polygalacturonic acid and rhamonglacturonan didn't adsorb on cellulose.

Studies on the adsorption kinetics and the equilibrium of those systems allowed to adjust the adsorption model, which can explain kind of interactions and thus help to characterize this interfacial phenomenon. Additionally, methods such as Fourier transform infrared spectroscopy (FT-IR), photon correlation spectroscopy (PCS) and differential scanning calorimetry (DSC) were also applied providing valuable information on the study.

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References

Cosgrove, D.J. (2005). Growth of the plant cell wall. Nature Reviews Molecular Cell Biology, 6, 850-861.

P90. Biomass conversion in integrated corn bioethanol and biogas production

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Presently, the majority of energy carriers that are used for transport purposes are obtained from crude oil. The above leads to a significant reduction in natural fuel resources and an increase in greenhouse gas emissions. Therefore, for many years, the European Union has been supporting the development of renewable energy sources, including, i.a., biofuels, wind, water and solar energy. In Poland, two types of liquid biofuels are used: *(i*) ethanol, which can replace petrol and *(ii*) biodiesel, which is used as an additive to diesel oil. At the moment, corn grain is the main raw material used for the production of ethanol for energy purposes.
The distillers grains, which are produced in ethanol plants, can be further processed in biogas plants as they contain some organic matter from which biogas can be manufactured. The concept of utilisation of waste biomass in a sequential combination of two biochemical processes, ethanol and methane fermentation, can also bring specific environmental benefits such as utilisation of waste from the agricultural sector, reduction of organic pollutants, reduction of dust and gas emissions from combustion of conventional sources of energy.
The study aims to determine the energy potential of biomass with the use of which bioethanol and biogas are produced. Based on the obtained results, the degree of conversion of biomass, corn grain in this case, into bioethanol was determined, as the efficiency of the process of production of bioethanol. In the next stage of the study, the unused energy potential of biomass, which was accumulated in the waste material in the form of distillers grains, was assessed. Thus, the degree of conversion of biomass into bioethanol and the susceptibility of biomass to convert into biogas were specified. The possibility to estimate the insufficient conversion of biomass allows to increase the optimisation of the production of energy carriers from renewable raw materials.

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References

Susmozas A., Martín-Sampedro R., Ibarra D., Eugenio M.E., Iglesias R., Manzanares P., Moreno A.D. (2020). Process strategies for the transition of 1G to advanced bioethanol production. Processes, 8, 1310-1355.
Pilarski K., Pilarska A.A., Boniecki P., Niedbała G., Durczak K., Witaszek K., Mioduszewska N., Kowalik I. (2020). The efficiency of industrial and laboratory anaerobic digesters of organic substrates: The use of the Biochemical Methane Potential Correction Coefficient. Energies, 13, 1280-1293.

P91. Climate changes and new, revolutionary strategies in economics and agriculture

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The ongoing climate changes and environmental problems that are the result of the overproduction of food due to consumerism and, consequently, food waste, continue to contribute to the depletion of natural resources of the Earth and impoverishment of its biodiversity. To deal with the above-mentioned issues, some systemic international actions are taken by the European Union, such as the idea of the Closed-loop Economy and the recently announced European Green Deal strategy.
Another initiative, taken by the European Union and introduced in 2015, is the concept of Circular Economy. The idea of a circular economy is to increase the efficiency of the use of primary resources in Europe (especially non-renewable and rare ones) to reduce the amount of generated waste and to move away from waste disposal in favour of recycling and a resource-efficient economy that promotes industrial symbiosis. With regards to agriculture, a circular economy is mainly about the management of residues from agri-food production to contribute to the development of techniques of biomass management such as pellet and briquette production, composting, biogas production or gasification and torrefaction.
In 2020, the European Commission announced a new revolutionary strategy that combines the principles of sustainable development and circular economy. The main goal of the strategy is to create an economy that will help to achieve net zero greenhouse gas emissions by 2050.
All courses of action following the European Green Deal are related to agriculture, directly or indirectly. In the context of agriculture, the key objectives of the Green Deal are to move towards zero emissions as well as clean and safe energy. The above involves the development of certain innovative solutions that will contribute to the efficient use of energy and the reduction or avoidance of greenhouse gas emissions. Modern solutions, especially in the agricultural sector, require research and confirmation of innovation/effectiveness expressed in the form of measurable parameters with the use of appropriate tools such as Life Cycle Assessment (LCA). The LCA methodology makes it possible to determine the environmental footprint of a product - that is, the selected impact of a given product, service or an organisation on the natural environment expressed in the equivalent of emitted CO_2.

References

Gajewski J., Paprocki W. (2020). Polityka klimatyczna i jej realizacja w pierwszej połowie XXI w., Centrum Myśli Strategicznych, Sopot 2020.
Zarębska J. (2017). Gospodarka o obiegu zamkniętym drogą do zrównoważonego rozwoju. Systemy Wspomagania w Inżynierii Produkcji, 6(7), 286-295.

P92. Polygalacturonase gene downregulation increased strawberry fruit resistance to *Botrytis cinerea*

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Plant health is a major target in breading programs because crops are under constant biotic stress, and climate change is exacerbating pests and disease negative impacts in agriculture. Obtaining crop varieties armed with better defences is a potential strategy to reduce losses from biotic attacks. Plant cell walls perform crucial roles on many physiological processes, and under biotic stress, play crucial defensive roles as protecting barrier, as well as a source of integrity signalling molecules. Plant immunity has evolved a complex multi-layered system which first line of defence is initiated by conserved molecular patterns coming from pathogens, named pathogen-associated molecular patterns or PAMPs, or from their own corrupted cell walls due to pathogen invasion, named damaged-associated molecular patterns or DAMPs. Accumulating evidence from cell wall mutants has unveiled several components and mechanisms of plant innate immunity under biotic stresses, mostly in Arabidopsis, but still little is known from species with agronomic interest as strawberry. Our group has an established strawberry transgenic collection of cell wall mutants. Among them, RNAseq expression profiles of FaPG1 mutants has shown downregulation of other cell wall related genes than PG [1], but the mechanisms underneath required further investigation. *FaPG* genes code for enzymes with endo-PG activity related to oligogalacturonic acid (OGA) release, which would be associated to the changes in gene expression of other cell wall genes than *FaPG*. In this work, postharvest assays of FaPG1 fruits showed not only the increased fruit firmness typical of this mutant, but a better resistance to fungal infections by *Botrytis cinerea*, enhancing fruit shelf life in comparison with control fruits. The next step will be to determine whether the differential biotic resistance of this transgenic strawberry line is due to modified DAMPs and assess its potential use as strategic tools to enhance plant resistance in strawberry crops.

KEYWORDS: food security, plant innate immunity, resilience, pathogen resistance, damage-associated molecular patterns (DAMPs), *Botrytis cinerea*, oligogalacturonic acid (OGA), postharvest shelf life

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References

Paniagua *et al* (2020). Elucidating the role of polygalacturonase genes in strawberry fruit softening. *Journal of Experimental Botany*, *71*(22), 7103-7117.

P93. Complex Study of Influence of Bacterial Infection to Physical Characteristics and Sowing Qualities of Zea mays seeds

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The optical imaging in two spectral ranges of corn seeds, X-ray radiography analysis, and electrophotography (Martinez at al., 2018) in combination with image analysis as well as standard methods of assessment of 4 corn seed samples and its sowing qualities were done. It is established that the corn seeds cv Krasnodarskaya significantly differed from three other samples in the following characteristics: average brightness (visible range of lighting), hue and color characteristics on the RGB model (visible and UV lighting ranges), maximum indicators of deficiency (shape abnormality) of an embryo, the maximum indicators of browning endosperm, the last fact is confirmed by results of automatic processing of digital X-ray images (the minimum values of an indicator "The average brightness"), minimum averaged intensity of gas discharge images, minimum values of emergence rate, germination, and additional growth indicators, minimum weight. It was found that the seeds cv. Krasnodarskaya were affected by phytopathogenic bacteria *Pantoea ananatis* s1 (Mamede at al., 2018). We concluded that it is possible to execute screening assessment of seeds deficiency and conclude on a decrease in their growth indicators during germinating with the help of non-destructive testing of seeds state based on surface, internal and electrphysical characteristics of digital X-ray images.

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References

Mamede, M.C., Tebaldi, N.D., Mota, L.C.B.M., Martins O.M., Coelho L. Detection of Pantoea ananatis in corn seeds on semi-selective medium. (2018) Trop. plant pathol. 43, 254–256. https://doi.org/10.1007/s40858-017-0203-z

Martinez, M.A., Priyatkin, N.S. and van Duijn, B. (2018). Electrophotography in analysis: basic concepts and methodology. Seed Testing International, 156, 53-56.

P94. Bacterial naturalization effect on the functional response of microbial communities inhabiting leaves and soil of cultivated raspberries

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Microorganisms are being used in plant growth and resistance stimulation, including biocontrol, as well as soil microbial activity and functionality maintenance or improvement, more and more often for past years. Bacterial biopreparations and bioproducts are now common in organic farming. Current trends in plant cultivation and pest control shift towards methods safe for the environment and microbial diversity (Pylak, Oszust and Frąc, 2019).
Naturalization is the process of introducing native microorganisms to farming grounds. Microorganisms chosen for this purpose should be isolated from the same type of plants that they will be applied to, furthermore from a similar climatic zone which highly affects their ability to inhibit the growth of locally occurring phytopathogens.
Phytotron pot experiment was set up to test the effect of bacterial inoculum on microorganisms in the leaves and rhizosphere of raspberry plants. 4 strains of locally isolated bacteria belonging to *Arthrobacter, Pseudomonas* and *Rhodococcus* genera were chosen based on their ability to inhibit the growth of chosen fungal and fungal-like plants pathogens. Furthermore, all raspberry plants were inoculated with different combinations of phytopathogens belonging to *Botrytis, Colletotrichum, Phytophthora* and *Verticillium* genera. Bacterial inoculum had been applied on roots during planting, with water during watering or both ways. Functional analysis of microbial communities was evaluated with the use of the Biolog® System ECO MicroPlates. Respiratory activity and biomass production were evaluated via absorbance check and based on the stress substrate index (SST) was calculated.
Noticed differences varied depending on both naturalization strategies and the genera of phytopathogen contamination. For particular phytopathogens contamination variants, some naturalization application strategies were affecting the microbial communities more profoundly.

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References

Pylak, M., Oszust, K. and Frąc, M. (2019) 'Review report on the role of bioproducts, biopreparations, biostimulants and microbial inoculants in organic production of fruit', *Reviews in Environmental Science and Biotechnology*, pp. 597–616. doi: 10.1007/s11157-019-09500-5.

P95. DSC study from sesame seeds to oil and products of various origin

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Recently, many alerts from EFSA concerned sesame seeds and products made from them. The safety of these products, imported to Europe from different parts of the world, was questioned. Hence, the aim of the research was to investigate thermodynamic properties of seeds, oil and products made from sesame (tahini, halva), and also assessing the authenticity of the sesame oil. In this study differential scanning calorimetry (DSC) was used to analyze sesame seeds, extracted oils as well as sesame products (tahini, halva) originated from various countries like Turkey, Nigeria, Sudan, Ethiopia, India. It was shown by DSC technique that origin of the seeds has no influence on the melting profile of sesame oil (peak temperature and enthalpy). The mean peak temperature was observed at -19.2 °C and enthalpy 23.9 J/g. Two oil extraction methods were tested i.e. by cold pressing and by hexane. It was stated that there were no significant differences ($p \leq 0.05$) in thermodynamic properties of sesame oils (peak temperature, enthalpy) obtained by two extraction methods. Melting sesame oil profiles were also compared with sesame products like tahini or halva. There were no significant differences in thermodynamic parameters between them ($p \leq 0.05$). The effect of addition of 20 % of palm olein to sesame oil on thermodynamic properties was also analyzed. Statistical analysis proved also that there were significant differences ($p \leq 0,05$) in thermal properties of DSC melting profiles (peak temperature, peak half width, enthalpy) between genuine sesame oil and oil with addition of palm olein, which proves that the DSC technique can be considered to detect adulteration of sesame oil and sesame products.

