ICA 2013

10th International Conference on Agrophysics

70th anniversary of Prof. Ryszard Walczak's birthday

5th - 7th June, 2013

LUBLIN, POLAND

Book of abstracts

Bohdan Dobrzański
Institute of Agrophysics
Polish Academy of Sciences

Polish Academy of Sciences
Branch in Lublin

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Organizers:

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PROGRAMME OF THE CONFERENCE

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13.00 – 14.30 Lunch

14.30 – 19.00 Excursion to the Old Town in Lublin

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E.A. Czyż, A.M. Gajda
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12.15 – 13.00 Final discussion and conclusions

13.00 – 14.30 Lunch

ABSTRACTS OF PLENARY LECTURES

SOILS AND FOOD SECURITY UNDER GLOBAL CHANGE

Blum, W.E.H.

University of Natural Resources and Life Sciences (BOKU) Vienna, Institute of Soil Research Peter Jordan Str. 82, 1190 Vienna, Austria, winfried.blum@boku.ac.at

Food and biomass production as a basis for a human life and the environment depend largely on soils. Therefore, we describe, the availability of soils for food and biomass production at a world wide and local level, and describe the relationship between soils and food security in the past.

However, biomass and food production is subject to global changes, which comprise much more than climate change, and are manifest in six main problem areas:

1. The increase of world population and changes in its spatial distribution.
2. The loss of best agricultural soils through urbanisation, industrialisation and further human impacts, including erosion, contamination and other adverse processes.
3. Changes in lifestyle, mainly due to increasing social and economic wealth, with increasing demand for food, especially for animal protein (meat), increasing the demand for grain. Moreover, in industrial countries, up to 50% of the purchased food is wasted.
4. Production of bioenergy, e.g. biogas, biofuel or solid materials, causing the actual problem of balancing between the production of bioenergy and the satisfaction of food supply.
5. Changes in world economy, with emerging new economic trends in food production and marketing, impacting food security through the increase of speculative performances, also expressed by "land grabbing", which indicates the need for more productive agricultural land and soil.
6. Climate change, one of the most important global factors influencing soil and land management, through changes in temperature and precipitation, their intensity and variability.

These changes are discussed, giving an outlook on future food and biomass production under the aspects of sustainability. One of the greatest challenges will be the availability of water.

RECENT DEVELOPMENTS IN HYPHENATED TECHNIQUES IN FOOD ANALYSIS

Jeleń, H.

Poznań University of Life Sciences, Faculty of Food Science and Nutrition, Wojska Polskiego 31, 60-624 Poznań, Poland, henrykj@up.poznan.pl

Food is a complex matrix regarding its chemical composition, physical properties and sensory characteristics. Its quality is a crucial factor for consumers, important in international trade and food production chain, so therefore methods for determination of food quality measures are equally important for food producers as well as controlling agencies. Because of food complexity from chemical point of view, methods for determination of food components and contaminants are getting more and more complex nowadays.

Chromatographic techniques have been used for the analysis of food constituents since their invention. Especially, since the beginning of this century there is a rapid leap in developments in food analysis related to chromatographic methods. Combination of gas and liquid chromatography as separation techniques with mass spectrometry for compounds identification opened new perspectives in food analysis. These combinations are referred to as hyphenated techniques and are the most important techniques in determination of food components nowadays. The lecture will focus on recent developments in hyphenated techniques applied to food analysis. Novel techniques and their potential will be discussed with examples from literature and speaker's laboratory.

RECENT DEVELOPMENT IN PROCESSING OF THERMOPLASTIC STARCH - A PERFECT COMPONENT FOR BIODEGRADABLE PACKAGING

Mościcki, L.

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A diversity of users like industry, retailers, farmers and medical care are faced with the growing pressure of society and legislation to minimise non-degradable packaging waste and to switch to biodegradable materials. Despite this pressure, there is at present no biodegradable alternative for disposable plastics combining all the features, functionalities and economics to become real competitive. Recent efforts to realise competitive biodegradable packaging have been frustrated by the problem of finding the optimal balance between strength, costs and the level of biodegradability.

An increased emphasis on sustainability, eco-efficiency and green chemistry has driven a search for renewable and environmentally friendly resources. Starch - a biodegradable polysaccharide produced in abundance at low cost - possesses thermoplastic behaviour, making it one of the most promising candidates as an alternative to traditional plastics in certain market segments, such as the food packaging industry.

Starch is a complex homo-polymer composed of a-D-glucose units linked together in two different forms: the linear form amylose and the highly branched amylopectin. Composition and structure of starch granules varies considerably between different plants, affecting the properties and function of starches from different crops.

Numerous studies have been conducted to optimize the performance of starch-based plastics. These studies show that important properties for evaluating a packaging material include mechanical and thermoforming properties, gas and water vapor permeability, resistance, transparency and availability. Designing and engineering a starch-based packaging product that possesses all of these required properties is, however, a significant challenge. Product cost and technical challenges - such as brittleness associated with high loads, and poor water and gas barrier properties - have to be overcome before renewable biomaterials can be commercialized. Currently, most research aimed at enhancing the functional properties and inherent bonding strength of starch have focused on incorporating additives, such as plasticizers, to improve the material's performance.

Department of Food Process Engineering, Lublin University of Life Sciences developed starch-based biodegradable packaging materials, which the biodegradability behaviour, physico-chemical and physico-mechanical properties, the handling, the shape and the end-product costs can compete in the future with the conventional plastics. The main results of investigations as well as other important information concerning thermoplastic starch and biodegradable plastics are discussed in the paper.

SEASONAL TRANSPIRATION AND BIOMASS PRODUCTION

Novák, V.

Institute of Hydrology, Slovak Academy of Sciences, Račianska 75, 83102 Bratislava, Slovakia, novak@uh.savba.sk

Optimal biomass production needs optimal state of many characteristics of Soil – Plant – Atmosphere – Continuum (SPAC), like meteorological characteristics, nutrition, agrotechnics, soil water and others. The soil water regime is one of them and usually it can be optimized. Its worthy to do that, because more than 40 percent of world biomass production is grown on 20 percent of irrigated soils. But in principle, there are not irrigated plants, but soils and only part of soil water is passing through the canopy by transpiration and thus influencing biomass production.

The aim of this contribution is to present a method of biomass production evaluation, based on empirical linear relationship betweeen seasonal transpiration totals and final biomass production. This relationship was estimated many times and can be taken as working hypothesis (Hanks & Hill, 1980). It can be used to quantify water consumption by plants and resulting biomass production, assuming other biomass production preconditions to be constant. This relationship is applicable locally and for particular crop, for which relationship transpiration - biomass production was estimated.

The application of this approach is illustrated on crops grown on site near Bratislava (South Slovakia). To evaluate the real impact of soil water regime on biomass production, the cumulative frequency distribution curves of seasonal transpiration were calculated (Novák, 2012). Then, knowing seasonal transpiration totals and using biomass production – seasonal transpiration totals linear relationship, the cumulative frequency curves of biomass production can be evaluated (Novák & van Genuchten, 2008).

Calculating the cumulative frequency distribution of seasonal potential transpiration, the cumulative frequency curves of potential biomass production (maximum possible under particular environmental conditions) can be evaluated. Then, the differences in production (and frequency curves of them) can be calculated and possible water regime optimisation can be proposed and evaluated.

Then, cost – benefit analysis can be evaluated and thus the decision about effectivity of soil water regime optimisation measures can be arised.

References

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Novák, V & van Genuchten, M. Th. 2008. Using the Transpiration Regime to Estimate Biomass Production. Soil Science 173, 6, 401-407.

