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SUSTAINABLE AGRICULTURE - NEW STRATEGIES FOR INCREASING GROWTH AND DEVELOPMENT OF CROPS

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BIOMOLECULES INDUCERS OF IMMUNITY: MECHANISMS AND CROSSTALK WITH BIOTIC STRESS RESPONSES

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The Green Revolution has enabled food production to meet demand, albeit through agricultural practices that carry environmental consequences, such as the increased use of fertilizers and agrochemicals. The present challenge lies in boosting agricultural production rates while minimizing environmental impacts. Diseases pose a substantial threat to global agricultural productivity, impacting both vegetable cultivation and major extensive crops due to the prevalence of numerous pathogens. Therefore, it is essential to develop effective tools to control pathogens without affecting other parameters of plant physiology to increase their productivity and ensure the sustainability of food production.

Plants possess a sophisticated and efficient immune system encompassing multiple defense levels, including PTI (PAMP-triggered immunity) and ETI (effector-triggered immunity). The activation of this system relies on the recognition of elicitor molecules derived from pathogens. Various bioactive compounds have demonstrated their ability to effectively suppress diseases across diverse crops by enhancing the plant's natural immune response, thereby reducing disease incidence and boosting productivity.

However, the regulatory effects of these compounds are complex. Organisms manage limited resources and energy, requiring intricate molecular trade-off mechanisms to balance allocation between growth and defense, ultimately aiming for optimal fitness.

Understanding the mechanisms of action of these molecules is paramount for developing innovative tools, such as immunity boosters, to ensure sustainable crop production. This research contributes to advancing our knowledge and capabilities in plant health management and crop sustainability.

In this presentation, we will review the topics covered and showcase examples of molecules utilized in our laboratory and others. These examples will illustrate the use of biomolecules as immunity boosters, examining their impact on plant physiology and responses to stress, such as nutrient uptake and drought tolerance.

ISOFLAVONES IN SOY (*GLYCINE MAX* [L.] MERR.): FUNCTION, BIOLOGICAL ACTIVITIES AND POSSIBILITIES OF INCREASING ITS CONTENT

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Isoflavones, secondary metabolites of legumes, are a significant group of polyphenols possessing many biological activities. One of the richest sources of isoflavones is soy (*Glycine max* (L.) Merr.), which is a widely used plant for human nutrition. Isoflavones in soy plants serve primarily as a part of a defence system against biotic and abiotic stress. In addition, they mediate the symbiotic relationship between the plant and nitrogen-fixing bacteria (*Bradyrhizobium japonicum*). Isoflavones are also accumulated in soybeans, which are used for various types of food, especially in Asia. Once consumed, isoflavones were reported to have different effects on human health. When the intake is in sufficient (or high) amounts, they can prevent (among other) hormone-dependent cancers, especially breast cancer, cardiovascular diseases, osteoporosis, and hot flashes in postmenopausal women.

Soy isoflavones are a mixture of twelve different compounds derived from three main aglycones, daidzein, genistein and glycitein, while daidzein and genistein are predominant. The derivatives include glucosides, malonyl- and acetylglucosides. The ratio between the free and conjugated forms of daidzein and genistein is up to 30:60 per cent, respectively.

The content of all these compounds can be increased in several ways, namely by physical, chemical and biological factors. Enhancing the content in the plant is of interest not only due to the above-mentioned health-promoting benefits but also because it promotes the plant's defence system.

In our experiment, we applied herbal hot water extracts (a mixture of common horsetail, dog rose, and common soapwort) to soy plants (Abaca variety). The soy seeds were pre-germinated and then cultivated in Phytotrones under controlled conditions. After 14 and 21 days of growth, the plants were treated with herbal extracts by spraying. Three days after each treatment, aerial parts of the plants were collected, and the isoflavones were analyzed using high-performance liquid chromatography coupled to a triple quadrupole mass spectrometer (LC-MS/MS).

The results of this preliminary study show that the application of the extracts significantly increased the content of isoflavones in the soy plants by 29 and 118% on the first and second sampling day, respectively. The application of the extracts seems to be a promising way of increasing the content of isoflavones, thus enhancing the plant defence system and promoting health-beneficial properties for humans. However, the extract application must be tested in real conditions in the future.

PRACTICAL USE OF ENTOMOPATHOGENIC AND MYCOPARASITIC FUNGI IN THE AGRICULTURE OR FOREST ECOSYSTEMS

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Integrated pest management is based on careful consideration of all available methods that control pest populations in order to produce healthy crops with the least disruption to agroecosystems. In the generally principles of integrated pest management, which are implemented in the legislation of all EU countries, there is a point which states a preference for non-chemical methods, in particular biological and physical methods, if they provide satisfactory control of pests or harmful organisms. Currently, biological control is well developed, focusing on the use of predators and parasitoids against pests. More intensive research is being carried out on the use of pathogenic microorganisms, especially entomopathogenic and mycoparasitic fungi against pests and plant pathogens respectively. Three studies on the practical use of entomopathogenic or mycoparasitic fungi in different environmental conditions were realized within the framework of the projects at our faculty. These model studies were basically based on monitoring the occurrence of entomopathogenic and mycoparasitic fungi in agricultural soils or bark beetle populations, where native fungal strains were isolated using different isolation techniques and subsequently characterized using a set of standard laboratory tests "in vivo" (host bioassay) and "in vitro" (growth and production characteristics of the strains). Also different methods of surface and/or submerged cultivation of selected fungal strains have been developed for their re-introduction into forest ecosystems to induce epizootics in the bark beetle populations or for the introduction of a selected fungal strain into the soil using coated seeds, or for the preparation of strain spore suspension for application in the greenhouses against greenhouse pests or powdery mildew. In all systems, the efficacy of filamentous fungi on target hosts or their effect on plant growth and development was tested. The suppressiveness of niches after their application or introduction into the target agroecosystem was monitored. Entomopathogenic and mycoparasitic fungi have great potential in the protection of crops or forest ecosystems against pests or plant pathogens.

STRATEGY FOR THE GREEN TRANSFORMATION OF AGRICULTURAL POLICY IN THE EUROPEAN UNION

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Agriculture is an economic sector that is particularly related to the natural environment. On the one hand, its efficiency depends largely on environmental resources, on the other hand, agricultural production often takes place with the negative impact to the environment. Currently, the so-called process of green transformation of agricultural policy is now underway in the European Union. Subsequent reforms increasingly emphasize the need to protect the natural resources, the natural environment and the climate. Growing environmental and climate problems force the research of effective solutions in business activities, including agriculture. Sustainable development strategies or programs have been implemented for years, which, despite initiating the desired direction of changes in agriculture, are still insufficient in relation to the perceived needs. The last stage of the green transformation of agricultural policy was initiated by the European Green Deal strategy announced by the European Commission at the end of 2019, the goals of which are very ambitious and will require a complex, multi-threaded approach to agricultural policy and a change in the attitude of farmers, i.e. greater consideration of non-production aspects of their business, in particular in the field of environmental protection. Sustainable agriculture is a global dynamic process taking place at five levels – areable land, farm, local community, country and international level. Organic farming, which is a manifestation of sustainable development, is currently practiced in 187 countries around the world, and organic production is carried out by at least 3.1 million farmers.
According to EUROSTAT data, in 2020 the average level of organic crop area in the EU was 8.5%. The highest share of organic agricultural land was in Austria (25%), Estonia (22%) and Sweden (20%). However, in as many as eight EU Member States (Luxembourg, the Netherlands, Cyprus, Poland, Ireland, Bulgaria, Romania, Malta), the share of farmland managed this way was below 5%. In 2020, organic crops were grown on 74.9 million hectares of agricultural land around the world. In the EU, in 2020, organic farming covered 14.8 million hectares, which represented 19.7% of organic crops in the world and 9.1% of EU agricultural land.
To ease the burden of agricultural policy changes due to the green transformation and improve farmers' attitudes, in 2020, 61.6% of EU agricultural land under organic farming received 84 specific organic support payments. The aim of the article is to present the main issues related to the implementation of the European Green Deal strategy and to identify key challenges for the agricultural sector.