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P96. Glucose Imaging, a new developed method for in situ visualization of glucose release in soil

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About 60% of photosynthetic product is transported to roots, and a significant portion of this carbon (1%–30%) is deposited in the rhizosphere. The release of organic compounds from roots into the rhizosphere is a key factor for microbial activity and functionality. Sugars such as glucose dominate root exudates. It is vital to identify the localities of high glucose release to identify microbial hotspots in the soil. These rhizodeposits, including root exudates, are the major source of carbon for the microbial populations in the soil and have been shown to impact the diversity and abundance of microbial populations in the rhizosphere. Hence, it is important to understand how carbon moves from the roots into the rhizosphere. Glucose is one the most important root exudate. In the previous studies, glucose was detected using a gel-based, enzyme-coupled, fluorometric assay. In this study, we further modified and developed a membrane-based enzyme-coupled colorimetric and fluorometric assay instead of the gel-based approach, to image glucose in situ and used this assay in combination with enzyme assay to show that there is spatial variability in glucose release from plant roots and how this dynamicity affects rhizosphere enzymatic activity. For this purpose, we saturated membrane in reaction solution (containing glucose oxidase, peroxidase and Ampliflu Red) and attached to the soil in the rhizobox. After 20 min, we took photos under UV light and the photos were calibrated with HPAE chromatography. Our results showed that wheat root had heterogeneous glucose release and had the highest glucose exudation rate in young roots and root tips. Also, Rhizosphere soil had the highest enzyme activity. We concluded that localities of high glucose release stimulated microbial activity, induced high enzyme activity. The developed method successfully localized glucose exudation rate from wheat root in the rhizosphere and within soil matrix and can be coupled with enzyme measurements to localize microbial hotspots.

P97. Using MAS-based breeding to create photoperiod-insensitive wheat varieties under controlled conditions

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Adaptation to climate change is a difficult process because of its complexity, its unpredictability, and its location specificity. Rate of progress is limited by the time required to make crosses and generate new stable lines. MAS has proven itself as useful tool in different crop improvement programs [1] and it is effective with known target genes, responsible for the trait of interest. Wheat has photoperiod-sensitive genes *Ppd-D1* that significant effect to not only heading stage and adaptation to wide agronomic environments so as productivity traits [2]. Photoperiod-insensitive wheat flower independently of day length, while photoperiod-sensitive wheat linger flowering under short days [3]. Breeding in controlled conditions with presence of photoperiod-insensitive genotypes allows to reduce breeding cycle and to obtain varieties with desired (predictable) traits. The aim of our study was to make photoperiod-insensitive genotypes with high values of productivity traits. Earlier identified [4] by allele-specific primers *Ppd-D1_F*, *Ppd-D1_R2, Ppd-D1_R1c* varieties «AFI-177» and «ITMI-7» *carry Ppd-D1a* and *Ppd-D1b* alleles resp. were crossed in controlled conditions. Variety «ITMI-7» although has high number of seeds per plant. The temperature was set to 24 °C day and 19 °C night, 16-hour photoperiod. Obtained hybrid plants self-pollinated generation F_1 to generation F_2. 158 plants of F_2 generation were obtained, 10 of them were chosen to cultivate up to F_3 generation and same to F_4. F_4 genotypes characterized with presence of photoperiod-insensitive allele of *Ppd-D1* gene with high productivity traits: «seed per plant», «grain weight» compared to parental forms. Each of generations was screened for the *Ppd-D1* gene alleles. Obtained genotypes can be recommended for implication in the further breeding process. Using MAS combined with growing in controlled conditions let breeders select photoperiod-insensitive genotypes without field testing and reduce the time for creating new varieties of soft wheat.

References

Das G., Patra J. K., Baek K. H. (2017). Insight into MAS: a molecular tool for development of stress resistant and quality of rice through gene stacking. Frontiers in plant science. T. 8. C. 985.

Likhenko I.E., Stasyuk A.I., Shcherban' A.B., Zyryanova A.F., Likhenko N.I., Salina E.A. (2014). Study of the allelic composition of the Vrn-1 and Ppd-1 genes in early-ripening and medium-early varieties of spring common wheat of Siberia. Vavil.zhurnal gen.& sel. T.18. №4/1. pp. 691-703.

A.R. Bentley, R. Horsnell, C.P. Werner, A.S. Turner, G.A. Rose,C. Bedard, P. Howell, E.P. Wilhelm, I.J. Mackay, R.M. Howells, A.Greenland, D.A. Laurie, N. Gosman (2013). Short, natural, and extended photoperiod response in BC2F4 lines of bread wheat with different Photoperiod-1 (Ppd-1) alleles. J. Exp. Bot., 64. pp. 1783-1793

Rushina, N.A. Mirskaya, G.V. (2020). The use of allele-specific markers of the PPD-D1 gene for the selection of early ripening forms of wheat at the initial stages of selection. Bulletin of the Buryat State Agricultural Academy n. a. I. V.R. Filippov. No. 3 (60). 45-54.

P98. Utilization of ^{15}N from fertilizers by components of barley-peas mixtures

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Introduction

A Green Deal Target set out in Biodiversity Strategy for 2030 and Farm to Fork concerns the decrease in fertilizers use by at least 20% to obtain the reduction of emissions by 50%. The increased N use efficiency in intercropping allows to reduce the requirements for fossil-based fertilizers. The objective of this paper was to determine the utilization of nitrogen from fertilizers by components of cereal-pea mixtures and to access the quantity of mineral fertilizers which could be saved by intercropping .

Material and Methods

Pot experiments were carried out at a greenhouse. The species chosen for the intercrops were field peas var. Basza and barley var. Muza. The factor of the experiment was the proportion of barley in the pot: 33%, 57%, 75% and 89%. Nitrogen fertilizers in the form of $^{15}NH_4{}^{15}NO_3$ were applied at the rates of 0.4, 0.8, 1.2, 1.6 g/pot according to the proportion of barley in the mixture. The coefficient of ^{15}N utilization was calculated both for barley and peas and for the whole mixtures.

Results

The coefficient of ^{15}N utilization by barley was comparable between the mixtures, and at the heading stage reached 47%, on the average. The coefficient calculated for peas increased together with the share of barley decreasing and amounted for 4.3 - 44%. At full maturity barley used 54% of nitrogen from fertilizers, regardless of the mixture's composition. On the contrary, utilization of ^{15}N by peas dropped together with the number of barley plants in the pot increasing and amounted between 46% and 8%. The percentage of ^{15}N derived from fertilizers by the whole mixtures accounted for 59-100%. The most optimal proportion for barley-pea mixtures was 33% of cereal, which guarantees the greatest accumulation of nitrogen by seed yield and the highest utilization of nitrogen from fertilizers.

Concussions

The adequate fertilizer rates applied to provide the cereal component with nitrogen, guarantee a relatively high coefficient of its utilization and reduce the risk of nitrogen loss. The risk increased strongly above 57% of barley in the mixture and thus nitrogen rates.

References

Jensen E., S., Carlsson G., Hauggaard-Nielsen G. (2020). Intercropping of grain legumes and cereals improves the use of soil N resources and reduces the requirement for synthetic fertilizer N: A global-scale analysis, Agronomy for Sustainable Development, 40: 5.

P99. The role of beneficial microorganisms in reducing the negative effects of drought stress in soil

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Poland is situated in a temperate transitional climate zone, but in spite of this, droughts with negative effects on plant cultivation, the economy, and the environment are becoming more and more frequent on its territory. Agricultural drought is associated with long-term water scarcity in large areas, which has an adverse and often irreversible impact on the physiological processes in plants and soil. Limited water resources and periodic water shortages are an increasingly common problem in agriculture.

Drought stress is one of the principal factors that directly reduce the size and quality of yields produced by crop plants and affect the course of processes occurring in the soil and in the rhizosphere of plants, which significantly reduces the profitability of plant production. Counteracting and limiting the effects of drought stress are of great importance for the normal functioning of plants and, consequently, for achieving optimal and high-quality yields. Beneficial microorganisms help plants to adapt to the unfavourable conditions of drought stress and high temperatures. In recent years, Poland has experienced increasing water deficiencies in the soil, which has caused an increased interest in the development of methods limiting the effects of drought on plants, including methods based on the application to the soil of organic matter enriched with microorganisms beneficial to plants. In Poland, droughts are often accompanied by high temperatures, which also have a negative impact on the growth and development of plants. In recent years, there has been an increased interest in the development of sustainable methods of plant cultivation and fertilization, using natural components of the soil biosphere, i.e. beneficial microorganisms, and also microbiologically enriched biofertilizers, composts, and biopesticides. Therefore, one of the methods of reducing the effects of drought stress in agriculture is the use of natural bioproducts enriched with beneficial microorganisms. The results of studies so far indicate positive effects of microbiological symbionts, such as arbuscular mycorrhizal fungi, filamentous fungi of the genus *Trichoderma*, or bacteria of the genera *Pseudomonas*, *Azospirillum* and *Bacillus* on the adaptation of plants to the unfavourable conditions of drought and high temperatures.

Studies conducted at the Department of Microbiology and Rhizosphere of the Institute of Horticulture – National Research Institute have demonstrated that beneficial microorganisms from the IO-PIB SYMBIO BANK reduce the negative effects of drought and high temperature stress on crop plants. The studies conducted by us in 2014–2019 proved the high potential of beneficial rhizosphere bacteria and filamentous fungi in reducing the negative effects of drought and high temperatures in the cultivation of vegetable and fruit plants. The combined application of biochar together with beneficial microorganisms stimulated the formation of starch grains in the cells of the root cortex and increased the diameter of xylem vascular bundles, which resulted in more intense water and mineral uptake by nectarine, apple, and peach plants growing under drought and high temperature stress conditions that occurred in the 2015 season. Other studies in this field indicated that inoculation of potato plants with the PsJN of *Burkholderia phytofirmans* bacteria helped the plants adapt to high temperature conditions. Applications of consortia of beneficial microorganisms in the cultivation of carrot, parsley, potato, and celery, as well as apple, peach, and nectarine trees increased the growth and yielding of plants, improved the water status of soil and plants and their mineral nutritional status. The most valuable species and strains of beneficial microorganisms, with the highest effectiveness in stimulating plant growth and yielding, and plant adaptation to unfavourable drought stress conditions, have been identified and characterized, and are used as components of microbiological consortia and products incorporating basic substances such as humic acids, yeast, and brown coal (lignite), which improve the adaptation of horticultural plants to the unfavourable conditions of drought stress in arable and horticultural crops.

These types of natural technologies are an effective and economically viable alternative in the organic production of horticultural plants. The newly developed consortia of microorganisms and microbiological plant cultivation technologies will contribute to increasing the yield size and quality of horticultural crops and to improving soil fertility of arable and horticultural crops under drought stress.