ENERGY AND MASS FLUXES MEASUREMENT TECHNIQUES APPLIED AT DIFFERENT GHG MONITORING SITES IN WESTERN POLAND

Olejnik, J., Chojnicki, B.H., Urbaniak, M., Juszczak, R., Leśny, B.H.

Poznań University of Life Sciences, janusz.olejnik@up.poznan.pl

There is the continuing development of micrometeorological measurement techniques at Meteorology Department of Poznan University of Life Sciences since the early eighties. The first Polish Eddy Covariance system for the measurements of mass and energy fluxes was developed at the end of 2001. This system was tested and calibrated at the Campbell River measuring station in Vancouver Island, Canada, and after returning back to Poland it was installed on croplands to measure CO_2 and H_2O fluxes over corn, rape, wheat and bare soil. In 2003 the PULS team took the efforts aiming at the joining to the European research project CarboEurope IP. The first permanent measuring station in Poland, over natural ecosystem, was established at the end of 2003 (Rzecin wetland, Western Poland) and it operates until now. Next to the research on the wetland station, thanks to The State Forests National Forest Holding support, the second EC site was developed in 2008 at the afforestation. This 52 years old pine forest is located in Tuczno. The micrometeorological station at the agricultural area (Brody village) was established at 2010 as a result of regional greenhouse gases balance assessment for Wielkopolska region. The values of the CO_2, CH_4 or N_2O fluxes obtained over those sites have been related to the meteorological conditions, as well as to the soil water contents during each year of measurements. It is done in order to parameterization of exchange processes between terrestrial ecosystems surfaces and the atmosphere. Presented sites are also planned to be part of European Integrated Carbon Observing System (ICOS) that will monitor greenhouse gases exchanges on the scale of continent. During the lecture all mentioned techniques will be described and results from different sites will be shown.

PEDOTRANSFER FOR SOILS IN AGRICULTURAL SYSTEMS – ADVANCES AND CHALLENGES

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Pedotransfer methodologies establish relationships between the available data and data that are needed. Most of current work is done in soil physics where model parameter measurement is laborious and yet parameters have to be estimated for societally important applications. The purpose of this presentation is to provide the overview of advances in pedotransfer in agrophysics and to outline the role of research in this direction that that Prof. Walczak initiated, led and advanced.

The traditional pedotransfer inputs, i.e. soil texture, bulk density and organic carbon content continue to be accumulated. Sensor networks and time-lapsed geophysical survey present the novel source of potential PTF inputs for estimating the spatial variability of soil hydraulic properties. Pedotransfer addressing spatial variability of soil properties attracts more and more attention, given the substantial increase in the interest to the spatial variability in soil water contents and soil hydraulic properties for model performance evaluation, multimodeling, soil water sensor data assimilation, and upscaling and downscaling soil water contents.

Scale plays a critical role in pedotransfer. Migrating from a sample scale to the pedon scale can be done by introducing corrections to estimates from the sample scale. The transition to the field/hillslope scale requires the introduction of new PTF inputs, such as topography. As the types of model change with scale, new pedotransfer functions may be needed for parameters of those models. Both accuracy of potential inputs and their dependence on scale evolves with scale.

Pedotransfer functions appear to be essential to address hot topics of environmental research, such as carbon sequestration with the growing of attention to soil aggregate composition and the role of organic matter in soil hydraulic properties, climate change with increasing frequency of extreme events when soil hydraulic properties at wet and dry ends become very important, and ecosystem services of soils. The technology-assisted pedotransfer substantially increases the value of Earth observation systems and

Pedotransfer is a developing field and a large number of regional and globally important knowledge gaps need to be closed. Saline and alkaline soils, tropical soils, peat soils, soils of cold regions have the utmost importance in regional agricultural systems, and yet have not received the attention in pedotransfer research. The temporal component in pedotransfer requires more understanding of regimes in soil properties as the source of pedotransfer basic data. It is till debatable whether the spatial structure the same for PTF-estimated and for actual soil variables. PTFs for very coarse scales have not received the proper attention.

Overall, diagnostics, monitoring, prediction, and management of oils in agricultural systems are currently benefiting from PTF development and application. Ryszard Walczak's Initiatives and leadership have created the impetus that continues to affect and facilitate the progress in this field.

ABSTRACTS OF ORAL PRESENTATIONS

PREDICTION OF THE OPTIMAL APPLE HARVEST WINDOW USING BIOSPECKLE METHOD

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The biospeckle technique is relatively new, noninvasive, optical method, which can be used for analyzing of biomaterials vitality. It is based on the analysis of laser light variations scattered from sample. The observed fluctuation relates to movements occurring inside the cells caused by processes such as cytoplasmic streaming, organelle movement, biochemical reactions or Brownian motion (Braga et al., 2009). Previous work (Szymanska-Chargot et al., 2012) revealed that biospeckle reflected biochemical changes during apple development and that biospeckle activity (BA) would be used as a new parameter for fruit quality evaluation. It was shown also that BA has a potential as a tool for determination of the optimal harvest date of apples.

Apples of the cultivars 'Ligol' and 'Szampion' were tested at eight stages of development and maturity. Diode laser with a wavelength of 635 nm was used. Biospeckle movies were recorded by a CCD camera. Correlation coefficient was used to evaluate the biospeckle activity. Destructive tests were conducted to estimate apples quality attributes (firmness, dry mass content, total soluble solids content, acidity, starch index). The parameters were used for calculation of maturity indices (Streif Index, De Jager and FARS index).

Results revealed that biospeckle activity reflects the biochemical changes during apple development and maturation. An increase of biospeckle activity in preharvest stages was observed. Decrease in BA, occurred for 6th apple developmental stage, may be related to the lowest metabolic activity. Significant correlation between BA and maturity indices suggests that biospeckle activity measurements may be used for prediction of the optimal apple harvest window.

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PECULIARITIES OF SOILS PARAMETERS CHANGES DYNAMICS ON THE BASIS OF TDR-MEASUREMENTS RESULTS DURING 2008-2012 YEARS ON THE UKRAINIAN WESTERN POLESIE TERRITORY

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Soil water and temperature regimes are main co-factors of soil formation process. Changing of these regimes, especially within the nature-protected territories, under influence of such factors as territory melioration, renaturalization, intensive man-caused loadings as well as solar activity and global climate changes (CC), lead to different soil properties changing as well as general soil transformation. In 2007 within the Neighborhood Program Poland-Belarus-Ukraine project monitoring system (TDR-/MUX/mpt) created in the Institute of Agrophysics (IA) of the PAS in Lyublin, had been installed on the Shatsk National Natural Park territory (Ukraine). Such soil functional physical parameters as temperature, moisture and salinity on different soil depths (from 10 cm up to 80 cm per each 10 cm respectively) and on different soil types (sod-podzolic soil under grassland, low-laying peatbog, pit-moss, antropogenic saline pit-moss, soddy clay sandy soil) were monitored during 2008-2012 years. As the result of data processing, experimental dependencies describing the dynamics of time-spatial changes of soil water content (Θ) and temperature (C°) were obtained.

Dynamics of these changes are determined by many natural and anthropogenic factors, including CC straight related to solar activity and solar radiation. The thermal mode of soil is determined by a relation between a solar radiation and physical soil descriptions, forming the spatial-temporal dynamics of the thermal field, which, probably, should have characteristics of rhythmics, characteristic for a solar radiation, and decrease of a temperature with a depth. But this problem while is small studied. Therefore the experimental rows of the hourly measuring during five years of temperature, relative humidity and salinity on different depths have been analysed. As they are disturbed by casual disturbing effect, a rhythmic is considered within the framework of the periodically correlated stochastic processes.