EVALUATION OF THE IMPACT OF TRACTOR FIELD WORKS ON CHANGES IN SELECTED PHYSICOCHEMICAL PROPERTIES OF ENGINE OILS

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Tractors are used for various types of fieldwork and transport on public roads in difficult and changing environmental conditions. An important role is to prevent energy and material losses due to improper lubrication of the internal combustion engine. The main goal of this study was to analyze the changes in the physicochemical properties of engine oil during various fieldwork conditions. To achieve this, engine oils from two tractors were chosen for the study. These tractors were coupled with a trailer, a reversible plow, a cultivator, and a tillage-sowing unit. Samples of the oil were taken before and after the completion of each unit's fieldwork, and the physicochemical parameters of the oil were measured using the FTIR method. These parameters included the degree of oxidation, nitration, and sulfonation, the content of impurities in the form of soot and fuel, the degradation of oil additives, and the acid and base number. The research provided more information on the sources of pollution that occur during tractors' real-world conditions. The study's results confirmed that the degree of oil degradation varies depending on the type of vehicle and fieldwork being performed.

EFFECT OF LACK OF ISOTHERMAL PACKAGING DURING TRANSPORTATION BY CONSUMERS OF FROZEN FOOD ON ITS THAWING

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The transport of temperature sensitive products takes place under special conditions defined by specific agreements and international standards. The only exception to this rule is consumer transport. This transport is carried out by the consumer and takes place on the way home from the shop. The study examined consumers' awareness of the consumer transport of frozen food and analysed this type of transport in terms of the continuity of the cold chain. Such situation affects the deterioration of frozen food quality especially in case of its later storage in the home freezer. It was found that the average distance that customers cover from shop to home was 4.98 km. They usually used a car and covered this distance in an average of 12.85 minutes. During the summer months, this time is sufficient to partially thaw a package of frozen vegetables. Only 33% of the respondents used insulated bags to protect frozen food on the way home. When analysing the transport of frozen raw material carried out by consumers in real conditions, the use of insulated bags was found to be justified. These bags are able to keep the temperature of the packed raw material below -5°C. It was found that the legal imposition of the necessity to use such bags or the introduction by the manufacturer of frozen food of appropriate packaging protecting the food against transport at inappropriate temperatures in the summer months is necessary.

POSSIBILITY OF USING IRON NANOPARTICLES FOR THE PRODUCTION OF FOOD PACKAGING

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Nanoparticles of iron and its oxides are commonly used in many areas, ranging from industry and medicine to agriculture and environmental protection. It is due to their unique properties and low production costs. The surface effects of nanoparticles are relevant to structural issues. Compared to other metallic NPs, iron nanoparticles are widely used. This is determined by their small size, superparamagnetic properties and biocompatibility. Two strategies are possible for the use of nano iron in packaging. The first is to insert sachets containing nZVI into the packaging, and the second way is to incorporate the nanoparticles into the packaging film using a monolayer or multilayer structure. The most important problem during food storage is spoilage by microorganisms. The use of different types of nanoparticles and nanocomposites with antimicrobial functions is an effective way to minimise the impact of microorganisms on food during processing or storage. Iron nanoparticles can be used to address food oxidation by applying antimicrobial coatings to the inner surface of the packaging. Such a coating gradually releases the antimicrobial substances or they are immobilised on the active surface of the packaging. The use of food-approved nanoparticles has enabled the creation of functional edi-ble coatings. These coatings consist of nanoemulsions, polymer nanoparticles, nanofibres, solid lipid nanoparticles (SLNs), nanostructured lipid carriers (NLCs), and traditional polymer nanocomposites (inorganic-organic). Food and Drug Administration has found that superparamagnetic iron oxide nanoparticles (SPIONP) are biocompatible (BC) with the human body.

UTILIZATION OF OILSEED CAKE FLOUR FROM MINOR OILSEEDS

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Oilseeds are important commodity crops that include various plant species from different botanical families. In addition to the major species (oilseed rape, sunflower, mustard, soybean and poppy), minor oilseeds such as oilseed flax, hemp, pumpkin and milk thistle are also important for cultivation and processing. Oilseed cakes and flours are obtained as byproducts after oil pressing. They contain 20-60% proteins with a relatively balanced amino acid spectrum and other valuable components such as dietary fibre, polyphenols, and other bioactive constituents. Proteins of oilseeds are mainly represented by globulins, especially 11-12S globulins, followed by albumins. Oilseed cakes are often used as feed for farm animals, but they can also be valorized in the form of flour and protein concentrate or by isolation using dry or wet processes. Due to their high protein content, oilseed cake flours represent a suitable alternative for replacing animal protein. They are also easily digestible and gluten-free, thus suitable for coeliacs.

This work aimed to analyze the composition of flours from cakes obtained from individual minor oilseeds. Their functional properties, total polyphenol content, and antioxidant activity were determined. Flaxseed and hemp cake flour contained 28% crude protein, milk thistle 23%, and pumpkin cake flour exhibited the highest crude protein content (59 %). Flaxseed cake flour showed a significant difference in functional properties compared to the other studied flours. The water solubility of flaxseed flour was 21.8 % (other flours 15.4-19.9 %), the water holding capacity reached 4.2 g/g flour (other flours had 1.5-2.7 g/g flour), the water holding capacity after cooking represented 8.1 g/g flour (other flours 1.7-3 g/g flour), and we also found that fat holding capacity was 1 g/g flour (other flours 0.7-0.8 g/g flour). The high water-holding capacity of flaxseed flour was determined by the high level of soluble fibre – flaxseed gum. Milk thistle extract flour had a significantly higher total polyphenol content (30.4 mg gallic acid equivalent/g flour) compared to other flours, specifically 5 times higher than flaxseed flour, 11.3 times higher than hemp flour and 20.3 times higher than oilseed pumpkin cake flour.

Based on the obtained results, oilseed cake flours may represent a valuable source of protein for human nutrition, and their nutritional potential predetermines them for fortification of food products.

GREENHOUSE GASES EMISSIONS OF THE AGRICULTURAL SECTOR AND THE SAFETY OF CROP IN SUSTAINABLE AGRICULTURE

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The use of agricultural machinery in the agricultural sector plays a significant role in assessing the sustainable development of the environment in this area. Substantial impacts arise from fuel consumption (from diesel oil) and emissions of harmful greenhouse gases. Over the past few centuries, human activity has had a tremendous, mostly negative, impact on the environment. As a result, we are witnessing a decrease in forest area, biodiversity, the presence of numerous harmful substances, and the impact on agricultural productivity. Climate change caused by anthropogenic heating of the atmosphere, resulting from increasing concentrations of greenhouse gases, especially CO2, is considered the main environmental threat. Commonly used fossil fuels and electricity have become essential elements of modern agricultural production. They are used directly to power machinery and indirectly for their construction, extraction of mineral fertilizers, or synthesis of nitrogen compounds. The accompanying environmental, social, and economic effects can be extremely severe. According to scientific reports, the relationship between agriculture and climate change is bilateral. Agriculture is the main emitter of greenhouse gases. Agricultural holdings are responsible for about 16–27% of all anthropogenic emissions and also for about 70% of emissions resulting from land use change, mainly due to deforestation. Emissions in agriculture occur at every stage of production, from seed preparation to harvesting and storage of finished products. At the same time, the agricultural sector is the most affected by ongoing processes, which is associated with an increasing problem in ensuring an adequate level of food production for a steadily growing population due to decreasing yields and rising food prices.