P100. Soil nitrogen in different crop rotation: organic nitrogen fractions and transformation

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Nitrogen is introduced into the soil in mineral and organic fertilizers, substantial amount of it is usually immobilized in the organic compounds (protein, amino acids, aminosugars) during the synthesis of microbial biomass. During the decomposition of microbial biomass, some of N-compounds are released as mineral forms and some part undergoes conversion to more stabile organic compounds, ultimately becoming a part of soil organic matter. From agricultural point of view very important is the amount fulvic and humic acids. These humic fractions are of great importance in shaping properties of soil.
We conducted field study to assess the effects of two crop rotations on soil organic nitrogen fractions and N transformation (urease activity). Crop rotations were as follows: faba bean (FR) or wheat (WR) (first year), wheat (second year) and triticale (third year). Faba bean and wheat residues were incorporated into the soil. Black fallow (BF) was used as a reference soil. Soil samples were collected 7 times. Organic N fractions were assessed based on acid hydrolysis with 6 M HCl (Bremner, 1965) and 2 steps analysis with 0.25 and 3 M H_2SO_4 (Kalembasa and Kalembasa, 2016) and N fractions in soil organic matter (SOM) was assessed (IHSS method).
The amount of total nitrogen in soil increased significantly in order: BF<WR<FR. N fractions (Bremner method): hydrolysable-N, amino acid-N, threonine and serine-N were the highest in FR and the lowest in BF, while ammonia-N and amino sugar-N were lower in BF than in soils with crops rotations. The sequential fractionation (Kalembasa and Kalembasa method) revealed significant effects of crop rotations on N fractions. Irrespective of treatments, the lowest amount of N (about 3%) was detected in fraction of soluble mineral and organic N compounds, about 10 times more in easily hydrolysable compounds and the highest (above 40%) in fraction difficult hydrolysable. N fractions in SOM in more cases were at the highest level in FR, the lowest in BF. N in humic compounds increased as follows: BF<WR<FR. Urease activity was induced in FR as compared with WR.
In summary, faba bean-based rotation was more beneficial to improve soil quality and fertility than the wheat rotation.

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References

Bremner J.M. (1965). Organic forms of nitrogen, In: Methods of soil analysis, Ed. Black C.A., Madison: American Society of Agronomy, 1238-1255.

Kalembasa S., Kalembasa D. (2016). Conversions and Pathways of Organic Carbon and Organic Nitrogen in Soils, In: Bioactive Compounds in Agricultural Soils, Ed. Szajdak L.W., Springer International Publishing, Switzerland

P101. Monitoring leaf potassium content in leaves using hyperspectral imaging

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Potassium is one of the most important biochemical components of plant organic matter. Its efficient application, as well as rapid and time monitoring of potassium content in crops is essential for observation of plant health and condition. Different nondestructive methods have been used in agricultural management for determination of nutrient concentration (Singh and Budihal., 2021). Among these sensors, hyperspectral reflectance stands out, as it allows obtaining information on the relationships between plants and electromagnetic energy in narrow bands of the electromagnetic spectrum. In recent years this technology has been used to detect of diseases in plants (Baranowski et al., 2015), as well as determine macronutrient content (Siedliska et al., 2021).
The proposed approach uses leaf spectral data in the region of 400 - 2500 to predict the amount of potassium level in plant leaves. A study was carried out on two species of popular crops: celery (*Apium graveolens* L., cv. *Neon*) and sugar beet (Beta vulgaris L., cv. Tapir) fertilized with four different doses of potassium (33%, 67%, 100% and 133% of the recommended potassium dose) over 120 days. Hyperspectral imaging was employed to estimation potassium content in plant leaves at three phonological stages. Twelve wavelengths were determined as the most appropriate that give the highest discrimination among different levels of K-treatment. Four machine learning algorithms: k-Nearest Neighbor, Linear Regression, Random Forest and Support Vector Machine were tested for predictive modelling of potassium content in plant leaves. The highest performances were obtained by the k-Nearest Neighbor algorithm. Results obtained in this study demonstrate that hyperspectral imaging could be utilized for developing a decision-making tool for farmers to allow a real-time foliar nutrient assessment leading to control fertilizer inputs in farm.

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References

Singh, A., & Budihal, S. V. (2021). Non-invasive techniques of nutrient detection in plants. In Intelligent Computing and Applications (pp. 407-417). Springer, Singapore.

Baranowski P., Jedryczka M., Mazurek W., Babula-Skowronska D., Siedliska A., Kaczmarek J. (2015). Hyperspectral and thermal imaging of oilseed rape (Brassica napus) response to fungal species of the genus Alternaria. PloS one, 10(3), e0122913.

Siedliska A., Baranowski P., Pastuszka-Woźniak J., Zubik M., & Krzyszczak J. (2021). Identification of plant leaf phosphorus content at different growth stages based on hyperspectral reflectance. BMC Plant Biology, 21(1), 1-17

P102. *Aprica* strawberry cultivation on four types of soil. Does it impact the mycobiome composition?

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Soil characteristics and plant health of agricultural and horticultural crops are dependent on microorganisms that are being present in the environment (Trivedi, Leach, Tringe, Sa, & Singh, 2020). One of the fundamental group of microorganisms, that play an important role in interacting with the plant host, are fungi. Different plant parts are characterized by different composition of colonizing mycobiome, and dependencies between microbial communities and theirs hosts are an important topic in today's agricultural research. Modifying the mycobiome in an optimal manner, opens the possibility to improve food production in a sustainable way (Gopal & Gupta, 2016).

The aim of this research was to determine the differences in the composition of the mycobiome in bulk soil, rhizosphere, shoots and roots of Aprica cultivar of organic strawberry, grown on different types of soil (acrisol, fluvisol, sandy compact, sandy loose).

Analyses consisted of isolation of the DNA from the environmental samples, collected in 2019, with the EURx Gene MATRIX Soil DNA Purification Kit and a Fast-Prep-24 homogenizer (6 m/s, 40 s). The sequencing of ITS1 marker was performed with Illumina MiSeq platform, and QIIME2 environment was used for processing of the data. Identification of fungi was based on the UNITE 8.2 database and for further analyses RStudio v.1.4 was used.

The mycobiome differences between various soil types did not directly reflect the composition of the microbial communities in the plant parts. Each type of the strawberry sample (rhizosphere, shoots and roots) was characterized by individual mycobiome composition, and different types of soil had an impact on the microorganisms present in the sample.

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References

Gopal, M., & Gupta, A. (2016). Microbiome selection could spur next-generation plant breeding strategies. *Frontiers in Microbiology*, *7*(DEC), 1–10. https://doi.org/10.3389/fmicb.2016.01971

Trivedi, P., Leach, J. E., Tringe, S. G., Sa, T., & Singh, B. K. (2020). Plant–microbiome interactions: from community assembly to plant health. *Nature Reviews Microbiology*, *18*(11), 607–621. https://doi.org/10.1038/s41579-020-0412-1

P103. Influence of hemicellulose addition on the properties of apple cellulose film

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Plant cell wall components include, among the others, polysaccharides, such as cellulose, hemicellulose and pectin, which can be isolated by common chemical methods. The formation of natural polysaccharide composites is a beneficial alternative to fossil plastics and has potential for use in packaging and medical applications on one hand (Zhao et al., 2020). On the other can mimic plant cell wall in macroscale. However, there is currently little information available about the interaction between cellulose and hemicellulose.
Hemicelluloses are classified into xylans, mannans and glucans. In this research, it was proposed to use apple cellulose isolated from apple pomace mixed with commercially available hemicelluloses. Firstly water dispersion of cellulose was obtained. Then the dispersion was mixed in four proportions (16:1, 16:2, 16:4 and 16:8) with hemicellulose, i.e. xylan, xyloglucan, arabinoxylan, glucomannan and β-D-glucan. After that the process of high vacuum filtration was performed and the obtained films were dried under pressure.
The films were characterized by FTIR, FT Raman and UV-vis spectroscopy. Research results showed that cellulose-hemicellulose composites have been successfully created. Thermal analysis of composites containing arabinoxylan and glucomannan suggests loosening of the film structure, which results in lowering the temperature of semimelting and degradation, which can most likely be used in the creation of three-component composites. Addition of hemicellulose to cellulose films didn't significantly influence their water contact angle.

Acknowledgments

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References

Zhao, Y., Sun, H., Yang, B., Weng, Y. (2020). Hemicellulose-based film: potential green films for food packaging. Polymers, 12, 1-14.

P104. Selection and genetic research of *Rafanus sativus* L. in condition of artificial light culture

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Condition of artificial light culture is now effectively used in modern protected ground, being an integral part of urbanized agricultural production. In the context of global climatic changes, its role is constantly increasing (Kozai T., 2020). In addition to industrial cultivation of plants, various of scientific research carried out in controlled condition, including selection and genetic research (Abdul Fiyaz et al., 2020). Over the past 30 years, it has been one of the important areas of scientific research of the Agrophysical Research Institute, that makes it possible to quickly implement the achievements of science into practice.

In present work, we applied the original accelerated breeding methodology based on the purposeful use of controlled conditions of artificial light culture (biopolygon of the FGBNU APHI) and the methodology for predicting transgressions based on economically valuable plant traits (Kochetov, Sinyavina, 2019). This approach made it possible in a short time (3-5 years) to create new accessions of small radish (*Raphanus sativus* var. *sativus*) - the Petersburg violet variety and the Petersburg pink line, with a root crop yield of 3,5-4 kg/m^2 in 23-25 days from sowing, having lettuce-type leaves, as well as lines of *Raphanus sativus* L., obtained by hybridization of radish and daikon, with root crops weigh 60-80 g in 45 days from sowing. The breeding and selection of all new accessions was carried out according to the characteristics of early maturity, high root weight, resistance to bolting, lettuce leaf type, realized under conditions of intensive light culture. The lettuce type of leaf allows consumers to use the whole plant of radish for food as a fresh salad. This is especially important since young leaves of *Raphanus sativus* L. have a higher nutritional value than root crops. The possibility of using new accessions for food as a whole (roots and leaves) increases the profitability of their cultivation in light culture and contributes to an improvement in the quality of nutrition of the population, especially in the Northern regions in winter.

The studies of the new accessions were also carried out in the open ground of the Leningrad region during planting in the first ten days of May. During this period, environmental stress factors act in the region, provoking premature bolting of small radish and daikon - a long day (16-18 hours) and low positive temperatures. All accessions were characterized by very high resistance to bolting, early maturity, high yield (4 kg/m^2 for small radish and 5-5.5 kg/m^2 for radish x daikon hybrids), which indicates their high adaptive ability to different growing conditions.

References

Kozai, T., Niu, G. (2020). Role of the plant factory with artificial lighting (PFAL) in urban areas. In Plant Factory (pp. 7-34). Academic Press. https://doi.org/10.1016/B978-0-12-816691-8.00002-9

Abdul Fiyaz R., Ajay B.C., Ramya K.T., Aravind Kumar J., Sundaram R.M., Subba Rao L.V. (2020) .Speed Breeding: Methods and Applications. In: Gosal S., Wani S. (eds) Accelerated Plant Breeding. Springer, Cham, 1, 31-49. https://doi.org/10.1007/978-3-030-41866-3_2– 2020.

Kochetov A.A., Sinyavina N.G. (2019). The strategy of creating highly productive forms of radish, adapted for cultivation under artificial light conditions. Russian Agricultural Sciences, 45(1), 29-33. https://10.31857/S2500-26272019129-33.