Behavior of diurnal variations of soil descriptions are got for different depths, exactness of results is estimated, the estimations of descriptions profile establishment delay with a depth are built, the regressive charts of descriptions values determination on the different soil depths on the values of air temperature are developed, influence degree of solar activity changes on descriptions changeability of the soil state on different depths is analyzed.

MULTISCALE PHOTONICS FOR PRECISION AGRICULTURE

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Plant production is subjected to variability in growing conditions for roots as well as environmental conditions for stems, leaves and fruits. This variability can be spatial as well time dependent and different factors can have variability effects at different temporal or spatial scales. Precision agriculture tries to address the variability in crop growth and its underlying causes in order to achieve the optimal plant behavior or yield (quantity as well as quality). This implies that tools must be available to describe the variability, to measure or estimate the status of soils and plants and to evaluate the effect of a treatment in terms of growth and yield and its effect on income generation for producers.

The photonic offers many opportunities because photons are ultrafast, and extremely focusable and function contactless which opens a number of usages for agricultural diagnostics and even treatment processes. In the speaking plant approach the response of plants to certain treatments is in most cases measured by optical means . These plant responses can be at the subcellular level, the leaf level or at the level of the whole plant, even for a field or for a region. The observations are frequently used in inverse modeling to identify underlying processes of growth, stress or infection. The models can then also be used for subsequent feedback control of the various growing conditions and treatments. The implementation of the speaking plant approach is very suitable for plant factories or greenhouse production where most conditions can be manipulated. It also offers a number of unexploited possibilities for field crop production.

ENVIRONMENTAL FACTORS CONTROLLING CH_4 EMISSION FROM MOSZNE WETLANDS DURING FIELD MEASUREMENT

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Wetlands are unique and dynamic ecosystems providing many ecological functions and become highly biodiverse environments. The changeable hydrological conditions, related to variable aeration status of wetlands, strongly affect biogeochemical cycling of nutrients and other elements, as sinks and sources of nutrients (Banach et al., 2009). One of the critical compound is methane, a greenhouse gas known as 20-25 times more radiatively active than carbon dioxide (IPCC, 2007).

The aim of the study was to investigate how environmental factors (water table level, temperature, vegetation cover type) and soil characteristics (aeration state, pH, nutrients composition) affect CH_4 emission from wetlands under natural conditions. The field monitoring has been performed in a transect on the south of Moszne Lake (Polesie Lubelskie Region, Poland) characterized by diverse stages of succession with and without of plant cover.

Field monitoring and correlative studies revealed that magnitude of CH_4 emission was positively correlated with water table and temperature (r=0.55-0.65) with and without plants. The presence of dissolved ions (reflected by Electric Conductivity) negatively affected amount of produced methane (r=-0.39-0.49). From tested nutrients N-NH_4(r=-0.68-0.71), N-NO_2 (r=-0.37-0,35), P-PO_4 (r=-0.72-0.73) and Mn^{2+} (r=0.51-0.54), Fe^{2+} (r=-0.27-0.45) and Cu^{2+} (r=0.03-0.24) had the strongest negative effect on CH_4 levels (r=-0.51-0.73) with and without vegetation cover.

Our study showed that methane emissions from peatlands depends on several environmental factors, as aeration state of peat expressed both by temperature and moisture contents (regulated by fluctuations of water table) and the contribution of peatland vegetation are the most important.

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ESTIMATION OF DIRECT RUN-OFF FROM RAINFALL EVENTS IN A SMALL LOWLAND CATCHMENT

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Estimation of direct runoff from small catchments is one of the key problems in hydrology. Curve Number (CN) method, developed by Soil Conservation Service (SCS) and commonly used by Natural Resources Conservation Service (NRCS) of USDA for estimation of the runoff, uses the concept of Hydrologic Soil Groups (HSGs), which play a prominent role in the methodology (ASCE 2009). Briefly, all surveyed soils are placed into one of four groups, A, B, C, or D, with A being the most porous, deepest, and least runoff-prone, and D the shallowest, finest textures, and most runoff-prone. As the method was introduced on the base of data from US catchments it requires to be checked in areas of other applications.

In this study, over 30 rainfall-runoff events, recorded in a small (A=82.4 km^2), lowland, agricultural catchment in center of Poland since 1980, were used to determine empirical Curve Numbers and to check a tendency of their changing. The observed CN declines with increasing rainfall depth, which according earlier views of Hawkins (1993) could be classified as a standard response of a catchment.

The analysis concluded, that using CN value according to the procedure described in USDA-SCS Handbook, one receives representative value for estimating runoff from high rainfall depths. This has been also confirmed by applying "asymptotic approach" for estimating the curve number from the rainfall-runoff data for other smaller catchment (Banasik & Woodward 2010). Furthermore, the analysis indicated that CN, estimated from mean retention parameter S of recorded events with rainfall depth higher than initial abstraction, is also approaching the theoretical CN. The observed CN, ranging from 52.3 to 95.5, declines with increasing storm size, which has been classified as a standard response of watershed. The investigation demonstrated also changeability of the CN during a year, with much lower values during the growing season.

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SUPERVISED CLASSIFICATION OF BRUISED APPLES ON THE BASE OF HYPERSPECTRAL IMAGING DATA*

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Apple bruise, as a mechanical damage, occurs due to impact, compression, vibration or abrasion during handling. However, the symptoms of this damage: browning and softening of the tissue appear not immediately but after a certain period of time after bruising. In this paper VNIR (Visible and Near-Infrared) and SWIR (Short Wavelength Infrared) spectral characteristics of sound and bruised apple tissues were analysed during the two-weeks period after bruising. The supervised classification methods including support vector machines, linear and logistic regression, neural networks and decision trees were used and compared to check their effectiveness for distinguishing bruised tissue in time for five studied varieties of apples. The classification models were also created and compared to distinguish between areas with defects in the tissue and the sound ones, and between particular varieties of apples. The detection system included hyperspectral cameras equipped with sensors working in the visible and near-infrared (400-1000 nm), short wavelength infrared (1000–2500 nm) ranges. The results of supervised classification revealed good applicability of hyperspectral imaging in VNIR and SWIR regions for detecting apple bruising, days after bruising and cultivars. The linear logistic regression model occurred to be the best for distinguishing between bruised and sound tissues 98.8% of correctly classified instances. The best performances, among the studied models for the class of days after bruising, independently on which day after bruising is assumed to be the positive in the models, were noticed for: the linear logistic regression models, the logistic model trees and the backpropagation neural networks. It was also evident that the AUC values of these models for 2nd day and 5th day after bruising were lower than for 14th day after bruising. The prediction accuracies of all the created classification models for distinguishing between five studied cultivars were very high. The percentage of correctly classified instanced ranged from 95.0% to 99.8%.

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MEAN TANGENT MODULUS AT FAILURE FOR TRINIDAD CLAY SOILS

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An investigation into the stress-strain non linear behaviour of three Trinidad clay soils was performed using the triaxial test (undrained) with the rate of strain at 2.4 mm/min. The soils were prepared in accordance to BS1377 standards into 38mm diameter cylindrical samples. The objective of the test was to observe the variation in soil strength as moisture content and % peat varied. A full factorial experiment was performed with 15%, 20%, 25%, 30% and 35% moisture content variations as well as 0%, 4%, 8% and 12% peat variations. Equations relating the mean tangent modulus (E_t) at failure to % moisture content and % peat was developed with R^2 adjusted value > 50% and $p<0.002$.