In EU countries, the structure of energy consumption in agriculture varies significantly depending on the country. In almost all countries, diesel and gas are of the greatest importance. Poland, as the only country in the EU, largely uses hard coal (about 20%) as an energy source in agriculture. As a result, the high emissions intensity of agriculture becomes the subject of political and social discussion. This is linked to the broader issue of achieving climate neutrality by 2050 through EU net-zero emissions. Considering the complete dependence of agriculture on fossil fuels, which are a significant source of greenhouse gas emissions, an increasing number of scientists are undertaking research on the emissions of these compounds, focusing their attention on the energy inputs used in agricultural production and their impact on the development of agricultural crops. Therefore, the agricultural production sector must be an integral part of any global, sustainable climate stabilization strategy without compromising food security and increased food production costs.

THE USE OF MULTISPECTRAL CAMERAS IN AGRICULTURE

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In recent years, the concepts of precision agriculture and agriculture 4.0 have gained increasing popularity. They are based on the use of digital techniques for collecting and processing data to analyze the health status of crops and to estimate yield size. The use of multispectral cameras is of particular importance for modern agriculture. These devices have the ability to record images in several bands – usually in the visible light and near-infrared range. Images are recorded using unmanned aerial vehicles (UAVs) in the form of multicopters or, less often, fixed-wing aircraft. A separate method is the use of multispectral equipment installed on satellites. The recorded images allow the generation of spectral maps for the studied area. Various indices are used to develop the maps, which allow the assessment of the development and health status of crops. In addition, these indices can be used to assess soil moisture or nutrient content in plant leaves. The obtained results can be used to plan fertilization and spraying in order to increase yields. This results in increased precision of agrotechnical treatments, saving time and reducing costs. Indirectly, it is also related to the implementation of the sustainable development policy – the negative impact on the environment is reduced compared to conventional cultivation methods due to the reduced use of diesel-powered machines and the reduced amount of pesticides used. It is predicted that multispectral cameras will be increasingly used in farms. The increasing availability of these devices results from the rapid development of technology and mass production of drones, which result in lower unit production costs.

IMPACT OF DIGESTATE APPLICATION AS A FERTILIZER ON THE YIELD AND QUALITY OF WINTER RAPE SEED

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As waste, digestate may be subjected to a disposal process, but it is generally recommended to carry out a recovery process. The most commonly used method of digestate pulp treatment is recovery using the R 10 method—"surface treatment for the benefit of agriculture or improvement of the state of environment". Therefore, the digestate may also be used as a soil quality improvement agent.
Analyzing the obtained test results, a discrepancy in yields was obtained in the first growing season from 3.32 to 3.45 t ha^{-1}. In the second growing season the sizes were similar and ranged from 3.35 to 3.47 t ha^{-1}. However, in the third growing season depending on the applied dose, from 3.28 to 3.41 t ha^{-1} were collected. The control plot produced 3.14 t ha^{-1} in the first growing season 3.15 t ha^{-1} in the second growing season and 3.09 t ha^{-1} in the third growing season. The obtained thousand seed weight for three growing periods was similar, and on average from three years of research it was 5.24 to 5.34 g. For the control object, the average thousand seed weight from three years of the experiment was 5.20 g.
Analyzing the obtained research results, the average fat content of winter rape seeds was increased depending on the applied digestate dose—it ranged from 42.44% to 43.62%. In the control object, the average fat content from three harvest years was 42.20%. Such fat content indicates a good quality of the collected seeds.
The average protein content in the winter rape seeds collected from the control plot was 22.39% from three years of research. In the remaining variants of the experiment, the average protein content increased with the increase in the digestate dose and ranged from 22.65% to 22.95%.
The obtained results indicate an increase in the content of macronutrients depending on the amount of the digestate dose applied. The average nitrogen content from three years of research ranged from 3.10% to 3.14%, and phosphorus from 7.69% to 7.85%. In turn, the potassium content ranged from 6.24[1] to 6.29 g kg^{-1}, calcium ranged from 3.30 to 3.39 g kg^{-1}, and magnesium ranged from 2.21 to 2.24 g kg^{-1}.
The amount of the digestate dose affects the amount of yield obtained and the mass of one thousand seeds. The amount of digestate dose determines the fat and protein content in winter rape.

USE OF AGRICULTURAL BY-PRODUCTS FOR ENERGY PURPOSES IN THE ASPECT OF REDUCING GREENHOUSE GAS EMISSIONS

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Transforming the economy towards climate neutrality and achieving zero greenhouse gas emissions in 2050 are the goals of the European Green Deal. This document in the European Union Member States set out the strategic directions of national policies in the energy sector, primarily related to giving priority to energy efficiency and the development of renewable energy sources. These activities are intended to contribute to mitigating climate change and should be implemented in accordance with the principles of sustainable development. In the era of this evolution, the perception of plant biomass is also changing, for which until the end of 2022 under the EU Emissions Trading System (EU ETS) it was possible to recognize the CO_2 emission factor from biomass combustion at the level of "0" in relation to biofuels, bioliquids and fuels from biomass, without the requirement for the biomass to meet the criteria for sustainable development and reducing greenhouse gas emissions specified for renewable sources. At the same time, it becomes important to supervise the improvement of the efficiency of processing biomass raw materials while reducing the use of energy from fossil fuels.

Therefore, the aim of the research was to analyze greenhouse gas emissions in terms of the use of by-products of agricultural plant production processed into briquettes. The research focused on herbaceous biomass raw materials popular in Poland, such as wheat, rye, oat straw and meadow hay. The research results were compared with wood sawdust representing an alternative source of waste biomass from the forest sector. For the obtained raw materials, their basic chemical and physical properties were determined. Then, after crushing the herbaceous biomass, it was processed into briquettes with a diameter of 50 mm. During the production of briquettes, the efficiency and energy consumption of the grinding and briquetting processes were determined. The next stage of research was related to determining CO_2 emissions during the processing of the analyzed biomass and its combustion. The results were also prepared for a 15-year period of use of such solid biofuels in a standard low-power heating device operated in a residential building with an area of 100 m^2.

The research results showed that the demand for energy (mainly electricity) during the processing of herbaceous biomass into briquettes was approximately 3 times higher than for the by-product in the form of wood sawdust. This also translates into 3 times lower CO_2 emissions when producing briquettes from sawdust. The analysis of research results over the adopted 15-year period of use of such biofuels, assuming energy consumption from fossil fuels (emissions of 700 gCO_2/kWh) showed that during the processing of oat straw (lowest carbon (C) content, similar energy consumption in the production of briquettes from herbaceous biomass) led to a negative CO_2 emission balance. However, in this case, an increase in the reduction of CO_2 emissions can be achieved by replacing energy from fossil fuels with fully renewable energy or by reducing CO_2 emissions from the production of electricity in the professional power industry below the assumed level of 550 gCO_2/kWh.

WATER QUALITY ASSESSMENT FOR SUSTAINABLE DEVELOPMENT SYSTEMS

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Water is one of the basic and necessary ingredients for the functioning of cells of both plant and animal organisms. Its quality affects our health. Both European and Polish legal acts impose maximum permissible values of physical, chemical and biological parameters of water for the economy in a sustainable system.