P105. Carbon sequestration in maize agroecosystem

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The presence of organic matter in soils is one of the essential drivers for their ability to perform ecosystem functions. Agricultural practices allowing introduction of assimilated C into the soil environment and/or slowing down the conversion of accumulated carbon into CO_2 are particularly important in the case of maize-based cropping systems, where management practices can increase the mineralization of soil organic matter (Lal, 2018).
The effect of tillage and fertilization practices on changes in soil organic carbon content under the cultivation of grain maize was assessed.
The two-year field study was conducted on Haplic Luvisol at the Experimental Farm in Czesławice. The scheme of the experiments consisted of the following treatments N1– 80 kg N/ha in urea form and conventional tillage N2 – 120 kg N/ha in urea form and conventional tillage; N3– 160 kg N/ha in urea form and conventional tillage; N2Urea – localized fertilization with a multicomponent NPS(M) fertilizer (120 kg N/ha) and reduced tillage.
It was found that the incorporation of organic materials such as maize residues, as well as the application of mineral fertilizers in N3 and N2Urea treatments significantly influenced organic carbon accumulation. The previous studies also showed that short-term (e.g. 2–4 years) straw return treatment combined with inorganic fertilizer addition was beneficial for the accumulation of SOC (Dou et al., 2016).

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References

Dou X., He P., Zhu P., Zhou W. (2016). Soil organic carbon dynamics under long-term fertilization in a black soil of China: Evidence from stable C isotopes. Scientific Reports, 6, 21488, DOI: 10.1038/srep21488.
Lal, R. (2018). Digging deeper: A holistic perspective of factors affecting soil organic carbon sequestration in agroecosystems. Global Change Biology, 24(8), 3285-3301.

P106. Extrusion-cooking process of corn snacks with coffee husk

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In recent years, the extrusion-cooking process has been increasingly used in food production. The group of products manufactured on the basis of this technology includes corn crisps. They are not of high nutritional value, but using the right additive allows to increase their quality. Recently research have been conducted on the use of by-products of the food industry in the production of a new group of extrudates. Coffee husk is a product characterized by high nutritional value, protein and lignins contents.
The aim of this study was to produce corn snacks with coffee husks using single-screw extruder-cooker TS-45, using different screw speeds (80, 100 and 120 rpm) and the amount of coffee husk additive (0-40%). During this study a decrease of process efficiency was observed with increasing coffee husk addition. In the case of the measurement of energy consumption it was observed that the SME increases with increasing the screw speed of the extruder-cooker and with increasing amount of coffee husks addition to 20%. For the other raw material mixtures, the specific mechanical energy was decreased with higher screw speed.

Keywords: extrusion-cooking, corn snacks, by-products of the food industry, extrusion-cooking process efficiency, extrusion-cooking specific energy consumption.

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P107. Soybean reaction to spring cold stress

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Soybean is a short-day plant with high temperature requirements, especially during the germinate and flowering stage, but there is little research on the response of soybean to low temperatures at earlier developmental stages. The aim of this study was to identify the response to cold stress applied at very early developmental stages of 16 soybean cultivars to yield and chemical composition of seeds.
In 2018-2019, experiments were conducted under controlled conditions (phytotrons) and partially controlled conditions (greenhouse). The research subjects were 16 cultivars of soybean *Glycine max* (L.) Merr., belonging to 3 earliness groups: very early and early (Aldana, Annushka, Augusta, Erica, Oressa, Paradis); semi-early (Abelina, Maja, Mavka, Merlin, Sculptor) as well as late and very late: (Aligator, GL Melanie, Lissabon, Madlen, Petrina). In the first phytotron (MICRO-CLIMA) the air temperature was 12/6^{o}C day/night (stress conditions), while in the second phytotron – 20/15^{o}C day/night (optimal conditions). Short-term cold stress (3 days) and long-term stress (9 days) was applied immediately after sowing. In the control treatment, the plants were in optimal conditions. After 21-days the plants were placed in a greenhouse.
Stress regime and genetic factor (cultivar) significantly affected soybean yield. Regardless of cultivar, the lowest seed yield was obtained in the control object and after application of a short stress, however seed yield obtained after a long cold stress was significantly higher, on average 21.5% than the control treatment. Considering cultivar earliness groups, the highest increase in seed yield after a long stress was shown in early and very early cultivars (by 27.3%), while a slightly smaller increase was shown in semi-early cultivars as well as late and very late cultivars (average by 19.7%). Regardless of stress regime, the lowest seed yield was obtained from Madlen and Annushka cultivars, while all other cultivars yielded significantly higher. The highest seed yield was obtained from Abelina, GL Melanie and Petrina cultivars. Statistical analysis of the test results confirmed the significant interaction of the cultivar with the stress regime. The nutrient content of soybean seeds depended on the genetic factor, while the stress regime had no significant effect on seed quality. Varietal differentiation was shown in the content of all studied nutrients.

P108. Soybean response to cold stress during flowering

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Climatic conditions are not favorable for soybean cultivation in Poland. The limiting factors are high thermal requirements of this species and sensitivity to day length. Soybean is temperature-sensitive from emergence to maturity, but the critical period associated with particular sensitivity to low temperatures is the flowering stage. The aim of this study was to evaluate the effect of 7-day cold stress at the flowering on yield and chemical composition of seeds of 15 soybean cultivars belonging to three earliness groups.

The pot experiment was conducted in 2019-2020 in the greenhouse of Institute of Soil Science and Plant Cultivation-State Research Institute in Puławy, Poland under partially controlled conditions. The research treatments were 15 cultivars of soybean *Glycine max* (L.) Merr., belonged to 3 earliness groups: EC - very early and early (Aldana, Annushka, Augusta, Erica, Oressa), MC - semi-early (Abelina, Maja, Mavka, Merlin, Sculptor) and LC - late and very late (Aligator, GL Melanie, Lissabon, Madlen, Petrina). At the flowering stage (BBCH 62-67), the pots were placed in the MICRO-CLIMA phytotron for 7 days, where cold stress was inflicted (17/13^{o}C day/night). The control treatments were under natural conditions at all times (mean temperature 24/17^{o}C day/night).

Cold stress and cultivar significantly differentiated soybean seed yield. Under the influence of plant cold stress at the flowering significantly reduced soybean seed yield (on average by 24.0%) compared to the control. In EC and MC cultivars the average yield decrease was 19.7 and 20.1%, respectively, while in LC cultivars - 31.2%. Irrespective of thermal conditions, significant differences in seed yield were found between soybean cultivars. Among the tested cultivars, the lowest yield was obtained from the Annushka and Madlen, while the highest seed yield was obtained from the cultivars GL Melanie and Abelina. Cold stress at the flowering stage caused a significant increase in protein content and ash content and a decrease in fat content in soybean seeds. The genetic factor significantly differentiated the protein, fat and ash content. The high genetic variability in soybean indicates that it has significant adaptive potential to different climatic conditions.

P109. Treatment of contaminated soil with mineral-organic mixtures and the determination of the content of polycyclic aromatic hydrocarbons

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Polycyclic aromatic hydrocarbons (PAHs) can have toxic, carcinogenic and even mutagenic effects on live organisms (Ukalska-Jaruga and Smreczak 2020). Generally, PAHs enter the environment during an incomplete combustion of organic matter in natural and anthropogenic processes. It is estimated that almost 90% of all PAHs are accumulated in soils. Considering the toxicity and global prevalence of PAHs, monitoring of PAHs content in soils and developing new methods of their immobilization and in situ decomposition has become a challenge.
Soil samples were collected after the corn growing season cultivated on contaminated (Zn, Cd and Pb) sandy loam soil. The pot experimental scheme included two treatments: C – soil without fertilization and MF – soil with NPK mineral fertilizer with addition of 3 or 6% of lignite/leonardite and 3% of zeolite composite (NaX-Ver or NaX-C). The qualitative and quantitative analysis of 16 polycyclic aromatic hydrocarbons (PAHs) in the collected soil from individual objects were established using gas chromatography-mass spectrometry (GC-MS). For the determination of the best recovery PAHs content of soil two extraction techniques (ultrasonification method and Soxtec) and different solvents were studied. Additionally, enzymatic activity of soils and content of the organic carbon and black carbon were determined (Mierzwa-Hersztek et al. 2019).
Generally, total content of PAHs in MF's soil was lower in comparison to soil without fertilization, especially for fertilization mixtures with zeolite NaX-C. The content of organic carbon, black carbon organic/black carbon and enzymatic activity varied in depend on applied fertilizer.

Acknowledgments

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References

Ukalska-Jaruga A., Smreczak B. (2020). The Impact of Organic Matter on Polycyclic Aromatic Hydrocarbon (PAH) Availability and Persistence in Soils. Molecules, 25, 2470.

Mierzwa-Hersztek M., Gondek K., Klimkowicz-Pawlas A., Chmiel M.J., Dziedzic K., Taras H. (2019). Assessment of soil quality after biochar application based on enzymatic activity and microbial composition**. International Agrophysics, 33, 331-336.

P110. Sunflower husks biochar: an ecological adsorbent of diuron

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In recent years, environmental pollution by pesticides is becoming more serious. Pesticides are chemicals widely used in agriculture and horticulture. They may be accumulated in all living organisms and involved in various trophic chains. The toxicity of pesticides results from the presence of biologically active ingredients, emulsifiers, etc. They are degradable substances, but most of them remain in the environment for very long time, e.g. diuron. Adsorption is an effective method of treating pesticide contamination. Based on specific interactions between adsorbent surface and adsorbed contaminants it is highly selective process, which does not require specialized apparatus. Nowadays, various types of adsorbents have been developed, e.g. biochar. This material is usually characterized by high adsorption capacity relative to inorganic and organic substances (Tomczyk et al., 2020).
The aim of the research was to determine the adsorptive ability of biochar relative to diuron. Biochar was prepared from sunflower husks by pyrolysis process of biomass at 650°C and characterized using several physico-chemical methods. Adsorption study was performed using the batch adsorption technique. The pesticide concentration was determined by high-pressure liquid chromatography (3000 Ultimate, Dionex).
The obtained results indicated that pseudo II-order and Redlich–Peterson isotherm models best fitted experimental data. Diuron adsorption was based on the creation of hydrogen bonds as well as donor-acceptor interactions between substituents present on solid surface and in pesticide molecules. The π–π electron-donor–acceptor interactions may also occur between pesticide and biochar (Szewczuk-Karpisz et al., 2021). Based on the noted adsorption levels it was stated that sunflower husks, as waste from agricultural industry, can be used to prepare environmentally friendly adsorbents capable of binding diuron.

References

Tomczyk A., Sokołowska Z., Boguta P. (2020). Biochar physicochemical properties: pyrolysis temperature and feedstock kind effects. Rev. Environ. Sci. Biotechnol., 19, 191–215.

Szewczuk-Karpisz K., Tomczyk A., Celińska M., Sokołowska Z., Kuśmierz M. (2021). Carboxin and Diuron Adsorption Mechanism on Sunflower Husks Biochar and Goethite in the Single/Mixed Pesticide Solutions. Materials, 14, 2584.