This information gives a relationship between soil strength and the combined effects of moisture content and peat on Trinidad clay soils. Such information would have uses in computer modelling or computer simulations that investigate soil-tool interactions especially in the area of tillage.

THE VISCO-ELASTIC BEHAVIOUR OF THE ST. JULIAN MANGO (*MANIFERA INDICA* L, VAR. JULIE) DURING RIPENING

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The visco-elastic behaviour of the St. Julian mango during ripening was investigated under ambient conditions (avg. Temperature; 28.2°C: rh 75-85%). Such behaviour was related to ripening. The objective of the research was to characterize the physical and rheological behaviour in the St. Julian mango to that of maturity, eating quality and shelf-life.

Quasi-static, constant-load test on intact mango samples were conducted over an eight-day period after harvest using a simple creep tester. Measurements on certain physiological changes such as pH, percentage soluble solids (TSS) and colour of the pulp were performed on the individual samples. Daily measurements of the rate of respiration on the test samples were also conducted. The response of the St. Julian mango to creep loading was visco-elastic in nature and was best represented by the Burgers model using the Quasi-Newton modelling technique. Over 95% of the samples fitted the data and R^2 values greater than 0.9 were obtained.

Correlation was obtained between the mechanical parameters in the Burgers model and that of certain physiological changes. The best correlation was observed ($p<0.05$) for that of the instantaneous shear constant (G1) and the viscous constant (η_1) against the parameters of pH, percentage soluble solids, colour, maturity (MAT) and shelf-life. By step-wise regression analysis technique, two equations were developed and accepted based on R^2 value greater than 0.5 and a high F statistic. The equations were as follows:

$$1.\ G_1 = 3.47\times10^6 - (14.84\pm4.13)\times10^4 * TSS(p\le0.001) - (187.60\pm5.50)\times10^3 * MAT(p<0.005)$$

$$2.\ \eta_1 = 9.11\times10^6 - (4.0\pm8.86)\times10^4 * TSS(p<0.005) - (3.88\pm1.82)\times10^5 * MAT(p=0.0036)$$

These equations characterized the physical behaviour of the mango fruit and related such behaviour to its physiological changes during ripening. The equations could have usefulness in the design and development of devices and systems that could enhance the efficient handling and processing of the fruit.

BEHAVIOR OF PLANETARY BOUNDARY LAYER HEIGHT IN LONG LASTING ANTICYCLONE WEATHER PERIOD

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Shallow convection is a fairly typical atmospheric process in the Carpathian basin. It is more frequent during long lasting anticyclone weather which is more and more typical summer weather type in the Carpathian basin

So, we focused on shallow convection analyzing the sensitivity of planetary boundary layer height to the given agricultural land cover in sand and loam texture soils. The research tool used is the WRF (Weather Research Forecasting) mesoscale model system (Chen & Dudhia, 2001). The area investigated is the south part of the Hungarian Great Plains at the West border of Szeged. The simulated days were extreme hot summer days when macro-scale circulation was determined by the anticyclone. Measurements of soil moisture at five sites with different agricultural cover and soil texture were carried out in the upper layer of soil (at 25-30 cm and 50-55 cm depth). Alongside PBL measurements with radiometer and windprofiler were also used to compare to simulations. The results obtained were analyzed from both physical and statistical point of view. The first results suggest that planetary boundary layer height is sensitive to soil moisture content but not to soil texture because of extreme dry soil conditions. The results are useful for understanding land-surface/atmosphere interactions on hot summer days typical for continental climate.

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DIDAS – A NEW APPROACH AND USER-FRIENDLY SOFTWARE PACKAGE FOR ASSISTING DRIP IRRIGATION DESIGN AND SCHEDULING

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The DIDAS software package was developed for the purpose of assisting irrigators in the design of drip irrigation systems and in irrigation scheduling. The program performs computations based on analytical solutions of the relevant linearized water flow and uptake problems. Water flow is described by superposition of solutions for positive sources (on-surface or subsurface emitters) and negative sources (plant root systems). Steady water flow is assumed in the design module and unsteady flow is used in the irrigation scheduling module. The design tool is based on a new, relative water uptake rate (RWUR, ratio between water uptake rate and irrigation rate) criterion suggested for deciding upon the distances between emitters along drip lines and between drip lines. The maximum possible RWUR is evaluated assuming no soil-plant-atmosphere resistance to water uptake. Namely, the plant roots apply maximum possible suction and the water uptake is determined just by the capability of the soil to conduct water from the sources (emitters) to the sinks (rooting zones). The computations of the RWUR requires only a minimum number of three parameters describing the soil texture, the size of the root zone and the potential evaporation, in the few cases when it is important to account for also evaporation form the soil surface. The irrigation scheduling optimizing tool is based on a relative water uptake volume (RWUV, ratio between daily water uptake volume and daily irrigation volume) criterion. The computations of the diurnal patterns of the water uptake rates and the daily RWUV for a given irrigation scenario require additional information on the diurnal pattern of the plant resistance to water uptake and on the hydraulic conductivity of the soil. DIDAS includes also a module of quasi-steady flow for evaluating the diurnal water uptake patterns that accounts for the diurnal plant resistance and evaporation patterns and serves for fine-tuning of the design and preliminary evaluation of scheduling scenarios. DIDAS was programmed in DELPHI and it runs on any Windows operating system-PC, with no further software requirements. The construction of the drip irrigation scenario is performed via few GUI windows, which contain also a library of the required input parameters, and several best-fitting procedures. The simulated scenario of irrigation scheduling should include a sufficient number of irrigation cycles (larger for clayey as compared to sandy soils) for approaching a quasi-steady periodic pattern. The computed RWURs and RWUVs are displayed graphically and the tabulated output results can be exported to e.g. Windows Excel for further processing. A beta version of the DIDAS freeware package can be downloaded from the web site of the Institute of Soil, Water and Environmental Sciences, ARO (http://www.agri.gov.il/en/units/institutes/6.aspx).

ENZYMATIC DEGRADATION OF PECTIN DURING POSTHARVEST RIPENING*

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Pectins are heterogeneous group of polysaccharides and they are present as the components of cell walls and middle lamella of higher plants. Functionality of pectic polymers is connected with the structure of these polysaccharides. Pectins are a class of polysaccharides, which are rich in galacturonic acid. There are three main fractions of pectin substances classified according to their solubility: water soluble pectin (WSP), chelator soluble pectins (CSP) and diluted alkali soluble pectins (DASP).

Pectinolytic enzymes (pectinases) cause degradation pectins in middle lamella and primary cell walls of plant tissues. Pectinolytic enzymes are classified to the cell-wall modifying enzymes. Their activity is correlated with biochemical processes leading to changes in cell wall structure and composition connected with ripening, leading to a loss of firmness, reducing shelf-life and fruit quality etc. To define the role of cell wall modifying-enzymes in pectin degradation during postharvest ripening of apple fruit and carrot, the activity of β-galactosidase (β-Gal), α-L-arabinofuranosidase (α-Af), polygalacturonase (PG) and pectin methylesterase (PME) was studied. During the whole storage period the activity of α-Af increased both in apple fruit and carrot, whereas the activity of PG and β-Gal increased to the fourth (carrot) or fifth (apple) term of storage and then decreased. The activity of PME persisted at the constant level in carrot and increased during storage in apple fruit.