The aim of the research was to assess the quality of water from the public water supply of the city of Kalisz in 2022-2023 - Warszawska/Szeroka intake. The wells in question are deep wells from jurassic water deposits. These waters are medium-hard, neutral or slightly alkaline, have a natural smell, are moderately mineralized, and often contain excessive amounts of iron and manganese compounds. Thanks to good deep water intakes, water treatment takes place naturally without the use of chemicals. The water is purified only from excessive amounts of iron and manganese compounds and disinfected with UV rays. No chemicals containing chlorine are used, the water is odorless and tasteless. In order to maintain bacteriological safety in the water supply network, water is periodically disinfected with sodium hypochlorite.

All tests were performed at the Water and Soil Testing Laboratory of PSSE (District Sanitary and Epidemiological Station) in Kalisz. The laboratory is accredited by the Polish Center for Accreditation (PCA) with the number PCA AB 578. Samples for testing were taken in accordance with the PN-ISO 5667-5:2017-10/Ap1:2019-07- Water quality standard. Sampling - Part 5: Guidelines for sampling drinking water from treatment plants and distribution systems.

The determination methodology was in accordance with the guidelines contained in the Regulation of the Minister of Health of December 7, 2017, these were turbidimetric, pH-metric, conductometric and spectrophotometric methods, and in the case of microbiological tests, deep inoculation or on membrane filters.

The water samples tested for physical parameters did not exceed the recommended values contained in the Regulation of the Minister of Health of December 2017. Microbiological parameters: the total number of microorganisms at 22ºC, the number of coliform bacteria, the number of *Eschrichia coli* and the number of fecal enterococci did not exceed the parametric value in any tested sample. No exceedances of chemical parameters were observed. There were no nitrogen compounds in the tested water (ammonium ion, nitrates (III) and (V)), and the concentration of total iron and manganese did not exceed the permissible value.

NANO-CU POTENTIAL IN *HORDEUM VULGARE* FOLIAR FERTILIZATION DURING CU STARVATION: THE INSIGHT INTO THE CHANGES IN CU HOMEOSTASIS GENES EXPRESSION PATTERNS

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Copper (Cu) is essential for plants proper growth and development due to its involvement in pivotal metabolic processes such as photosynthesis or hormone perception. However, both deficiency and excess of Cu cause disruption of several metabolic processes, including oxidative stress response. Therefore, for safe and effective nutrient management, new approaches to plant fertilization are continuously developed. Due to the importance of *Hordeum vulgare* as agricultural plant, the aim of our study was to analyze the transcriptional response of barley suffering from Cu starvation to foliar application of copper nanoparticles (nano-Cu) and its ionic form ($CuSO_4$). Two doses of Cu were chosen (100 and 1000 mg L^{-1}) to examine their fertilizing efficiency and to assess the fertilizing potential of reduced Cu doses. The initial interactions of Cu-compounds with barley leaves were analyzed with spectroscopic (ICP-OES) and microscopic (SEM-EDS) methods. The real-time qPCR was used to compare transcriptional responses to Cu-compounds on the expression of genes involved in regulating Cu homeostasis (PAA1, PAA2, RAN1, COPT5), aquaporins (NIP2.1, PIP1.1, TIP1.1, TIP1.2) and antioxidant defense response (SOD Cu-Zn, SOD Fe, SOD Mn, CAT) after 1 and 7 days of exposure. Despite the detection of Cu accumulation in plant leaves after 7 days, the Cu content in plants exposed to nano-Cu was 44.5% lower than in $CuSO_4$ at 100 mg L^{-1}. Noteworthy, the nano-Cu aggregates found on the leaf surface could indicate a potential difference between the measured Cu content and the real Cu pool present in the plant. Moreover, a significant changes in the gene expression patters were found, depending on Cu-compound type and dose.

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MUTUAL COMPATIBILITY OF BENEFICIAL FUNGI AND THEI USE IN BIOLOGICAL CONTROL

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Beneficial fungal species are part of soil ecosystems where they are able to act in their habitat of occurrence to suppress soil insects and plant pathogens. Entomopathogenic fungi induce disease in soil-dwelling pests and thus regulate their populations. Mycoparasitic fungi are able to protect plants against soil-borne fungal plant pathogens. Beneficial fungal species are able to colonize the soil environment, so mutual compatibility among them and plant pathogenic fungal species were tested in experiments. Mycoparasitic fungi of the genus *Trichoderma* were tested against plant pathogenic species, such as *Sclerotinia sclerotiorum, Rhizoctonia solani, Botrytis cinerea* and fungal species of the genus *Fusarium* spp. The touch zone was measured between the fungal species to monitor growth and development rates in combination. The touch zone indicates how fast the fungi are able to colonize the environment. The mycoparasitic zone was also monitored, which determines the effectiveness of the mycoparasitic fungus against the plant pathogenic species. The entomopathogenic fungi species, *Metarhizium brunneum, Isaria fumosorosea, Akanthomyces attenutatus* and *Beauveria bassiana* were also tested against the same plant pathogenic species. Antagonistic zones were recorded for entomopathogenic fungi in combination with plant pathogenic species. The results show that entomopathogenic fungi have a secondary effect in addition to their primary ability to infect insects, which is very interesting. From a practical point of view, it can be said that entomopathogenic fungi have great potential not only for controlling soil-dwelling pest populations but also have a positive effect on the control of plant pathogens. At the same time, interactions among entomopathogenic fungal species were tested. The interactions of entomopathogenic fungi provide information on how individual species may interact and cooperate when a suspension containing multiple species of entomopathogenic fungi is applied to the target agroecosystem.

QUALITATIVE ANALYSIS OF BIOACTIVE COMPOUNDS AND ANTIOXIDANT POTENTIAL OF HORSETAIL, ROSEHIP AND SOAPWORT AQUEOUS EXTRACTS

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Horsetail (*Equisetum arvense* L.), rosehip (*Rosa canina* L.) and common soapwort (*Saponaria officinalis* L.) belong to the plant species often used as herbs. Due to the putative high content of bioactive compounds in rosehip, silicon in horsetail and surfactant properties of soapwort compounds, the products of these herbs may potentially be applied as the functional complex biostimulant protecting the crops against biotic or abiotic stress. The aim of this work was the optimization of the aqueous extraction of compounds occurring in these herbs, assessment of the protein content and ash content, total polyphenol content, antioxidant activity and qualitative analyses of bioactive compounds by LC-MS/MS in the dry matter or aqueous extracts of single herbs and their mixture. Besides, the effects of the gliding arc and low-pressure microwave types of plasma treatments on dried herbs and aqueous extract on some of the mentioned parameters were observed.

Proximate chemical composition analyses showed that horsetail contains significantly higher levels of total proteins and ashes than rosehip and soapwort. Extraction time and temperature did not affect total polyphenol content significantly. However, the extracts obtained after 30 min at 100 °C exhibited the highest total polyphenols content. Rosehip aqueous extract had a substantially higher content of total polyphenols (2175.2 mg GAE/ l of aqueous extract) compared to two other herbs and herbal mixture, specifically 4.5x higher than horsetail, 23,5x higher than soapwort and 3.8x higher than the mixture. The dry herbal mixture, treated by microwave plasma at 500 W for 60 seconds, exhibited a statistically higher content of total polyphenols and antioxidant activity compared to untreated control variant. These results indicate that microwave-assisted plasma treatment of dried herbs can increase the extractability of phenolic compounds and the related antioxidant potential of aqueous extracts.