P111. Impact of *Dystric Cambisol* modification by biochar and macromolecular compounds on cadmium(II) ions immobilization

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Nowadays, soil contamination with trace metals is reported in many regions. Through intensive use of fertilizers and plant protection products as well as industrial emissions, trace metals enter agricultural soils and are able to penetrate into the edible part of crops (Polcaro et al., 2004). The availability of metal or non-metal ions is extremely high when the soil is acidic. Under such conditions they can quickly get incorporated into plants and finally into animals, where they can damage multiple organs. Therefore, it is very important to immobilize trace metals and prevent their transfer into the food chain. This can be achieved by the use of various soil amendments, such as biochar and macromolecular compounds.
For this reason, it was decided to conduct research on the sorption of cadmium(II) ions in a silty soil (*Dystric Cambisol*) with and without selected additives: sunflower husks biochar, wood waste biochar, bacterial exopolysaccharide and polyacrylamide conditioners. The soil was collected from Rogóżno, Lublin province, Poland (Sokołowska et al., 2020). The biochar doses equaled 0.1 and 5 wt%, whereas the polymer concentration was 50 mg/L. Cadmium(II) concentration in the samples was determined using ion-selective electrode. Based on the obtained results, it was found that the combination of biochar and anionic polyacrylamide contributed to the strongest cadmium(II) immobilization in silty soil.

References

Polcaro A.M.; Mascia M.; Palmas S.; Vacca A.; Tola G. (2004) Competitive sorption of heavy metal ions by soils. Environmental Engineering Science, 20(6), 607.

Sokołowska, Z.; Szewczuk-Karpisz, K.; Turski, M.; Tomczyk, A.; Cybulak, M.; Skic, K. (2020) Effect of Wood Waste and Sunflower Husk Biochar on Tensile Strength and Porosity of Dystric Cambisol Artificial Aggregates. Agronomy, 10, 244.

P112. Effect of inoculation with *Bradyrhizobium japonicum* on fatty acids profile in soybean seeds

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Soybean is capable of fixing atmospheric nitrogen in symbiosis with *Bradyrhizobium japonicum* bacteria. Since these bacteria are not found in European soils, soybean seeds must be inoculated with *Bradyrhizobium* strains before sowing in order to fix nitrogen and realize their yield potential. Inoculation with papillary bacteria of legumes is a reliable agronomic practice to increase production levels, protect the environment and provide quality food for humans and animals. Inoculation can also cause changes in the chemical composition of seeds of different legume species. It has been shown to increase the antioxidant potential and content of some bioactive compounds such as phenols, flavonoids, organic acids, proteins and fatty acids (FA).

Field experiments were carried out in 2016–2019 at the Experimental Station for Cultivar Assessment in Przecław (south east Poland). The effect of bacterial inoculation (which contains *B. japonicum*, symbiotic bacteria for soybean seeds) on fatty acid composition of Aldana and Annushka soybean seeds was determined in the experiment. The following bacterial inoculants were used: without inoculation (control), HiStick®Soy (BASF, Germany), Nitragina (Institute of Soil Science and Plant Cultivation -State Research Institute, Poland). FA profile of soybean seeds was determined by gas chromatography with flame ionization detection FID (Clarus 580, Perkin-Elmer, Shelton, USA) using a ZB-WAX column.

This study indicates the genetic determinants of FA composition in soybean seeds and their differential accumulation levels for C16:0, C16:1, C18:1n9 , C18:2 , C18:3 and C20:0, as well as saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA) FAs. Inoculation of soybean seeds with a strain of *B. japonicum* (HiStick® Soy and Nitragina) is recommended as it will cause a decrease in SFA and C16:0 acid levels. This is considered nutritionally beneficial as its contribution to total FAs determines the hypercholesterolemic index, and it is the third most heavily accumulated FA in soybean seeds. The interaction of cultivars and inoculation formulation on the FA content of soybean seeds was demonstrated. An increase in the value of C16:0 content resulted in a decrease in the accumulation of C18:1, C18:2, and C18:3 acids. The content of each decreased by almost one unit for every 1% increase in C16:0 content.

P113. Fluoride in Japanese green tea matcha

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Abstract
Fluoride is one of the essential elements in human body (1). It's a component of dentin, enamel and bones but also soil, water, food (mainly tea, especially green (2), grain products, rennet cheeses and fish) and chemical preparations. (3) (4) Though its many benefits, fluoride may be toxic. Long-term consumption of low concentrations leads to the accumulation of fluoride in the body that leads to fluorosis (1).
Pro – health properties of green tea are known and appreciated around the world. One of its variaties is matcha – Japanese powdered green tea (*Camellia sinensis*). It's known for high contrentation of antioxidants, phenolic acids, flavonoids (provided by growing in the shade) (5) (6) as well as microelements and macroelements. An additional advantage of such growing is specific taste, aroma and color of tea, thanks to the lower content of catechins and high content of theanine and caffeine. Matcha has antioxidant, antiviral, anti-inflammatory, chemopreventive, immunostimulating and cardioprotective properties(6).
Statement of the research problem
Determination of fluoride content in samples of matcha powder and its infusions prepared with water in different temperatures.
Materials and methods
Two types of matcha (*Camellia sinensis*) were examined: traditional matcha and daily matcha. The infusions were prepared with water at a temperature 25°C, 70°C, 80°C and 90°C. Fluorides content was determined by selective potentiometric electrode. Statistical analysis was performed with Stat Soft Statistica 13.0 i Microsoft Excel 2017.
Results
Fluoride content in matcha infusions was between 3.36 mg/l to 4.03 mg/l and depended on harvest time and brewing temperature. In both types of matcha, the lowest fluoride content was noted in infusions prepared in temperature 25°C, and the highest in temperatures 70 and 90°C. Fluoride content in traditional matcha was 118.39 mg/l and in daily matcha – 121.65 mg/l.
Conclusions
Matcha may be an additional element in daily diet, however, it's important to be aware of significant amount of fluoride in its infusions. The brewing temperature had a significant influence on the content of this element. The lowest value was recorded at the temperature of 25°C, which is associated with the dose that is the most safe for humans.

References

Barbier O, Arreola-Mendoza L, Del Razo LM. Molecular mechanisms of fluoride toxicity. Chem Biol Interact. 5 listopad 2010;188(2):319–33.
Maleki A, Daraei H, Mohammadi E, Zandi S, Teymouri P, Mahvi AH, i in. Daily Fluoride Intake from Iranian Green Tea: Evaluation of Various Flavorings on Fluoride Release. Environ Health Insights. 28 marzec 2016;10:59–63.
Scientific Opinion on Dietary Reference Values for fluoride. EFSA J. 2013;11(8):3332.
Tabele składu i wartości odżywczej żywności [Internet]. Księgarnia Medyczna PZWL. [cytowane 5 styczeń 2021]. Dostępne na: https://pzwl.pl/Tabele-skladu-i-wartosci-odzywczej-zywnosci,56121347,p.html
Kochman J, Jakubczyk K, Antoniewicz J, Mruk H, Janda K. Health Benefits and Chemical Composition of Matcha Green Tea: A Review. Molecules. styczeń 2021;26(1):85.
Jakubczyk K, Kochman J, Kwiatkowska A, Kałduńska J, Dec K, Kawczuga D, i in. Antioxidant Properties and Nutritional Composition of Matcha Green Tea. Foods. kwiecień 2020;9(4):483.

P114. The use of a biological assay based on the growth parameters of the *Saccharomyces cerevisiae* Δ*sod1* mutant to assess the antioxidant properties of extracts of the aerial parts of dog rose (*Rosa canina* L.)

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For many years dog rose (*Rosa canina* L.) has been used as a material rich in bioactive substances. The herbal materials are the fruits (pseudofruits), seeds (true fruits), leaves, flowers, petals, leaf and flower buds, shoots, and also the root, although the highest content of health-promoting substances is found in the aerial parts of the plant. The aim of the study was to assess the antioxidant properties of water, ethanol + water, and glycerol + water extracts of various organs of dog rose (obtained in their natural state and purchased at a herbalist's shop) using various methods: chemical, biochemical, and biological. The leaves, both young and mature, proved to be the richest sources of phenolic compounds. They contain from 128.29 to 159.14 mg phenolic compounds/mL expressed as chlorogenic acid equivalent. The fruits and leaf buds are significantly poorer sources of these substances. On the other hand, vitamin C content was highest in the fruits of dog rose (whole fruits from Dary Natury and ground peel from Sanbios). It was much lower (by about 70%) in the extracts prepared from fruits obtained in their natural state in the previous growing season, and the lowest in extracts from the leaf buds and leaves. The extracts also had varied antioxidant properties as determined by the $ABTS^{\bullet+}$ and $DPPH^{\bullet}$ assays. The extracts of leaf buds and leaves (young and mature) had a greater capacity to neutralize the DPPH radical than the ABTS radical cation, whereas the fruit extracts were more active against the ABTS radical than DPPH. The two biological assays, involving analysis of the growth of Δ*sod1* mutant cells in a hypertonic medium (test 1) and in YNB minimal medium, without essential amino acids lysine and methionine (test 2), produced similar results. The extracts of whole fruits from Dary Natury and the ground fruit skins from Sanbios showed the greatest capacity to restore growth to Δ*sod1* mutant cells. The highest OD values of the cultures were noted following the addition of glycerol + water extracts and the lowest in the case of water extracts, irrespective of the type of material used. Extracts prepared from fruit from the previous growing season had a lower capacity to restore growth to Δ*sod1* mutants in comparison to commercially available fruits in both assays. The results suggest that bioassays based on the growth parameters of the Δ*sod1* mutant of *S. cerevisiae* yeast can be used to assess the antioxidant properties of plant extracts *in vivo*, but their usefulness seems to depend mainly on the content of hydrophilic antioxidants.

P115. Wood biochar as natural organic adsorbent of silver nanoparticles

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Currently, in the 21st century, the use of nanoparticles is becoming more common. They are used in agriculture, medicine, textiles, cosmetics, pharmaceuticals, etc. Silver nanoparticles (Ag-NPs) exhibit antibacterial activity. However, it is also pointed out that the excessive use of Ag-NPs and their appearance in the environment may have a different impact on the quality of the environment. Unfortunately, the modern wastewater treatment systems do not completely remove nanoparticles due to their small size. Biochars are among the most promising materials in the removal of these kinds of impurities. Biochar exhibits a high specific surface area and high content of surface functional groups [1].
This paper presents the adsorption capacity of biochar towards Ag-NPs. The performed experiments included the following two steps: i) a study of adsorption kinetics and equilibrium isotherm of adsorption Ag-NPs on biochar; ii) the evaluation of the efficiency of biochar in Ag-NPs removal. Biochar were produced from during the Paulownia tree waste pyrolysis process, which called "double barrel method". Biochar were characterized by several physico-chemical methods. The adsorption capacity was determined using the batch adsorption technique.
The pseudo-second order model best described obtained adsorption kinetics, and the Freundlich model accounted for the registered adsorption data. The adsorption of Ag-NPs is probably based on the hydrogen bonds creation between surface oxygen atoms and hydroxyl groups of stabilizer Ag-NPs [2]. Biochar may be used as eco-friendly material in water purification or wastewater treatment.

References

Tomczyk A., Sokołowska Z., Boguta P. (2020). Biochar physicochemical properties: pyrolysis temperature and feedstock kind effects. Rev. Environ. Sci. Biotechnol., 19, 191–215.

Tomczyk, A., Szewczuk-Karpisz, K., Sokołowska, Z., Kercheva, M., Dimitrov, E., 2020. Purification of aqueous media by biochars: Feedstock type effect on silver nanoparticles removal. Molecules 25(12), 25122930.