During postharvest ripening, degradation of DASP was associated with decrease of galacturonan content in this fraction. Homogalacturonan fragments moved to CSP and WSP fractions what resulted in increasing of galacturonic acid content. Enzymatic activity influenced on structure of pectic compounds. Significant decrease of geometrical dimensions of pectin chains as well as separation of their sidechains was observed on topographs registered with atomic force microscope. Changes of FT IR spectra corresponded with structural changes caused by pectinolytic enzymes.

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ON THE TWO SECRET PROPERTIES OF SOIL CAPILLARITY*

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Two phenomena related to soil capillarity seem to have a little bit secret character are presented.

The first one concerns a cylindrical capillary of known radius r and wetting angle θ. According to Laplace equation

$$h_{\max}\rho g = \frac{2\sigma\cos\theta}{r};$$

What will happen if $h = h_{max}/2$? In this case the system is in equilibrium state as well. However the hydrostatic pressure does not equal capillary pressure. As liquid properties (σ, ρ) remain constant the only possibility of equilibrium explanation is a change of wetting angle θ in such a way that the new θ_n and the old θ are related by the equation

$$\cos\theta_n = 0.5 * \cos\theta;$$

If for example θ=0° than θ_n=60° . However wetting angle is determined by 3 inter phase tensions which are constant and θ should be stable. How to explain above disagreement?

The second problem concerns a meniscus created by water in the contact of two soil particles. The meniscus has a shape of a lens characterized by two radii R_1 and R_2 of opposite signs . The capillary pressure P_c related to them can be shown as (Iwata et al., 1997)

$$P_c = \sigma(R_1^{-1} - R_2^{-1});$$

and the force F_c

$$F_c = \pi R_1^2 P_c;$$

Capillary pressure and capillary force are non monotonic function of water amount in the meniscus and can be positive (repulsive) or negative (attractive).

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INFLUENCE OF CATIONS ON NITRATE UPTAKE AND ASSIMILATION OF EXCISED BARLEY LEAVES

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Nutrients uptake and assimilation by seedling is an early indicator of subsequent plant growth and development. This study was conducted to compare the effect of cations type (Ca^{2+},NH_4^+,K^+,Na^+) and it`s concentration on NO_3 uptake and assimilation by excised Barely leaves. The Barley seedling (Hordeum Vulgare L.C.V.U.C 337) were sown in vermiculite (as a medium for growth) in pots, which kept in growth chamber at 25°C .The Tip 10 cm portion of barley leaves excised and placed in small glass vials, containing 10 ml from 3.0, 6.0 and 10 mmol of $Ca(NO_3)_2$, NH_4NO_3,KNO_3 and $NaNO_3$ solutions.

NO_3 uptake were determined by following its depletion from uptake solution that initially contained the same concentration of NO_3 as the induction solution

The data shows that NO_3 uptake increased as a function of increasing external nitrate concentration with all cation types. The highest NO_3 uptake value was recorded with NH_4 cation (4103.23 NO_3/gm leaves). Nitrate uptake following the ascending order of NH_4>K>Na>Ca.

In contrast, Nitrate assimilation decreased with increasing external NO_3 concentration. The highest NO_3 assimilation value recorded with Ca^{2+} (38.89%). NO_3 assimilation following the ascending order of Ca>NH_4>Na>K.

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THE INFLUENCE OF EXTERNAL MECHANICAL INTERACTION ON CELLULAR STRUCTURE OF POTATO TUBER TISSUE

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This paper shows research concerning influence exterior interaction on cellular structure of potato tuber tissue.

The experiments were made In BIA INRA laboratory In Nantes in France. 10 potatoes tubers of several sizes and shapes of Marbel variety were used to the research.

Each tuber was undergone mechanical effects by CHMI technique. The techniques rely on throwing a tuber this same part on hard surface.

As a result of the test there were not outer damages according to the classification made by Baritelle et al., 2000.

Two samples 20 mm thickness and 10 mm diameter of cylinder shape were taken from the outer core and slice of 0.1 mm thickness was cut. The cell structure was observed using the optical macroscopic set BlueBox designed at BIA INRA Nantes (Devaux et al., 2008, Gancarz, 2010). Field of view of 26 mm² were observed with a resolution of 3.6 µm per pixels allowing to visualize around 1500 cells per samples.

The images were analysed using grey level granulometry as image texture analysis (VTA) (Devaux et al., 2008, Gancarz, 2010). The method measures relative changes of gray levels by applying masks of increasing size therefore assessing a grey level granulometric curve for each image that is characteristic of cell size. Research shows that the cellular structure of the outer core tissue of potato's tuber is homogeneous in all its scope and it did not change consequently to outer mechanical influences i.e. damage of tissue did not appear.

Keywords: potato tuber, cellular structure, macroscopy, image analysis.

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MICROSCOPIC AND MACROSCOPIC OBSERVATIONS OF POTATO TUBERS TISSUE CELLULAR STRUCTURE IN THE PLACE OF BLACKSPOT APPEAR

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Abstract: The work show researches of potato tubers tissue cellular structure in the place of blackspot appear.

10 tubers Irys and 10 tubers Irga variety in similar size 4-6 cm faction were used to experiment. They were stored over 6 months. Each tubers was undergone mechanical test by CHMI technique. The techniques rely on throwing a tuber from the constant level this same part in tuber on hard surface in order to receive internal damage. As a result of the test there were issue damages of 7 Irys tubers and 8 Irga tubers as a blackspot according to the classification system made by Baritelle et al., 2000.

A sample about 0.1 mm thickness and 10 mm diameter of the cylinder shape were taken from the potato tissue and microscopic and macroscopic observations were made. The sample was taken from damage place or if damage not appear from the place of outer core near to the point of tuber contact with surface.

In the research of cell structure the laser confocal microscope and optical macroscope set were used (Devaux et al., 2008, Gancarz, 2010).

It was impossible to make a quantitative image analysis of damage tissue structure for receiving images due to lack of visible all cells borders. Consequently only qualitative analysis was made.

In the viciniti of spot there are cells smaller than the scope more distant from that place which spots did not appear. It was shown on microscopic and macroscopic pictures.

As a result of the experiment did not show damages of cell's walls in the scope of tissue damage in the form of blackspot occur. It was observed on microscopic and macroscopic pictures.

Keywords: potato, blackspot, cellular structure, confocal microscopy, macroscopy.

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GRAIN SILO LOADS: EXPERIMENTS AND DEM SIMULATIONS

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The contribution presents the review of results of experimental studies and numerical DEM simulations of loads distribution in model silos selected from several research projects performed by the authors. Experiments on model flat floor silos have been conducted in the Department of Biosystems and Agricultural Engng, Univ. of Kentucky, USA and in the Institute of Agrophysics PAS. The silo loads were investigated for different filling and discharge methods as well as to examine the influence of inserts embedded in the grain.

The filling was found to influence markedly the geometric structure of the assembly observed as distribution of vectors normal to contact points. Centric filling resulted in an assembly of more regular distribution of the normal directions than that generated by sprinkle filling. In the case of centric filling the normal vectors directions concentrated along vertical line and two axes forming a nearly regular hexagonal structure.

The horizontal moment of force exerted on the wall was determined for smooth and corrugated wall model bin during off-center discharge. The moment was found to be the highest for the discharge orifice located at half the radius of the silo floor. Smoother silo wall resulted in a larger asymmetry of load distribution. Non-axial filling of the silo produced asymmetric load distribution. This asymmetry was a result of anisotropy of the bedding of granular material produced by grains rolling along the surface of the cone of natural repose. The asymmetry generated by off-center filling can increase or reduce the asymmetry of load generated by off-center discharge depending on mutual position of filling chute and discharging orifices.