Using HPLC-MS/MS analyses, 66 compounds were detected in the biostimulator in total, of which 16 were not identified. Of the 50 tentatively identified compounds, 36 belonged to the group of polyphenols coming from all three herbs, 2 cyclitols were found in rosehip and 12 saponins in soapwort. The highest number of polyphenols (26) were found in rosehip. Most of the unidentified compounds were detected in soapwort. Moreover, the presence of all identified compounds in plasma-treated variants of analysed samples was confirmed. To sum up, our results showed that the mixture of these plants might represent a promising complex and versatile phytostimulant product.

FRICTION PARAMETERS OF SOAPS WITH THE ADDITION OF GRADUATED HAZELNUT SHELLS

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Soaps are commonly used as household cleaning and personal hygiene products. The use of the addition of various types of waste mate-rials is becoming more and more common, including: almond shells, orange peels or used cooking oil for the production of everyday soap. A new and interesting addition to soaps may also be walnut shells, which can act as an agent that helps cleanse the skin of impurities, and therefore an important feature characterizing such a product is its friction coefficient. Soap samples with the addition of 5% shredded walnut shells by weight came from three size fractions (0.5, 1 and 2 mm). The tests were carried out using cylindrical soap samples with a diameter of 26 mm and a height of 12 mm and weight of 5 g. The sample loads during the test were 100, 200 and 500g. Friction resistance measurements were carried out on the surface of the dry synthetic leather and when the substrate was moistened with dis-tilled water. Additionally, a comparative test was also carried out using dry sandpaper with a grit of 320. The measurements were carried out based on the measurement method developed by Stable Micro, which was developed in accordance with the modified ASTM Standard Method D1894. For all tested variants, the initial friction of the soap ranged from 0.33 N to 2.42 N, the dynamic friction ranged from 0.13 N to 1.85 N. The static and dynamic friction coefficients ranged from 0.02 to 0.48 and 0.006 to 0.006 to 0.30. The prepared soaps, along with the increase in the size of walnut shell particles, were characterized by an increase in the value of static and dynamic friction on dry and water-moistened material.

THE USE OF ULTRASOUND IN THE PRODUCTION OF ICE CREAM WITH OLEOGEL BASED ON SESAME SEED OIL

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Ultrasound refers to sound waves with frequencies higher than the upper limit of human hearing (above 20 kHz). They can be utilized in the food industry, including ice cream production, as an alternative to traditional pasteurization and homogenization methods. The ultrasonic process generates micro-shocks in the liquid, improving emulsion homogenization, resulting in even distribution of ingredients and a better texture of the final product. This is a promising technology that can enhance the efficiency and quality of ice cream production. Additionally, oleogels are emulsions primarily composed of plant oils and water, stabilized with gelling agents. These agents can be of natural or synthetic origin and serve as binding substances, enhancing the texture, consistency, and stability of products. The aim of the study was to investigate the potential application of ultrasonic waves as an alternative to replace pasteurization and homogenization in the process of obtaining ice creams with 6.8%, 8.4%, and 10% oleogel based on sesame seed oil. The obtained ice creams underwent analysis of physical and chemical properties. Based on the conducted research, it was demonstrated that ice creams containing oleogels based on sesame seed oil, where the ice cream mixture was subjected to ultrasonic waves, exhibited significantly higher dry matter content (37.36%), carbohydrates (54.54 [$g \cdot (100\ g)^{-1}$]), total melting time (27.54 min), significantly lower fat content (15.87 [$g \cdot (100\ g)^{-1}$]) and overrun (28.94%) compared to pasteurization. The values of freezing temperature and the amount of frozen water for these ice cream sample were significantly lower. Furthermore, sensory evaluation did not show significant differences between ice creams subjected to ultrasonic waves and pasteurization.

MOLECULAR DETERMINANTS OF THE BOLTING OCCURRENCE IN SUGAR BEET

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Flowering in the first year of cultivation, known as bolting, is an unfavorable phenomenon causing a significant decrease in the quantity and quality of the sugar beet yield. For effective breeding of bolting-tolerant cultivars, it is crucial to have a comprehensive understanding of the genetic background of flowering induction. The presented research aimed to analyze the transcriptome of sugar beet lines with different levels of bolters occurrence and to identify structural variations associated with a decrease in the tendency to bolting.

In the presented study we used data including transcriptome sequences of 12 sugar beet breeding lines from the KHBC Ltd. collection, which were previously characterized for their tendency to bolting, based on long-term observations. The percentage of bolters for the tested materials ranged from 0 to 100%.

The transcriptomes of analyzed lines were sequenced using the RNAseq technique, and the obtained sequences were mapped to the reference genome of sugar beet. Subsequently, the single nucleotide polymorphisms (SNPs) associated with low bolting tendency within the sequences of the transcripts were identified. In the next step, the protein products of these transcripts were determined and the influence of identified SNPs on their amino acid composition was analyzed.

The results allowed the identification of numerous SNP-type polymorphisms associated with the tendency of sugar beet plants to flower in the first year of cultivation. The strongest association with the trait was shown in the study by sequences located on chromosome 4. Given that the main described genetic regulator of flowering in sugar beet is the *BOLTING TIME CONTROL 1* (*BTC1*) gene located on chromosome 2, our results suggest the functioning of a different mechanism of flowering regulation in the studied sugar beet genotypes.

To date, only a few genetic sources determining flowering time in sugar beet are known. The obtained results allowed for the identification of transcripts not previously associated with flowering regulation, associated with a tendency to bolting which may shed new light on this issue.

THE USE OF NATURAL FILLERS IN EPOXY REGENERATIVE MASSES

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Epoxy adhesive compounds are a durable and resistant material. In engineering, epoxy adhesive compounds are used in a range of applications due to many variations of this material and the ability to bond two dissimilar materials together. For this reason, they are used as remanufacturing compounds for components that have deteriorated as a result of long-term use. When using this material as a regenerative mass, it is often subjected to modifications that make it possible to change its properties such as thermal and electrical conductivity as well as increase its strength. The material is mainly modified by the addition of fillers in the form of powders, fibres or small flakes, which may come from plastics or natural materials. The epoxy adhesive compound with the addition of a filler can be categorised as a composite. Environmental awareness is forcing manufacturers of regenerative compounds to create biocomposites where at least one of the materials is of natural origin. Among fillers of natural origin, hemp is an important material, whose fibres are known for their high strength. Appropriate preparation of biocomposites based on epoxy adhesive compounds containing hemp fibres as filler can enable their use as regenerative masses in the automotive, where attention is focused on maximising material strength with a reduction in weight.

WAYS TO REDUCE SPRAY DRIFT DURING AGRICULTURAL SPRAYING OPERATIONS

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The appropriate quantity and quality of crops is possible largely with the use of plant protection products. These agents are most often used using pressure sprayers by appropriately spraying the working liquid and applying it to the sprayed surface or space in the case of orchard crops. Liquid spraying involves the production of liquid drops of different spectrum, which is important from the point of view of covering protected crops. Obtaining very good droplets is desirable from the point of view of the quality of surface coverage, but carries the risk of drifting during spraying.

The problem of liquid drift is currently widely researched because it poses a serious threat to the natural environment, as well as to agricultural crops located in the vicinity of sprayed fields or orchards. There are many design and operational solutions used in plant protection technology aimed at eliminating this phenomenon. To assess the effectiveness of drift reduction techniques, a methodology and ISO standard for measuring liquid drift during spraying (ISO 22866) was developed.