P116. Upgraded biochar derived from sunflower husks as eco-friendly adsorbent for the tetracycline removal

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Currently, approximately 100-200000 tones of antibiotics are consumed per year around the world. These substances are continuously released into the environment without any restriction [1]. Tetracyclines are the second most common group of antibiotics used in the treatment of various infectious diseases. Their presence in the aquatic environment can cause various allergic reactions and enhance development of antibiotic-resistant pathogens. Many methods and technologies have been developed for the purification of soils and sewage including adsorption enabling effective removal of antibiotic pollution. In decontamination of water-ground environment, biochar and its modified varieties can be applied as adsorbents [2].

The main aim of the performed experiments was to determine the influence of biochar modification on its adsorption capacity relative to tetracycline. This goal was achieved by analyzing and comparing the surface and adsorption properties of modified and non-modified biochar in the selected systems. Biochar was prepared from sunflower husks by pyrolysis process at 650°C. Its modification was conducted using ascorbic acid. All solids were characterized by several physico-chemical methods. Their adsorption capacity was determined using the batch adsorption technique and high-pressure liquid chromatography (3000 Ultimate, Dionex).

Experimental adsorption data were well described by the pseudo II-order and Freundlich isotherm models. The surface functional groups of biochars interact with antibiotic molecules through van der Waals interactions as well as formation of hydrogen bonds. In addition, tetracycline contains hydrogen atoms – Lewis acids, which can interact with the adsorbent based on acid-base reactions. The biochar modification with ascorbic acid increased its adsorption capacity. Thus, the chemically upgraded biochar material can be used as an effective adsorbent of tetracycline in groundwater/soil treatment.

References

Cycoń M. Mrozik A., Piotrowska-Seget Z. (2019). Antibiotics in the soil environment—degradation and their impact on microbial activity and diversity. Front. Microbiol. 10, 338.

Tomczyk A., Sokołowska Z., Boguta P. (2020). Biochar physicochemical properties: pyrolysis temperature and feedstock kind effects. Rev. Environ. Sci. Biotechnol., 19, 191–215.

P117. The impact of natural soil on the response of potato cultivars to biotic and abiotic stresses

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Potato plants grown in natural soil under pathogen or drought stress had significantly lower root weight with slight differences in the weight of the canopy and the length of the roots. The potato genotype influenced these parameters more than the stress, regardless of its type. The average number of tubers produced by one plant was the highest in control. However, abiotic and biotic stress only slightly decreased this parameter. Drought drastically reduced the weight of tubers produced by one plant and the average weight of a single tuber. At the same time, biotic stress only slightly decreased the tuber weight. Overall, these results indicate that the natural microbiome of field soil had a higher potential to counterbalance the biotic stress than the drought impact on plants.

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P118. Can we combat plant pathogens using bio-silver nanoparticles?

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Crop pathogens reduce the yield and quality of agricultural production. Microbial disease leading to serve yield loss in the number of crop plants [1.] Therefore, to overcome these problems there is an urgent need to develop an eco-friendly, and sustainable approach for the effective management of plant pathogens to avoid the crop yield losses. Biosynthesized silver nanoparticles could become an alternative strategy for traditional agrochemicals [2].
The study included myco-synthesis of silver nanoparticles (AgNPs) and evaluation their antimicrobial activity against common fungal and bacterial plant pathogens. Bio AgNPs were characterized by using UV-Vis spectroscopy, Transmission Electron Microscopy (TEM) and Fourier Transform Infrared Spectroscopy (FTIR). Antibacterial activity of biogenic AgNPs was evaluated by determination of minimum inhibitory and minimum biocidal concentrations (MICs and MBCs) against *Pectobacterium carotovorum, Xanthomonas campertris, Agrobacterium tumefaciens* and *Pseudomonas syringae*. Disc diffusion and well diffusion methods were used to determine antifungal activity of AgNPs (concentration 3 mg ml $^{-1}$).
Six fungal strains were selected for effective synthesis of AgNPs, namely *Fusarium culmorum, F. oxysporum, F. tricinctum, F. solani, Phoma lingam, Trichoderma sp.* and *Colletrotrichum acutatum*. Bionanoparticles showed a peak with a maximum absorbance at wavelength in range 420 - 435 nm which is specified for AgNPs. TEM analysis proved that the AgNPs average size ranged from 9 to 25 nm. FTIR analysis confirmed the occurrence of proteins on the surface of AgNPs. Myco-synthesized silver nanoparticles exhibited antibacterial activity (MIC of 2 – 256 µg ml $^{-1}$, MBC of 32–1024 µg ml $^{-1}$). The inhibition zones of fungal growth were in range of 1 - 15 mm. AgNPs showed the highest antifungal activity against *Botritis cinerea, Sclerotina sclerotiorum, Phoma lingam* and *Rhizoctonia solani* 476. The fungal extracts were found to have potential for the biological synthesis of silver nanoparticles through a non-toxic, economical and environmentally friendly method. Silver bionanoparticles in view of their unique properties, have potential as a promising agent to eliminate or reduce bacterial and fungal plant pathogens.

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References

Savary S., Willocquet L., Pethybridge S. J., Esker P., McRoberts N., Nelson A. (2019). The global burden of pathogens and pests on major food crops. Nature ecology & evolution, *3*, 430-439.

Ali M., Ahmed T., Wu W., Hossain A., Hafeez R., Islam Masum M., Li B. (2020). Advancements in plant and microbe-based synthesis of metallic nanoparticles and their antimicrobial activity against plant pathogens. Nanomaterials, 10, 1146.

P119. Assessment of potential sorption properties of humic substances

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Organic matter plays a many beneficial functions in the soil and its considerable portion constitute a humic substances (HS) such as fulvic acids-FA, humic acids-HA and humin-HN. HS differ in molecular weight, elemental composition and chemical structure, including the amount and type of functional groups that affect their reactivity and transformation processes in soil. The aim of the study was to evaluate the differences in the molecular structure of humic substances (FA, HA, HN) using spectroscopic (UV-VIS and VIS-nearIR) and electrochemical (zeta potential, particle size diameter) techniques.
Soil material (n = 30) used for the study were sampled from the surface layer (0-30 cm) of agricultural soils. The basic soil physicochemical properties included clay (0-7%), silt (7-77%), pHK_{Cl} (4.8-7.5), C_{org} (6.4-15.9 $g \cdot kg^{-1}$) and C_{tot} (7.4-75.4 $g \cdot kg^{-1}$) content. FA and HA were isolated and purified according to the IHSS method while HN were isolated by extraction with benzene and purified by HF/HCL mixture. The quantitative content of HS was expressed by carbon content while qualitative analyzes were carried out by UV-VIS spectrofotometer (Lambda),VIS-nearIR spectroradiometer (PSR-3500®, Spectral Evolution) and electrochemical characteristics by Litesizer™ 500 (Anton Paar).
The coefficients of Q2 / Q4 (ʎ = 280 nm, ʎ = 465 nm) and Q4 / Q6 (ʎ = 465 nm, ʎ = 665 nm) analyzed in the UV-VIS range indicated that HN are characterized by the highest concentration of aromatic compounds in their molecular structure and highest weight, whereas FA contains mainly aliphatic compounds with low molecular weight. HA exhibited aliphatic-aromatic structure as an intermediate form between FA and HN. Analyzes in the VIS-NIR range pointed that FA contains substituents belonging to hydroxyl, alkyl and amino groups, while HA and HN have mainly ethyl, phenyl, carbonyl and benzyl functional groups. Measured values of zeta potential an particle size diameter indicated that the FA particles exhibited ellipsoidal shape while HA and HN spherical shape. All HS have a bivalent charge capable of attracting anions and cations.
The spectroscopic and electrochemical methods used in this research, allowed for a detailed assessment of the humic substances molecular structure, proving differences in their chemical nature and molecular composition.

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P120. Divergence of *BEAS* gene and beauvericin biosynthesis by *Fusarium* and *Trichoderma* species

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Beauvericin (BEA) is a non-ribosomal cyclodepsipeptide mycotoxin produced by a wide range of fungal species, including saprotrophs and plant pathogens, particularly belonging to *Fusarium* and *Trichoderma* genera (Urbaniak et al. 2020). The aim of the study was to identify BEA naturally-synthesized by strains of *Fusarium* and *Trichoderma* species. Moreover, because of the unknown ability to produce beauvericin by investigated fungal strains, it was quantified in the samples of in vitro cultures using mass spectrometry. We also analyzed the polymorphism of *BEAS* gene by sequencing partial *BEAS* regions from *Trichoderma* and *Fusarium* species.

The quantitative analysis of beauvericin was performed using a UPLC-MS in eleven *Trichoderma* and six *Fusarium* rice cultures. The phylogenic analyses of beauvericin synthase (*BEAS*) gene divergence were performed on the basis of sequenced PCR-amplified fragments from *Trichoderma* and *Fusarium* fungi and reference sequences obtained from the GenBank database (representing *Fusarium* and *Trichoderma* genera).

This study demonstrates the differences in beauvericin production by a number of distant relatives—fungal species belonging to *Fusarium* and *Trichoderma* genera. It also shows that fungi belonging to the *Trichoderma* genus present the ability to produce beauvericin.

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References

Urbaniak M., Waśkiewicz A., Koczyk G., Błaszczyk L., Stępień Ł. (2020). Divergence of Beauvericin Synthase Gene among *Fusarium* and *Trichoderma* Species. Journal of Fungi, 6, 288.

P121. Impact of different biochar doses on soil hydrophysical characteristics

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Our laboratory experiment was focused on impact of different biochar doses on silt loam soil hydrophysical characteristics. Biochar was produced by mix of poplar varies (*Populus*) by pyrolysis at 520 °C in UNIPYR reactor, which is part of AgroBioTech Research Center of the Slovak University of Agriculture in Nitra (Slovakia). Mixtures of soil and biochar were prepared in laboratory conditions with three different biochar doses: 20, 40 and 80 t/ha (calculated based on biochar application into 10 cm depth in field conditions). Soil water retention curves were determined from samples with volume of 100 cm^3 through the use of standard pressure plate apparatus. Soil bulk density was established based on core method (volumetric cylinder method). In this measurement was used pycnometric method with pycnometer volume of 100 ml to determine particle density. Porosity was calculated based on known soil bulk density and particle density and saturated hydraulic conductivity was measured by the falling head method. Our results showed that higher amount of biochar increased available water capacity by 16% or 39%, respectively. The difference between 40 and 80 t/ha was statistically insignificant (same for both variants = 39%). In comparison to pure soil, the particle density of mixed samples decreased by 0.8%, 3% or 9%, respectively; the soil bulk density decreased by 10%, 20% or 32%, respectively and porosity of soil increased by 10%, 19% or 26%, respectively. Saturated hydraulic conductivity decreased by 38% for variant 20 t/ha in comparison to pure soil. But it increased by 51% or 243%, respectively for variants 40 or 80 t/ha, respectively. We found out positive effect of used biochar on retention capacity and some hydrophysical characteristics. Based on our results we can conclude that amount of 80 t/ha of this type of biochar is not needed to apply into silt loam soil, because a higher positive effect of biochar was not occur in all studied parameters.

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P122. Does the type and day of fermentation affect the elemental composition of kombucha?