The DEM simulations of off-center filling and discharge of a model silo gave similar results to those of experimental testing. Simulations indicated some minor asymmetry of loads during centric filling and discharge, which increased for off-center filling and off-center discharge. Resultant lateral force exerted on the wall and the bottom corresponded to resultant moment of force.

Internals in the grain bedding were found to change pressure distribution in the silo. Obstructions attached to wall disturbed the load symmetry to the highest degree, but centrally located inserts also influenced pressure distribution significantly. The results of DEM simulations were found in a good qualitative and quantitative agreement with results of laboratory testing.

Close agreement of results of laboratory testing and DEM simulations despite considerably smaller simulated objects (scales 1:4 to 1:24) pointed out to DEM as promising method for investigation of mechanical processes in granular materials.

AREAS OF AGRICULTURAL APPLICABILITY OF BIOSURFACTANTS

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Biosurfactants are amphiphilic compounds synthesized or excreted extracellularly by some living organisms. Owing to the general properties of surfactants, they are soluble in both water and oil due to the presence of hydrophobic and hydrophilic domains in a molecule. In concentrations of surfactants higher than the Critical Micelle Concentration (CMC), they are able to decrease surface and interfacial tension at the interfaces between liquids, solids, and gases and they can also increase solubility, bioavailability, mobility, and subsequent biodegradation of hydrophobic or water-insoluble organic compounds.

Biosurfactants are mainly categorized by their chemical composition to:

- glycolipids;
- liposaccharides;
- lipopeptides;
- fatty acids and neutral lipids;
- phospholipids (Zajic & Seffens, 1984).

The best-known group of biosurfactants are glycolipids, and among them - rhamnolipids synthesized by different *Pseudomonas* species and sophorolipids produced by different species of the yeast *Candida* (formerly *Torulopsis*). Biosurfactants are a possible alternative to classically used surfactants because they are biodegradable, exhibit low toxicity to the natural environment, and are effective at extremely low or high temperatures and pH.

Some biosurfactants can be used in agriculture in the process of enhanced bioremediation of soil, e.g. during removal of hydrocarbons and heavy metals (Mulligan, 2005). They can also replace more toxic classical surfactants that are pesticides components. Due to their amphihilic properties and antimicrobial activity against plant pathogens, several biosurfactants can be involved in production of fertilizers (Sachdev & Cameotra, 2013).

The aim of our work is to present the areas of agricultural applicability of biosurfactants.

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AGROPHYSICAL PARAMETERS OF UKRAINIAN WESTERN POLISSYA LIGHT SOILS AS INITIAL POINT TO PREDICT DEFLATION PROCESSES DYNAMIC

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Due to expansion of winter and spring snow free periods, which are uncommon in Western Polissya area, and due to continuous rainless periods in summer the initial conditions for intense occurrence of deflation processes start to form.

Structureless sandy clay and sandy loam soils relate to the range of soils with light granulometric composition. The sand content (0.05-1 mm) in the surface layer of soil is 85% and more, which is the highest figure among Ukrainian soils (Medvedev, 2008). The adhesion of the local sod-podzol soil types with various grade of podzolization and glaying constitute 20-40% and adhesion of artificial soil block (lab test) equals 15% (Medvedev & Laktionova, 2011).

Deflationary dangerous grading fractions, moving as a part of air-dust flow, which results from saltation, pose a threat acting as a driving force that dislocates surface layer of peat soils, incorporating them into process.

Researches conducted during 2008-2012 have verified the facts of deflation processes expansion, on elevated terrain elements in particular (approx. 115-120 m above sea level). The basic agrophysic parameters for diagnostics were: content of elementary soil particles (ESP) (Bulygin et al., 2000), adhesion of artificial soil block, crumbly condition (1 mm), content of agronomically valuable aggregates (10 mm) (Koliada, 2012).

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PHYSICOCHEMICAL PROPERTIES OF SODIUM ALGINATE MICROCAPSULES

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Most large brown seaweeds are potential sources of alginates. The properties of alginates vary from one species to another, as they differ characteristically from each other in the relative proportions (G ratios) of two constituent sugar acids as well as in their sequences within the polymer chain. Alginates can be used for production of microcapsules.

Due to their structure and properties, microcapsules are now widely used in many industries. They can contain valuable components protecting them from degradation caused by environmental factors or technology, such as pressure, temperature, and oxidizing agents (ferrous, copper).

The aim of this study was to characterize the stability of alginate capsules and to determine the chemical properties of the materials that they are made from.

For the investigations, two types of sodium alginate (G39 and G63) and calcium chloride were used. The study included measurements of deformation of alginate capsules and measurements of surface tension in alginates used for manufacture of capsules.

The level of deformation of alginate capsules made of alginate G63 is lower than in the case of alginate G39, because alginate G63 has a larger number of cluster structure domains that are organized by a greater amount of Ca^{2+} ions. These are responsible for the gelation process. For this reason, calcium alginate membranes made of alginate G63 are stronger and stiffer. Alginate solutions show surface-active properties, because surface tension decreases with time. The measurements show that there is a larger decrease in surface tension for higher alginate concentrations.

Conclusions:

- The studies have shown that alginate capsules made of alginate G63 formed structures with higher resistance.
- The investigations have shown that the sodium alginates have surface-active properties. This is probably due to the presence of naturally occurring bacteria in algae from which alginates are produced.

MODELLING SOIL WATER DYNAMICS USING THE PHYSICAL AND SOFT-COMPUTING METHODS*

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Two models, one physically based (HYDRUS-1D) and the other being soft-computing technique (v-SVM (Supporting Vector Machine)), has been used to create a long-term daily prediction of soil water content at different depths of soil. This prediction is an important issue in terms of improving agricultural water management, particularly in regions where soil needs to be irrigated, as it may help to ensure proper vegetation conditions and serve as a method that will increase the efficiency of crop production. To compare obtained results to measured data, experimental field station on premises of the Institute of Agrophysics in Lublin was established. Soil moisture has been measured using TDR sensors.

The used models provide quite accurate results for soil moisture content, especially in the most important layers for the processes of crop growth - those close to the surface. The root mean squared error (RMSE) of estimations of volumetric soil water content in topsoil made by the SVM based model was 0.0353 cm^3/cm^3, 0.0304 cm^3/cm^3 and 0.0209 cm^3/cm^3 for depths of 5, 10 and 25 cm, respectively, while the physically based model had RMSE values of 0.0423 cm^3/cm^3, 0.0490 cm^3/cm^3 and 0.0451 cm^3/cm^3 for the same depths. Our results show that the v-SVM modeling approach can be used for estimations of soil water content changes in time in the same way as physically valid models are used, with comparable accuracy of predictions.

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SPATIO-TEMPORAL BIOSPECKLE IMAGING AS A TOOL FOR VISUALIZATION OF PLANT TISSUE DAMAGE

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Coherent light, backscattered from biological objects, forms in an observation plane variable in time and space speckle patterns, termed biospeckle. Biospeckle is observed only for biological materials and is a result of the micro-movement of internal elements of a biological object. Given that the biospeckle activity observed on living tissue is largely the result of biological processes, it is reasonable to use the biospeckle phenomenon in the study of the specific parameters of living organisms. At present, biospeckle is studied as a potential tool in plant biology and agriculture, e.g.: in non-destructive evaluation of viability of seeds (Sendra et al., 2005), analysis of maturation and bruising of fruits and vegetables (Rabelo et al., 2005) and monitoring of apple shelf life (Zdunek et al., 2007). Group of methods used to qualitative evaluation the biospeckle activity are spatial analysis, as Fuji (Fujii et al., 1985) or Laser Speckle Contras Analysis LASCA (Briers & Webster, 1996), which allow for creation of maps of the biospeckle activity of the whole visible area of the organ (e.g. leaf or fruit). During the experiments, it was noted the possibility of using of spatial biospeckle analysis for early detection and visualization of mechanical defects and fungal infections of fruits as well as deteriorating health of plants.