The most popular form of reducing drift is the use of spray nozzles with structures that allow large drops to be obtained. Nozzles are available in many varieties and a number of design solutions, ranging from the use of inserts for classic nozzles through the construction of injector nozzles, which are designed to produce large aerated drops.

The operational approach is to maintain an appropriate procedure scenario. If possible, reduce the spraying speed and spray at a speed of 5-7 km/h. This will reduce air turbulence occurring behind the sprayer boom. Another way to reduce drift is to use larger spray nozzles while lowering the operating pressure. This will allow you to maintain a specific dose of working liquid per hectare while increasing the size of the drops produced by the sprayer.

In fruit crops, techniques and technologies used during spatial spraying of rows of trees and shrubs are also possible. First of all, in orchard sprayers, the sprayer fan output should be adjusted to the size and density (leaf size) of the rows of trees and shrubs being sprayed. Air flow emission systems should be used, the air guide and outlet slots of sprayer fan columns should be properly adjusted, nozzles unnecessary for a given spraying should be closed, so as to match the spraying geometry to the geometry of trees or bushes, and low-drift nozzles or tunnel sprayers should be used. You should turn off the spraying sections in places where there are no trees, and avoid double spraying of trees and bushes.

Technological progress in the construction of sprayers makes it possible to perform protection treatments using advanced spraying space recognition systems. Perform selective spraying only in those places where it is necessary. However, the greatest impact on reducing drift will have the appropriate selection of techniques and technologies as well as the knowledge and experience of the agricultural sprayer operator.

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THE EFFECT OF BIOSTIMULATION ON SOIL CONDITION CHANGE

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Climate change is an urgent cause for the revision of current methods of agricultural production. Mitigation and adaptation are becoming key measures to maintain food security for future generations (Vermeulen et al., 2012). According to FAO data, agriculture, forestry and other forms of land use generate 24% of global greenhouse gas emissions, with emissions from livestock alone reaching 7.1 Gigatons of CO2 equivalent per year, which represents 14.5% of total anthropogenic greenhouse gas emissions. Innovations in the application of biostimulants represent a significant advance in the field of agriculture, especially when it comes to maximizing their effectiveness. Current research focuses on new methods of applying biostimulants, while encapsulation proves to be an innovative method capable of increasing the stability and durability of biostimulants in field conditions (Findura et al., 2023). This technique enables the controlled release of active substances, improves their availability for plants and minimizes losses caused by leaching into the soil, which has the potential to increase the effectiveness of biostimulants and reduce their environmental impact (Jiménez-Arias et al., 2022). Nevertheless, there is great variability in the efficacy of biostimulants and limited understanding of the mechanisms in field-tested applications where differences are observed. These unknown mechanisms could be related to recognized indicators of soil health, providing opportunities for the unrealized potential of biostimulants beyond crop growth and development. (Sible et al., 2021). Kulhánek et al., (2022) also draws attention to the risks of the effectiveness of the application of biostimulants, when in the soil environment there is a decrease in the survival of introduced microorganisms due to competition with the original ones, which is manifested by the non-acceptance of "intruders". Microorganisms compete for nutrients with plants, especially in nutrient-poor soils. Different soil properties of the target plot may limit the viability of biostimulants obtained from other environments. Incorrect timing and method of application of biostimulants significantly reduce their effectiveness, often causing only short-term contact with plant roots. The effectiveness of biostimulants can also be affected by weather and abiotic stress of plants. In field conditions, for economic reasons, lower doses of biostimulants are used than in laboratory tests.

We determined the measured variants during the cultivation of oilseed rape (brassica napus), where the preparation of the soil in the fall was already solved in 2021. For variant A and C, we applied the widely distributed preparation NEOSOL at a dose of 200 $kg.ha^{-1}$. While the variant of conventional technology was represented by a 6-blade rotary plow set to a depth of 0.2 m, while for the soil protection technology we also processed the soil to a depth of 0.2 m with a Horsch Tiger 4 blade cultivator.

EFFECT OF ASAHI SL BIOSTIMULANT APPLICATION ON PHYSICAL PARAMETERS OF SOYBEAN SEEDS

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One of the significant problems of legume cultivation is the high sensitivity of their seeds to mechanical damage, which occurs during threshing, cleaning, drying, transportation, storage and processing. As a result, this results in significant quantitative and qualitative losses. On the other hand, the optimal moisture content of soybean seeds can vary depending on the specific application. Too high a moisture content can lead to storage problems such as mold, fermentation or seed quality degradation. On the other hand, too low a moisture content can cause seeds to crumble during storage, transportation or processing processes.

The purpose of this study was determinion the effect of the growth biostimulant Asahi SL on the shape and compressive strength of Abelina soybean seeds. After harvesting, the seeds were dried to moisture contents of 6, 8 and 10% and then subjected to measurements of width, depth and height. Specific weight, bulk density and weight of 1,000 seeds were determined for each moisture content. Corey's coefficient of sphericity was used to evaluate the shape of soybean seeds. Compressive strength tests were conducted on a Zwick/Roell Z005 testing machine equipped with a compression head with a maximum force of 500N.

In the tests conducted, a significant 5% reduction in seed weight was observed for seeds with 8% moisture content after application of the biostimulant. On the other hand, assessing shape, soybean seeds with 6% moisture content were noticeably more spherical in control trials than after using Asahi SL. Considering strength, it was observed that as moisture content increased, seeds were less resistant to compressive force and only at 10% moisture content were more resistant after biostimulant application.

PARTICLE SIZE, COLOR, SPECTRAL CHARACTERISTICS AND ANTIOXIDANT ACTIVITY OF MICRONIZED ROSE FLOWER PETAL POWDERS

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Edible flowers have lately gained appeal in the food production industry due to their potential as a source of bioactive compounds. Flower petals can also be used to produce colorants. Rose petals include significant levels of dietary phytochemicals such as flavonoids, carotenoids, and phenolic acids. Previous study has revealed that the petals of various types of rose flowers have variable antioxidant capabilities, and that the manner of processing them alters the qualities of the resulting powders. Furthermore, few studies have examined the molecular characteristics of the produced compounds, highlighting the need for further research in this area.
In this study, the impact of the micronization process on the properties of obtained powders derived from wild rose petals of the rugosa (*Rosa rugosa Thunb*.) variety was examined.
In order to achieve the micronization process, the freeze-dried powder from rose flower petals was finely ground in a ball mill (Pulverisette 6 Fritsh). The micronized rose petal powders were subjected to an investigation regarding their particle size (Mastersizer 3000, Malvern), color (4Wave CR30-16 colorimeter, Planeta), spectral characterization (FTIR, IRSprit spectrometer, Shimatzu) and antioxidant activity (ABTS•+ , DPPH• and FRAP).
The results demonstrated that the d50 particle size for control samples of rose petals powder was 98.6 μm, whereas those micronized for 10 and 20 minutes were 45.9 μm and 39.9 μm, respectively. Rose petal powders, particularly in micronized form, are a very useful antioxidant raw material due to their high total phenolic content. This indicator for micronized rose flower petals powders ranged from 90.5 to 93.3 mg GAE per gram. For most of the tested indicators, the sufficient micronization time is 10 minutes, and the antioxidant potential measured using ABTS, DPPH and FRAP for micronized powders was 1,14 mmol TE/g, 1,22 mm TE/g and 1,94 mmol $Fe^{2+/}$g, respectively. Analysis using FTIR infrared spectroscopy revealed the presence of characteristic bands of the applied micronization process, with the most significant spectral bands peaking at approximately: 2980, 1340, 1225 cm^{-1}.