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Introduction: One of the products widespread as a functional drink is kombucha. Known mainly for its antioxidant, anti-inflammatory, anti-cancer features and its' ability to improve immune and digestive system functioning[2]. This product is made by fermenting tea and sugar in the presence of bacteria and yeasts (SCOBY), which occur mostly in form of the Japanese mushroom [1]. Detailed composition and properties of kombucha are not fully understood.
Aims and Objectives: The purpose of this study was to investigate whether the fermentation time and the type of tea affect the elemental composition of kombucha.
Methods: The research material was kombucha made of four types of tea leafs: Ceylon black, Gunpowder green, white and red (Pu-ERH). Kombucha starter cultures, also known as SCOBY, were obtained from a Polish company. One hundred grams of sugar, eight grams of tea and 1 liter of hot distilled water (90 ° C) were mixed. The mixture was incubated for 10 minutes in a sterile conical flask. After cooling to 30 ° C, the tea infusion was filtered into clean glass bottles. SCOBY tea mushroom starter cultures were then placed in each trial. Fermentation was performed by incubating the kombucha culture at 28 ± 1 ° C for 1,7 and 14 days. To evaluate the content of elements, emission spectrometry with excitation in inductively coupled plasma (ICP-OES, ICAP 7400 Duo, Termo Scientific) was performed.
Results: The content of selected micronutrients changed depending both on the type of used tea and the day of fermentation itself. The content of zinc ranged from 0.136 mg / l to 2.225 mg / l, copper from 0.016 mg / l to 0.316 mg / l, manganese from 0.380 mg / l to 1.471 mg / l, and iron from 0.114 mg / l to 0.770 mg / l .
Conclusions: Based on the obtained results, it can be concluded that the type of tea and the day of fermentation have a significant impact on the content of micronutrients. Kombucha is characterized by the highest amount of minerals on the 14th day of fermentation, regardless of the type of tea.

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References

Greenwalt CJ, Steinkraus KH, Ledford RA. Kombucha, the fermented tea: microbiology, composition, and claimed health effects. J Food Prot. 2000 63(7):976-81. doi: 10.4315/0362-028x-63.7.976. PMID: 10914673.

Julie M. Kapp, Walton Sumner, Kombucha: a systematic review of the empirical evidence of human health benefit, Annals of Epidemiology. 2019 30:66-70, https://doi.org/10.1016/j.annepidem.2018.11.001.

P123. Agricultural water management in changing climate – a call for a reform in Poland. Case analysis of reference – a 1200 years of irrigation communities in Spain

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The presentation is a contribution to the discussion on the necessary system reform in the field of water management in rural areas. Simulations of climate change scenarios in terms of the formation of the hydrological balance indicate a high risk of frequent periods of rainfall deficits in the future (Kozyra et al., 2020). These deficits may be so large that Polish agriculture will be forced to switch to irrigated agriculture. One should take into account a sharp increase in water abstraction for agricultural purposes, for which the current system of granting water permits is not prepared (Wawer, 2020). Reform is needed, including land use planning, land taxation, organization of drainage networks, landscape and soil water retention, optimization of irrigation practices, water reuse and rainwater harvesting. Some of these practices were included in the Stop Drought Program, but there is still no systemic solution ensuring both fair sharing and distribution of water, as well as resource renewal. The article analyzes) the advantages (Del Campo, 2018 and disadvantages (Baker, 2018; Barea, 2018) of the Spanish irrigation water distribution model, based on Irrigation Communities, in operation for 1,200 years). Possible solutions for the automation, monitoring and control of water intake and the size of its resources in the light of current information technologies and trends in their development are also indicated.

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References

Kozyra J., Król-Badziak A., Żyłowski T., Koza P., Pudełko R., (2020). Zmiany klimatu i ich wpływ na gospodarkę wodną i rolnictwo. Konferencja „Adaptacja gospodarki wodnej w rolnictwie do zmieniającego się klimatu”, IUNG-PIB, Puławy, 05.03.2020 r., http://iung.pl/images/pdf/2020/woda/kozyra.pdf

Wawer R., (2020). Water management in agriculture in a changing climate. The prospect of a transition to irrigated, fair and sustainable agriculture use of water in the light of Spanish solutions and progress in computer sciencePolish Journal of Agronomy, No. 41, 2020

Baker S., (2019). Spain’s vast network of illegal wells exposed after death of toddler. Deutsche Welle (DW), https://www.dw.com/en/spains-vast-network-of-illegal-wells-exposed-after-death-of-toddler/a-47311150.

Barea Luchena J., (2018). Los pozos ilegales nos roban el agua. Greenpeace: https://es.greenpeace.org/es/noticias/los-pozos-ilegales-nos-roban-el-agua/

Del Campo Garcia A., (2018). The Irrigators Communities of Spain and their National Federation. Las Comunidades de Regantes de España y su Federación Nacional, FENACORE, 104 ss.

P124. Studies of the gluten network - phenolic acids interactions during overmixing process with application of FT-Raman spectroscopy

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Gluten proteins (gliadins and glutenins) play important role in the formation of gluten network during dough mixing which is essential for many wheat based products. Glutenins are composed of high and low-molecular weight subunits (LMW and HMW, respectively), which are attached to each other via disulphide bonds, whereas gliadins interact with glutenin subunits through hydrogen bonds and hydrophobic interactions. Polyphenols are natural antioxidants occurring in cereals, fruits and vegetables. Dietary polyphenols have attracted attention because of their biologically significant functions and health benefits.
In our research we focused on explanation of the mechanism responsible for interaction between gluten proteins and selected phenolic acids (caffeic and vanillic acid). These acids belong to the groups of hydroxybenzoic acid derivatives and hydroxycinnamic acid derivatives, respectively. They have different molecular size as well as the type of functional group on the aromatic ring. Interactions leading to changes in structure of proteins in the dough overmixing process were analyzed. FT-Raman technique was used to determine changes in secondary as well as in tertiary structure of gluten. Additionally, the content of S=S and free SH groups in gluten protein supplemented with phenolic acids was calculated. Analysis of Amide I band, which is associated with secondary structure of proteins, showed that modification of gluten by phenolic acids results in formation of aggregates and unordered structures at the expense of protein stabilizing structures (e.g. βS or βT). Amino acids environment studies (the ratio of tyrosine doublet (I(850)/I(830)) and tryptophan band intensity (I(760)) confirmed abnormal protein folding and/or disordered structures formation. Additionally, reduction of disulphide bonds stability as a result of phenolic acid addition was observed. The results of our experiments suggest that the mechanism of gluten-phenolic acid interaction depends on the size of acid molecules rather than the type of functional groups on the aromatic ring of phenolic acid.

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References

Shewry, P. R., Halford, N. G., Belton, P. S. & Tatham, A. S. (2002). The structure and properties of gluten: an elastic protein from wheat grain. *Philos. Trans. R. Soc. Lond. B. Biol. Sci.* 357, 133–142.
Tozzi, S., Zanna, N. & Taddei, P (2013). Study on the interaction between gliadins and a coumarin as molecular model system of the gliadins–anthocyanidins complexes. *Food Chem.* 141, 3586–3597.
Taddei, P., Zanna, N. & Tozzi, S (2013). Raman characterization of the interactions between gliadins and anthocyanins. *J. Raman Spectrosc.* 44, 1435–1439.

P125. Mechanical characteristics of sawdust pellets: experiment and DEM modelling

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As a renewable source of energy, biomass is widely used in the processed form of briquettes or pellets. Wood biomass is composed of particles of varying size and shape, which determine the strength of biomass fuel pellets. Knowledge of the mechanical properties of granular biomass is important for the design and efficient operation of equipment for handling, storing, and processing such materials (Adapa *et al.*, 2009; Zulfigar *et al.*, 2006; Guo *et al.*, 2006). Characteristics of strength of biomass pellets are of particular interest in the bioenergy market. Those strength properties standardized in design codes (such as Eurocode 1, 2006) are necessary for the design of storage facilities and handling appliances.
The diametral compression tests of pellets produced of various wood sawdust (beech, birch, oak, pine, poplar and willow) were conducted to determine the tensile strength of pellets. Experiments were performed for sawdust of the moisture content (*MC*) of 8% and 20% compacted up to pressure of 60 and 120 MPa. The lowest tensile strength was obtained for birch pellets and the highest for oak pellets. Comparison of the tensile strength of pellets composed of sawdust of different moisture contents has shown that for all materials, the tensile strength was the highest for MC=8% and the compaction pressure of 120 MPa.
Experimental tests were complemented by numerical technique (Discrete Element Method DEM) providing some deeper insight into interactions between particles in wood pellets. Breakage process of pellets was simulated using the Bonded Particle Model (BPM) (Potyondy and Cundall, 2006). Both, qualitative and quantitative agreement between experimental data and numerical results was obtained for the ratio of the elastic modulus to the tensile strength of bonds higher than 0.25. Cracks were initiated in locations close to the centre of the pellet and developed in the direction of loading and towards interior of the pellet.

References

Adapa P., Taabil L., Schoenau G. (2009). Compaction characteristics of barley, canola, oat and wheat straw. Biosyst. Eng. 104, 335–344.
Zulfigar M., Moghtaderi B., Wall T.F. (2006). Flow properties of biomass and coal blends. Fuel Process. Technol. 87, 281–288.
Guo Z., Chen X., Liu H., Lu H., Guo X., Gong X. (2014). Effect of storage time on the flowability of biomass-coal granular system. Fuel Process. Technol. 125, 59–66.
Eurocode 1, Part 4, (2006). Basis of design and actions on structures. Actions in silos and tanks. EN 1991-4
Potyondy D.O., Cundall P.A. (2004). A bonded-particle model for rock. Int. J. Rock Mech. Min. Sci. 41, 1329–1364.

P126. Application of the Internet of Things to the monitoring and visualization of soil profile moisture

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One of the tasks of the Internet of Things is the monitoring of environmental factors. IoT is a very convenient tool for integrating diverse monitoring systems. By using cloud services and IoT it is possible to combine monitoring with control. With the current large water deficit and climate change, the implementation of soil profile moisture monitoring seems to be crucial. The next step could be automatic irrigation control. Based on the moisture information from IoT but also on weather forecasts, significant water and energy savings in crop irrigation can be achieved.
The aim of this work was to integrate an eight-channel TDR device for soil moisture measurement and PTDT (Profile Time Domain Transmission) probes in one IoT-based monitoring system. The paper presents the IT technologies used for this purpose. It also includes a description of wireless communication hardware solutions and presents the latest measurement results obtained over a period of one year. Thanks to the use of two-way communication, it was possible to remotely change the measurement interval, which helps in times of solar energy deficit to maintain an efficiently operating system. The developed system has been equipped with a notification mechanism in critical situations, such as: lack of data for more than a few hours, excessively discharged battery, etc. Current tests indicate that the system may be useful for further development targeted at automation in precision agriculture.

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References

Athani S., Tejeshwar C.H., Patil M.M., Patil P., Kulkarni R. (2017). Soil moisture monitoring using IoT enabled arduino sensors with neural networks for improving soil management for farmers and predict seasonal rainfall for planning future harvest in North Karnataka — India. International Conference on I-SMAC, pp. 43-48, doi: 10.1109/I-SMAC.2017.8058385.