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SOIL MOISTURE IN POLAND – SATELLITE AND GROUND OBSERVATIONS*

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Water circulation between oceans, atmosphere and land is one of the most important processes occurring on the Earth and a crucial component of the weather and climate. Evaporation, transpiration and runoff of water are driven by the surface soil moisture, while soil moisture in the vadose zone governs the rate of water uptake by vegetation. Sufficient amount of water in soil is one of the most important factors determining effective crop production. Soil moisture is the key factor in the Earths hydrological cycle, so soil moisture datasets of good quality at various scales are needed for sustainable land and water management. Soil Moisture and Ocean Salinity (SMOS) satellite, launched in Nov. 2009 by the European Space Agency (ESA), operates in the passive L-band microwave (f=1.4 GHz), which is preferred frequency for soil moisture retrieval (Wagner et al., 2007). This satellite provides global map of surface soil moisture every 3 days with 40 km resolution (Kerr et al., 2012). The data are coherent, but need to be validated using ground measurements. This was done with an aid of soil moisture time series, obtained from SWEX_POLAND network of ground monitoring stations, maintained by Institute of Agrophysics Polish Academy of Sciences. It was shown that the SMOS satellite measurements are reliable and can be used to detect areas of frozen, dry and moist soil. In Poland the trends indicating the growth of droughts are depicted by SMOS very well, even better than national drought services for the agriculture. Moreover, the examined SMOS data prove the well-known property of central Poland to be drier than the rest of the country.

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APPLICATION OF BIOSPECKLES FOR ASSESSMENT PROCESS IN SKELETAL MUSCLES

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Laser illumination of biological objects can cause complex physical and chemical processes in cells through light absorption, scattering and reflection on the surface and subsurface layers. Light interaction with cell membranes leads to their size changes, motion of cytoplasm, organelles etc. The dynamic laser speckles (biospeckles) field is formed as a result of this interaction.

To assess of physical and chemical processes in skeletal muscles, an experimental setup that captures digital images of dynamic biospeckle fields was developed. The setup was utilized to establish the quantitative relationships between the degradation processes in the skeletal muscle and biospeckle dynamics by means of periodic registration and processing of speckle patterns of the sample surfaces that have been stored in the refrigerator for several days. We used the digital images to calculate the sequence values of correlation coefficients $C_{m,n}^{k+l}$ (Frankevych et al., 2005), where m,n is the number of square image fragment; k is a number of the first speckle image; *k+l* is the number of following speckle image.

Fulfilled analysis of the time dependencies $C_{m,n}^{k+l}$ allowed us to set a number of the specific parameters and introduce the coefficient of biospeckle activity (CBA) as a quantitative indicator of the overall activity of the physical and chemical processes in the skeletal muscle.

The average CAB values for two samples of pork skeletal muscle, which was stored for several days at +4°C were calculated for different laser light polarization and skeletal muscles fiber orientation. The results of experimental research have shown that physical and chemical ageing processes in skeletal muscle lead to decrease the CBA averaging value and strongly depend on the storage duration.

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CONCEPT AND TECHNOLOGY FOR OPTIMIZATION SOIL PHYSICAL PARAMETERS OF ARABLE LAYER FOR FIELD CROPS

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The concept and technology for optimization of physical parameters of the arable layer taking into account variability of field crops requirements to them at different stages of plant development has been proposed. According to this concept, plants contact with the soil in the form of seeds and vegetating plants. Each of these forms requires different soil physical conditions. In order to obtain seedlings dense soil physical condition is preferable. For further development of the growing plants and formation of their maximum productivity a more loose soil composition is optimal. It is difficult and, sometimes, impossible to meet at the same time the requirements of seeds and plants in the process of seedbed preparation.

The developed technology involves sowing into the initially dense soil (direct drilling is possible) with its further loosening at the whole depth of the arable layer, after seed germination before the emergence of sprouts. For some crops such loosening is acceptable after the emergence of sprouts. Consequently, the plants requirements are met in the most optimal way during the whole development period: dense soil at the starting period and loose soil – during the whole following period of vegetation.

The field experiments accomplished during long period from 1986 up to 2012 year on soddy-podzolic sandy loam, grey forest light loam, chernozem soils with potatoes corn, oat and it mixtures with legumes, soybeans, horse beans, winter wheat.

The characteristic feature of the proposed technology is to purposefully make the soil cloddy and cracked at a considerable length (from 16-18 cm to 38-40 cm) in the process of cultivation.

The major positive factor for optimization of soil conditions for plant development is a significant improvement of their water supply due to the creation of conditions for high level of water permeability through the system of artificial cracks in the arable layer.

During 9 years of field experiments the given technology provided for the 20 mm higher accessible water content in the 1-meter soil layer in the average during the vegetation period compared to the conventional technology.

Depending on the type of the soil and the weather conditions the rise in productivity of field crops from 9-11% to up to 2.4 times is observed. The highest positive results are observed in soils with low structure and in the extremely droughty conditions.

The need for development of methods and instruments of studying cracky soil structure for further development of soil cultivation theory and practice is expressed.

MATHEMATICAL MODEL FOR ANALYSING THE EXTENSOGRAPH CURVE SHAPE

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The Brabender extensograph have a notable significance in testing of the baking quality of wheat flour and of various additions enhancing the sensory and health properties of bakery products. Results of this testing are read directly from the diagram of the extensograph curve which represents changes in the resistance of the dough to extension (R) as a function of the extension distance (x). The height and span of the curve are graphical measures of the maximum resistance (Rm) and extensibility (EXT) of the dough, respectively. To make possible more detailed analysis of the shape of extensograph curves, a seven-parameter regression model was developed:

$$R(x)= R_m\cdot(1-(a-b\cdot x/EXT)\cdot(c-x/EXT)^2-R_I\cdot\exp(-x/(EXT\cdot D_I))$$
$$-R_F\cdot\exp((-1+x/EXT)/D_F)),$$

where a, b, c, R_I, D_I, R_F and D_F are the model parameters. The degree of fit of the model to the experimental data (R^2) placed within the range from 0.995 to 0.999. Curves $R(x)$ can also be transformed to the normalized form $R(x/EXT)/R_m$, facilitating the comparison of shapes of extensograph curves.

The developed model permits division of extensograph resistance of the dough into three components: initial resistance (RI and DI), parabolic resistance (a, b and c) and final resistance (R_F and D_F). They reflect the varying rheological behaviours of dough in the course of its extension. The behaviours can be defined as follows: linear viscoelasticity, strain hardening and fracture properties.

The research conducted on supplementation of wheat dough with carob fibre and oat wholemeal showed the strongest variation of the model parameters describing the slope (a) and deflection (b) of parabolic arms of the extensograph curve and the position of its peak (c), while the parameters R_F and D_F showing final course of the curve were subject to only slight changes. The reactivity of the fibre additions during dough proving had a much stronger effect on the model parameters than on the variation of the standard indices R_m and EXT. The results indicate that the proposed model can be a useful tool for improving the analysis of extensional behaviours of bread dough.