QUICK AND EFFECTIVE EVALUATION METHODS FOR BIOCONTROL AGENTS AND BIOSTIMULANTS AGAINST PHYTOPATHOGENIC FUNGI AND OOMYCETES IN EXTENSIVE CROPS

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Fungal diseases present a significant challenge to global agricultural productivity. They can lead to substantial crop losses, impacting both the yield and quality of agricultural products. The emergence of fungicide-resistant fungal strains has further intensified the challenge of managing fungal diseases effectively. Therefore, it is imperative to explore and implement effective strategies for the prevention, monitoring, and control of fungal diseases. Among the array of sustainable practices being explored, the use of Biological Control Agents (BCAs) and Biostimulants with Protective Effects (BPEs) are emerging as focal points of interest. BCAs combat plant diseases either directly by producing harmful metabolites against pathogens and competing for resources, or indirectly by improving plant resistance and soil health. BEPs, on the other hand, operate by stimulating plant nutritional processes, thereby increasing efficiency in nutrient utilization, enhancing tolerance to abiotic stresses, and improving the availability of nutrients in the soil or rhizosphere. Additionally, they provide protective benefits by serving as biopesticides or inducers of plant resistance. This category primarily includes beneficial microorganisms and its metabolites, along with organic and inorganic non-microbial substances. Beneficial microorganisms primarily comprise Plant Growth-Promoting Rhizobacteria (PGPRs), bacterial endosymbionts, and Arbuscular Mycorrhizal Fungi (AMF).These novel solutions provide a sustainable alternative to traditional agricultural methodologies, emphasizing the enhancement of plant growth and resilience while minimizing the ecological footprint. Considering the expanding research in the field of BCAs and BPEs, a pressing need for developing efficient methods to assess the impact of these products is crucial. Therefore, this conference will present a summary of simple, accessible, user-friendly, and effective protocols for evaluating the protective potential of BCAs and BPEs. These protocols involve both the pathogen and the host organism from its early stages, including seeds and seedlings. Among the classical methods focused on pathogens, the dual culture assay stands as a pivotal technique for showcasing the effectiveness of BCAs in combating pathogens. *In vitro* sensitivity assays are frequently utilized to determine the susceptibility of a pathogen to a BPE. These methodologies are instrumental in quantifying the effects of BPEs on fungal growth, specifically by monitoring the reaction of the fungal mycelium to the introduction of the extract into the culture medium. Methods integrating the host and the pathogen include seed-based assays and detached leaves or leaves discs assays. Lastly, greenhouse assays are commonly conducted to study the effects of BCAs and BPEs on plant diseases. While *in vitro* studies, focusing solely on pathogens, provide valuable insights, the intricate dynamics of plant-pathogen interactions call for more comprehensive evaluations. System-based approaches, which include the plant, offer a broader perspective by accurately capturing the complex interplay between biostimulants, plant hosts, and pathogens, thereby providing a holistic understanding of biostimulant efficacy in real-world settings.

THE IMPACT OF CULTIVATION TECHNIQUES ON GREENHOUSE GAS EMISSIONS IN SUSTAINABLE AGRICULTURE

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Climate change is a significant environmental issue that affects people worldwide. Therefore, actions taken to reduce the impact of agriculture on the environment and enable more efficient use of soil and machinery while maintaining production profitability are key factors in current considerations. This applies to many different industries, from the energy sector to healthcare and agriculture. The emission of greenhouse gases, such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), emitted as a result of various human activities associated with unsustainable agriculture (excessive use of pesticides and fertilizers), is a challenge of the contemporary world. Therefore, one of the key practices of sustainable agriculture is to strive to reduce greenhouse gas emissions. According to the goals of the European Green Deal, the European Union aims to achieve climate neutrality by 2050. Agricultural activities have a significant impact on the emission of three greenhouse gases: carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4). Soil cultivation technologies have a significant impact on the release of these gases into the atmosphere. A large portion of CO_2 is released from the soil due to excessive mineralization of soil organic matter, which occurs when improper cultivation techniques are used. It has been shown that zero tillage affects the reduction of methane emissions depending on the cultivation technique used, and here we can mention conventional plowing and no-till methods. Zero or simplified tillage positively impacts the sustainable development of agriculture, increases carbon sequestration in the soil, reduces soil erosion, improves soil physical conditions, and reduces greenhouse gas emissions without reducing crop yields. Comparing no-till cultivation with traditional cultivation, it is characterized by methane reduction. During soil cultivation in a no-till system, the plow is replaced by other cultivation tools such as disc harrows, cultivators, and rotary tillers. The use of such tools results in non-inversion of the soil, crop residues and cover crops are left in the field, thereby reducing the number of passes. This technology leads to better field water retention, lower CO_2 emissions, and reduced erosion losses. Studies conducted so far are not conclusive regarding the impact of no-till on gas emissions. Results vary depending on climate, soil type, etc. Plowing is considered to be the most energy-intensive tillage operation. During the combustion of fuel during the operation of machinery, the main component of the exhaust gases is carbon dioxide. It has been calculated that 1 liter of diesel consumed equals 3,15 kg of carbon dioxide produced. Stopping plowing results in fuel savings and lower greenhouse gas emissions. In preliminary analyses conducted in 2010 by Goebel et al., the fuel used in three different tillage systems was converted to CO_2. Based on these calculations, it was found that conventional plow tillage emits 180,76 kg CO_2/ha, no-till emits 89,36 kg CO_2/ha, while zero tillage emits only 19,50 kg CO_2/ha.

GENE EXPRESSION CHANGES OCCURRING IN SOY PLANTS IN RESPONSE TO BIOSTIMULANTS APPLICATION

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Growing demand for food and feed as well as the need to protect the environment present a challenge to modern agriculture. Novel strategies for increasing plants yield and resistance are required, therefore the use of ecological biostimulants that would improve the growth and development of crop plants has become an important topic of research. This study aimed to investigate the changes occurring in soy plants at the transcriptional level after biostimulants application. During the experiment, the soy seedlings growing in controlled phytotron conditions were treated with three different variants of biostimulant. The spraying was carried out twice. The gene expression analysis was performed with the use of the RT-qPCR technique. The expression of 13 different genes of interest (GOIs) was studied in both the roots and leaves of soy plants subjected to biostimulants treatment. Prior to the analysis of GOIs, the identification of reference genes showing stable expression in the tested material was conducted. As a result of the biostimulants application mRNA level of several GOIs changed. Among others, transcription upregulation of genes encoding chitinase (*CHIA*) and β-1,3-glucanase (*GLU*) was revealed. In plants, both of these enzymes participate in the stress-related defense mechanisms against pathogen attack. Noteworthy is the fact that increased transcript levels of *CHIA* and *GLU* were consistently observed after both treatments of all variants of biostimulants used in the experiment. The obtained results suggest the possible bioprotective effect of using tested biostimulants in soy cultivation.

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THE EFFECT OF PLOW MODIFICATION ON DRAWBAR POWER REQUIREMENT DURING PLOUGHING

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This study attempts to address the problem of excessive soil compaction in the subsoil layer caused by the movement and operation of agricultural machinery by modifying the plough design to combine two operations with high energy requirements, ploughing and subsoiling. The aim of this study was to modify and develop the design of the share plough by adding an additional frame (heavy-duty tines) on which the mounted working elements operate below the ploughing layer immediately after the wheel travels on the bottom of the furrow and behind the first and the second plough bodies, using different tines settings (depth and type), at different speeds, to loosen the effect of the wheel travel before it is buried by the soil that cuts during the ploughing operation. The effect of the plough modification was to destroy the plow pan, leading to a decrease in the penetration resistance of the soil in the subsoil layer.