Rafi Ullah, Arbab Waseem Abbas, Mohib Ullah, Rafi Ullah Khan, Irfan Ullah Khan, Nida Aslam, Sumayh S. Aljameel, (2021) EEWMP: An IoT-Based Energy-Efficient Water Management Platform for Smart Irrigation. Scientific Programming, vol. 2021, Article ID 5536884, 9 pages, https://doi.org/10.1155/2021/5536884

Kafarski M, Majcher J, Wilczek A, Szyplowska A, Lewandowski A, Zackiewicz A, Skierucha W. (2019) Penetration Depth of a Soil Moisture Profile Probe Working in Time-Domain Transmission Mode. Sensors. 19(24):5485. https://doi.org/10.3390/s19245485

P127. The impact of season on fungal microbiome biodiversity in a crop rotation soil

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Fungi, among other soil organisms are considered as critical components of each soil ecosystems (Ellouze et al. 2014) as they are the primary decomposers of the soil complex compounds, i.e. lignocelluloses (Choudhary et al., 2018) and provide ecological services that impact the production of food and bioproducts (Ellouze et al. 2014). However, knowledge about fungal communities structure in arable soils is still limited (Wang et al. 2016) which can be concluded that fungi lose out to bacteria in terms of research intensity. Thus, the main goal of this study was to determine fungal microbiome changes in crop rotation soil in response to the term of the vegetation season. The study was conducted in K3 field (81 ha) located in Janin (53,177˚N, 17,780˚E) and belonging to agricultural area of Potulicka Foundation Economic Center. The crop rotation used in this field was wheat (crop year 2014) - corn (2015, 2016) - wheat (2017) - corn (2018) - wheat (2019) - corn (2020). Crop residue was plowed, while straw was harvested after wheat harvest. From K3 field, 23 individual rasters (each about 3.2 ha) were separated, from which representative soil samples (0-20 cm) were taken three times: in spring, summer and autumn 2020. DNA was isolated using the DNeasy PowerLyzer PowerSoil kit (Qiagen) and submitted to next-generation sequencing (Illumina MiSeq, Genomed S.A.). Metagenomic analyses were performed based on the hypervariable ITS1 region located between 18S and 5.8S rRNA genes. Changeability in the structure of fungi were found depending on the time of the vegetation season. Among fungal phyla dominance of Mortierellomycota, Ascomycota and Basidiomycota representatives were confirmed.

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References

Choudhary M., Sharma P.C., Jat H.S., McDonald A., Jat M.L. Choudhary S., Garg N. (2018). Soil biological properties and fungal diversity under conservation agriculture in Ingo-Gangetic Plains in India. Journal of Soil Sciences and Plant Nutrition, 18(4), 1142-1156.

Ellouze W., Taheri A.E., Bainard L.D., Yang C., Bazghaleh N., Navarro-Borrel A., Hanson K., Hamel C. (2014). Soil fungal resources in annual cropping systems and their potential for management. BioMed Reserch International, 2014, 531824.

Wang Z., Chen Q., Liu L., Wen X., Liao Y. (2016). Responses of soil fungi to 5-year conservation tillage treatments in the dryland of northern China. Applied Soil Ecology, 101, 132-140.

P128. The interactions between biochar properties and the soil microorganisms community under soy cultivation

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The aim of the study was to discover differences in the structure of bacteria, the level of soil enzymatic activity (BIF – Biochemical Index of Fertility) and *Fusarium* sp. number after the application of a biofertilizer, made of lignocellulosic substrate and biochar, containing various microorganisms (algae, mycorrhizal fungi of the *Glomus* genus, the consortium of *Bacillus* sp. bacteria and *Bradyrhizobium* sp.). The chemical composition and yield of soy were a measurable indicators of the effectiveness of the fertilisers. The biofertilisers influenced both, the structure and the percentage share of individual bacterial operational taxonomic units (OTU). The cultivation of soy also modified the qualitative and quantitative changes in the soil bacterial microbiome.
The activity of soil enzymes (BIF) was strongly correlated with the type of applied biofertiliser and to some extent it was correlated with the soil pH. The study showed that the biofertilizer with the consortium of *Bacillus* sp. bacteria had very positive effect on the nitrogen and protein content in plants.
Moreover, the above mentioned product significantly influenced the activity of the studied enzymes (BIF index) and inhibited the development of fungi from the *Fusarium* genus.
The tested biofertilizers, especially the variant with *Bacillus* bacteria are in line with the European Biodiversity Strategy of 20 May 2020.

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References

Pokharel, P., Ma, Z., Chang, S.X. (2020). Biochar increases soil microbial biomass with changes in extra-and intracellular enzyme activities: a global meta-analysis. Biochar, 2(1), 65-79.
Wolna-Maruwka, A., Piechota, T., Niewiadomska, A., Kamiński, A., Kayzer, D., Grzyb, A., Pilarska, A.A. (2021). The effect of biochar-based organic amendments on the structure of soil bacterial community and yield of maize (*Zea mays* L.). Agronomy, 11(7), 1286.

P129. Effect of mineral and organic additions on soil microbiological composition

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The aim of the study was to assess the effect of the addition of organic materials on changes in soil microbiological composition. The pot experiment design included: C – soil without fertilisation; MF – soil with NPK mineral fertilisers; CW3%, CW6% – soil with the addition of 3 or 6% of lignite and 3% of a zeolite/vermiculite composite (NaX-Ver); CL3% and CL6% – soil with the addition of 3 or 6% of leonardite and 3% of a zeolite/vermiculite composite. The test plants were rape and wheat. The number of bacteria, mould fungi, actinomycetes, and *Azotobacter* were determined in the soil material. Microbiological analyses were performed using the serial dilution method according to Koch (Kopeć et al. 2020; Mierzwa-Hersztek et al. 2020).
The study revealed that the number of soil microorganisms depended on the type and amount of organic material applied and the plant grown. The highest number of microorganisms was observed: for rape – in the soil with 3 and 6% addition of brown coal, and for wheat – in the soil with 3 and 6% addition of leonardite. For both test plants, both the mineral NPK fertilisation and the addition of organic fertilisers, i.e. brown coal and leonardite, was found to increase the number of microorganisms, as compared to the control (soil without fertilisation) (Fig. 1).

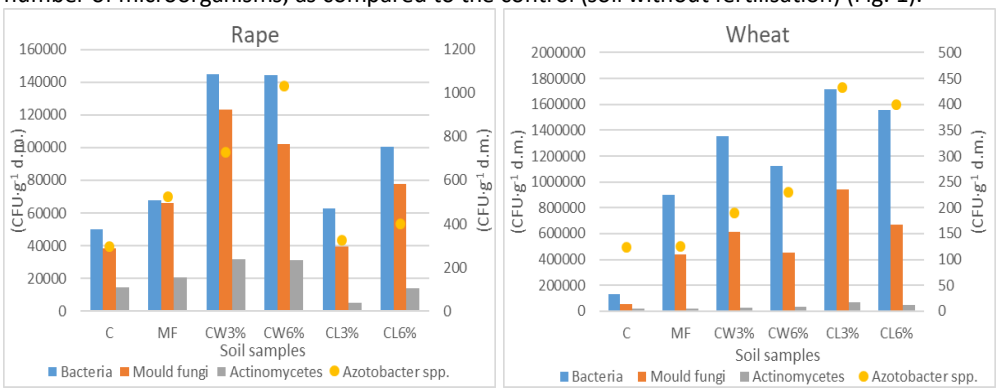

Figure 1. Average number of microorganisms in the soil samples.

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References

Kopeć M., Mierzwa-Hersztek M., Gondek K., Wolny-Koładka K., Zdaniewicz M., Jarosz R. (2020). Biological activity of composts obtained from hop waste generated during the brewing. Biomass Conversion and Biorefinery, DOI: 10.1007/s13399-020-00746-6.
Mierzwa-Hersztek M., Wolny-Koładka K., Gondek K., Gałązka A., Gawryjołek K. (2020). Effect of coapplication of biochar and nutrients on microbiocenotic composition, dehydrogenase activity index and chemical properties of sandy soil. Waste and Biomass Valorization, 11:3911–3923. DOI: 10.1007/s12649-019-00757-z.

P130. The response of soil microbiome to contamination with bisphenols

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Bisphenols are currently one of the most commonly produced synthetic compounds in the world (Baralla et al. 2021). Increased migration of these phenolic compounds to the environment is caused, among others, by the production and processing of bisphenols, and the hydrolysis of polymers, resulting in the release of bisphenol monomers into ecosystems and into food (Jiang et al. 2018). This fact has given rise to ongoing extensive discussions on international fora concerning threats caused by the dispersion of bisphenol A (BPA) and it analogues, bisphenol F (BPF) and bisphenol S (BPS) in the environment. Despite the fact that these compounds arouse great interest and their impact on humans is already more widely known, they have not been thoroughly analysed so far in terms of their influence on biological activity of soils. Thus, the choice of aim of the study was dictated by the lack of precise data relating to the potential toxicity of BPA, BPF and BPS on the number and diversity of the soil microbiome and biochemical activity, as well as the search for means of restoring homeostasis of soils degraded by organic pollutants. For this purpose, soil biostimulation of *Chlorella* sp. and rhamnolipid 90 were used, as well as soil bioaugmentation by a consortium of bacteria and a consortium of mold fungi.

The tested bisphenols (BPA, BPF, BPS) significantly interfere with the soil microbiome. Cellulolytic bacteria and *Arthrobacter* bacteria are the most sensitive to soil contamination with bisphenols. All phenolic compounds stimulate the number of *Pseudomonas* bacteria and mold fungi. They change the structure of microorganisms from strategy K to strategy r. The phylum *Actinobacteria* and *Proteobacteria* taxa dominate in uncontaminated and subject to BPA pressure soil. BPF and BPS reduce the abundance of *Proteobacteria* and *Acidobacteria* and increase *Actinobacteria*. The biochemical activity of soil is shaped to the greatest extent by BPS, and the least by BPA. Soil biostimulation with *Chlorella* sp. and bioaugmentation of the bacterial consortium has a better effect on the soil microbiome than rhamnolipid 90 and bioaugmentation of the fungal consortium. Bisphenols interfere with the growth and development of dicotyledons more than monocotyledons.

References

Baralla E., Pasciu V., Varoni M. V., Nieddu M., Demuro R., Demontis M.P. (2021). Bisphenols' occurrence in bivalves as sentinel of environmental contamination. Science of The Total Environment, 78, 147263

Jiang Y., Longmiao Y., Liu L., Guang L., Shi A., Mu Z. (2018). Bisphenol A in the yellow river: sorption characteristics and influential factors. Journal of Hydrology, 564, 307–313.

P131. Assessment of the yields of the common thyme *Thymus vulgaris* L. and the creeping thyme *Thymus serpyllum* L. in the conditions of south-eastern Poland

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The common thyme is one of the most important herbal plants cultivated in south-eastern Poland. Thyme herb has an expectorant and bactericidal effect, which is associated with e.g. the presence of essential oil and tannins in the raw material. Sometimes common thyme herb is adulterated with creeping thyme, which is a medicinal plant as well, but has slightly weaker activity. With its more delicate scent, the creeping thyme can be an alternative to the common thyme, whose smell is often dominant, in herbal mixtures. The common thyme is used as culinary seasoning with an intense aroma, whereas the creeping thyme is not a common additive to dishes. However, it is advisable to promote the use of the latter as more delicate seasoning for dishes. The study presents assessment of the yields of the common thyme and the creeping thyme cultivated in south-eastern Poland. The plantation was established from seedlings produced in a greenhouse. The seedlings were planted at 30 x 30 cm spacing. The analyses involved plants grown in an annual cycle due to the large lignification of their stems in the second year of vegetation. The laboratory analyses were focused on determination of the content of some biologically active substances (essential oil, tannins, and phenolic acids) taking into account the drying conditions. It was shown that the drying conditions did not influence the yield of dry and grated herb of both species. The content of essential oil in the raw materials depended on the drying conditions. It was in the range from 1.01 to 1.2% in the creeping thyme herb and from 1.3 to 2.2% in the common thyme herb. The levels of tannins and phenolic acids were similar in both species.

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