MECHANICAL BEHAVIOUR OF CYLINDRICAL APPLE SAMPLES UNDER DIFFERENT LOADING CONDITIONS

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Compression tests of cylindrical samples were carried out on two apple cultivars with flesh firmness differing in a statistically significant way. The tests were performed under both quasi-static and impact loading conditions, which required the use of two test stands. For this purpose, an impact measuring stand was designed and built.

The tests showed that the firmness of the apple flesh influenced the mechanical response under both quasi-static and impact loading conditions. The elasticity modulus had much higher values under impact than quasi-static loading conditions. This indicates that the stiffness of the apple tissue was higher during impact than in low-speed compression.

Different failure mechanisms of cylindrical apple flesh samples were found depending on the loading conditions. Under quasi-static loading conditions, apples of both cultivars were damaged at the same strain value. However, during impact, apples failed at a constant stress value regardless of the firmness of the tested cultivar. The toughness of the apple tissue depended on firmness and was higher under quasi-static loading conditions for apples with higher firmness. However, under impact loading conditions, the toughness was greater for apples with lower firmness.

APPLICATION TECHNOLOGY AND PRELIMINARY RESULTS OF STUDIES ON DIGESTATE FROM THE PIASKI BIOGAS PLANT

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The matter which remains after fermentation, and contains organic matter and mineral compounds, valuable for plant nutrition, is termed digestate (also referred to as post-digestion matter or pulp). It contains considerable amounts of mineral elements (nitrogen, phosphorus, potassium). In terms of rapidity of action (absorption of elements by plants) it resembles mineral fertilizers since N, P and K elements are easily available for plants. Digestate also contains a part of organic matter which has a positive effect on physicochemical properties of fertilized soil.
Digestate obtained from the biogas plant in Piaski (Lubelskie Province) was applied on experimental fields for alfalfa and spring wheat cultivation. There were sown fodder alfalfa of *Kometa* variety.
Analyzing the obtained test results, the heavy metal content was below the detection limit of the measuring apparatus. In addition, digestate contains significant amounts of macronutrients, therefore it has been found possible to use digestate as a fertilizer.
The analysis of the study results showed a percentage increase of particular macroelements in alfalfa leaves from the first harvest. The highest increase was observed in the content of nitrogen and potassium, which rose by 0,55 p. p. (percentage point) and 0,29 p. p., respectively. The relative percent differences for the examined macroelements were as follows: nitrogen – 17,68%, phosphorus – 7,14%, potassium – 17,37%, calcium – 5,95%, magnesium – 2,70%. The analysis of the test results for the content of particular macroelements in alfalfa leaves from the second harvest revealed the highest increase in the content of calcium, by 1,13 p. p., and nitrogen – by 0,96 p. p. As regards the relative percent difference, the following values were recorded for the examined macroelements: nitrogen - 36,23%, phosphorus – 36,84%, potassium – 2,99%, calcium – 57,07%, magnesium – 26,92%.
The investigation revealed that post-digestion liquid contains large amounts of macroelements. Its composition is similar to bovine liquid manure. However, no heavy metals were found in digestate. The examination of soil samples before and after digestate application showed increase in the content of macroelements in the soil, which implies a good fertilizing value of digestate. An increase in the content of macroelements was observed in the leaves of the alfalfa fertilized with digestate in comparison with the alfalfa fertilized with mineral fertilizers, both from the first and second harvest. Consequently, post-fermentation residues from biogas plants can be used as a fertilizer. The only condition is the rational utilization of such residues.

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INVESTIGATING THE EFFECT OF TRACTOR'S TIRE PARAMETERS ON SOIL COMPACTION

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The aim of this study was to investigate soil compaction under two sizes of tractor tyres, taking into account the effects of tyre pressure and movement at different soil depths. The tests were conducted using a randomised complete block design with three replications. We tested two tyre types using three pressures. Analysis of variance showed that tyre size had a significant effect on the change in soil density, and the binary effect of tyre size on depth and intensity of movement was also significant. The main effects of tyre pressure, traffic intensity and depth were significant for soil density at the 1% level for both tyre types. Inputs to the ANFIS model included tyre type, soil depth, number of tyre passes and tyre pressure. It was found that the narrow tyre was more effective in soil compaction, as the narrow tyre significantly increased soil density in the surface and subsurface layers.

POTENTIAL USE OF POMACE FROM THE SELECTED PLANT SEEDS AS FUNCTIONAL FOOD INGREDIENTS

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Recently, there has been an increase in researchers' interest in the possibility of further use of agricultural by-products, including pomace, in various industrial sectors. One of the possibilities of using plant by-products is to develop them as a new material for biocomposites. Another direction may be the appropriate processing of food by-products, which can be reused as food fortification ingredients, pharmaceuticals or dietary supplements.

For the research, pomace from camelina (*Camelina sativa*), black cumin (*Nigella sativa*) and Oenothera seeds were obtained, which were purchased from the producer (Pliczko Farm, Woźniki, Poland). By the information provided by the manufacturer, this product was obtained by cold pressing in a screw press with a temperature of around 38°C. The basic chemical composition of plant pomace powders was determined. The obtained plant powders' amino acid profile and fatty acid content were also analysed. The pomace was characterised by a higher content of protein and total fibre at the levels of 29.81 g/100g and 35.57 g/100g (black cumin), 22.70 g/100g and 50.12 g/100g (Oenothera), and 34.28 g/100g and 40.2 g/100g (camelina), respectively. Black cumin pomace was the richest in fat, with a fat content of 23.1 g/100g, while in the case of camelina and oenothera pomace, the fat content was approximately 11.3 g/100g. Linoleic acid (LA) and oleic acid were the dominating fatty acids (OMEGA 6 i 9) in black cumin and camelina pomace, while only LA accumulated in pomace from Oenothera. Amino acids analysis showed that glutamic, aspartic and arginine were the most abundant amino acids in all tested plant pomace. Moreover, the essential fraction: leucine > valine > lysine was found at a higher level in the amino acids profile of Oenothera pomace compared with the protein profile of other plant pomace.

These findings suggested that the pomace from seeds like camelina, black cumin and Oenothera could be used as a valuable functional ingredient to enhance the nutritive content of different kinds of foods.

ANALYSIS OF USED ENGINE OILS FROM AGRICULTURAL TRACTORS IN THE ASPECT OF THEIR REPLACEMENT TIMES

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Predictive maintenance is a popular strategy for minimising expenses and improving maintenance vehicles. Among the essential tools of a predictive maintenance program is monitoring vehicle health through engine oil analysis. Agricultural tractors operate in diverse conditions, such as various applications, terrains, and weather conditions. This variety of usage results in different levels of oil degradation, making it challenging for manufacturers to optimize the oil change interval to meet farmers' needs.

The research aims to analyse the chosen physicochemical parameters of used engine oils collected during periodic inspections of agricultural tractors. The FTIR technique was used to assess the degree of oxidation, nitration, and sulfonation, fuel content, total base number (TBN), total acid number (TAN), other anti-wear additives, and kinematic viscosity at 40°C and 100°C. The tests were carried out based on the ASTM E2412-10 standard. The results obtained were used to present the limit values for selected parameters. The research findings can be used to optimise the frequency of engine oil replacement. This will ensure that the decision to change oil is justified in ecological, economic, and technical terms, considering the need to maintain the durability of the agricultural tractor.