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EQUIVALENT CIRCUITS FOR MODELLING PHYSICOCHEMICAL PROPERTIES OF LOW-CONCENTRATED AQUEOUS SOLUTIONS OF COMMON FOOD PRESERVATIVES*

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Determining the artificial preservatives content of foods and other natural products plays a vital role in checking their quality. Due to low concentrations of the additives in liquid materials under consideration, the applied techniques ought to deal with highly diluted solutions. Furthermore, their effectiveness requires carrying out quick and non-destructive analyses. Impedance spectroscopy (IS) measurements at low frequencies fulfil the above requirements. For this reason they are expected to provide valuable information in an efficient way.

The result of an IS measurement is the impedance of the examined probe as a function of frequency of an applied voltage (Barsoukov & Macdonald, 2005). The measuring system consists of a sensor made from acid resistant steel connected to the LCR Agilent E4980A meter and immersed in a low-concentrated solution of a particular food preservative. The readings are taken at 25.0±0.1°C within the frequency range of 20 Hz - 2 MHz.

An initial step in analysing the obtained data is the construction of an equivalent electrical circuit (EEC), whose impedance spectrum reproduces the one obtained during the IS measurements of an investigated sample (Harrington & van den Driessche, 2011). A sequence of attempts to adjust an appropriate EEC for low-concentrated aqueous solutions of selected chemical compounds used for food preservation will be presented. The chosen optimal version of EEC shall serve for future investigations focused on determination of types and estimation of an amount of artificial additives in natural products.

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STUDY ON NUMERICAL MODELLING OF PLANT TISSUE USING THE FINITE ELEMENT METHOD

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The goal of this research was to create a computational model that incorporates micro-scale geometrical features of plant tissue, and which will provide qualitative and quantitative predictions of mechanical properties. The finite element method was chosen for mathematical modeling due to its computational efficiency, flexibility and ability to incorporate histological features of tissue at microscale. The proposed technique of simulation of micromechanical cellular systems was demonstrated on case study of onion (Allium cepa L.) upper epidermis. Onion epidermis was chosen due to its simple single-layer structure, the lack of intercellular spaces and ease of sample preparation. The geometry of the FEM model was created on basis of images obtained using a confocal scanning laser microscope CSLM (OLYMPUS FluoView300, Olympus Corporation, Tokyo, Japan). The geometrical features of onion tissue were reconstructed in FEM environment by means of vectorization procedure. Then, uniaxial tensile test were carried out to determine the mechanical parameters of tissue samples. Mechanical testing was carried out up to 50% of strain with a deformation speed of 1.5 mm/min. During mechanical test the tensile force and elongation of the sample were recorded. Both values were converted into stress and strain respectively.

The uniaxial tensile tests were simulated in FEM environment using created virtual models of onion epidermis. The qualitative validation was based on the comparison of the force-strain curves from laboratory tensile test and the simulations. On the basis of calculated mechanical parameters we were able to provide a qualitative and quantitative validation of FEM models. The values of cell wall mechanical properties from the experiments were compared with those from FEM models that gave the best fit of the force deformation curves.

The developed model showed good qualitative and quantitative agreement with experimental results. The curves obtained through simulation preserved all the key characteristics of the real object. The FEM model was able to predict mechanical properties of cell wall with average estimation error of 15%.

PENMAN-MONTEITH APPROACHES FOR ESTIMATING CROP EVAPOTRANSPIRATION IN SCREENHOUSES - A CASE STUDY FOR TABLE-GRAPE

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In arid and semi-arid regions many crops are grown under screens or in screenhouses to protect them from excessive radiation, strong winds, hailstorms and insects, and to reduce crop water requirements. Screens modify the crop microclimate, which means that it is necessary to accurately estimate crop water use under screens in order to improve the irrigation management and thereby increase water-use efficiency. The goal of the present study was to develop a set of calibrated relationships between inside and outside climatic variables, which would enable growers to predict crop water use under screens, based on standard external meteorological measurements and evapotranspiration (ET) models. Experiments were carried out in a table-grape vineyard in the Jordan Valley region of eastern Israel, which was covered with a transparent screen that provided 10% shading. An eddy covariance system was deployed in the middle of the vineyard and meteorological variables were measured inside and outside the screenhouse. Two ET models were evaluated: a classical Penman-Monteith model (PM) and a Penman-Monteith model modified for screenhouse conditions by the inclusion of an additional boundary-layer resistance (PMsc). Energy-balance closure analysis, presented as a linear relation between half-hourly values of available and consumed energy (1344 data points), yielded the regression $Y = 1.05X - 9.93$ (W m^{-2}), in which Y = sum of latent and sensible heat fluxes, and X = net radiation minus soil heat flux, with $R^2 = 0.81$. To compensate for overestimation of the eddy fluxes, ET was corrected by forcing the energy balance closure. Average daily ET under the screen was 5.4 ± 0.54 mm d^{-1}, in general agreement with the model estimates and the applied irrigation. The results showed that measured ET under the screen was, on average, 34% lower than that estimated outside, indicating significant potential water saving through screening irrigated vineyards. The PM model was somewhat more accurate than the PMsc for estimating ET under the screen. A model sensitivity analysis illustrates how changes in certain climatic conditions or screen properties would affect the evapotranspiration.

EXPERIMENTAL STUDIES OF DIRECT N_2O EMISSIONS FROM AGRICULTURAL SOILS IN NORTH-WESTERN AND CENTRAL REGIONS OF RUSSIA

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Field measurements of direct N_2O emissions from agricultural soils in North-Western and Central regions of Russia have been carried out during the last 10 years (2003-2012) to: i) make the inventory of N_2O emissions from soils; ii) study the effects of soil tillage, incorporation of different N-fertilizers as well as organic and green manures, cow grazing, different crops growing on N_2O emissions from soils. Gas samples were taken during growing seasons by a closed chamber method. All the gas measurements were done with a gas chromatograph fitted with an electron capture detector. Air and soil temperatures were measured on each gas-sampling occasion and daily maximum and minimum air temperatures, and rainfalls are recorded. Besides, soil samples were collected to measure pH, bulk density and total porosity, water content, mineral N in the laboratory conditions.

Strong correlations of N_2O emission to amounts of nitrates during each growing season were mainly distinguished. N_2O fluxes from soils containing less than 10 mg N per kg^{-1} soil were newer high even if other soil parameters were favorable for nitrification and denitrification. The soils with high amount of available soil organic carbon (SOC) were emitting more N_2O than the soil with the low SOC content, especially in wet growing seasons. In dry years N_2O fluxes very often were low even from soils with high mineral nitrogen and available SOC content. Soils under crops grown on ridges almost always emitted more N_2O than the soils of the flat beds. The highest N_2O cumulative fluxes from pastures were measured from the areas with high grazing impact. In terms of N_2O emission, shallow tine cultivation to 6-8 cm combined with deep ploughing to 28-30 cm once in 5 years was the best tillage systems from an agro-ecological point of view.

Recent studies of N_2O emissions are induced by the interest of the world in the sequestration of carbon and nitrogen in soils by converting organic materials into biochar. Application of biochar to soils has many advantages including a reduction in greenhouse gas emissions from soils. The laboratory experiment in 2011 and small-scale field experiment during the growing season of 2012 were conducted on a loamy-sand Spodosol with different soil fertility to evaluate the effect of wood-derived biochar on N_2O emission. The results have shown that application of biochar to the soils resulted in significant decrease of N_2O emission from the soil with a high fertility and did not result in any increase of N_2O emission from the soil with low fertility.

The accumulated information on direct greenhouse gas emissions from soils is being used to validate the DNDC model to predict N_2O dynamics in future seasons.

EVAPOTRANSPIRATION FROM STONY SOILS: WHAT ARE THE DIFFERENCES BETWEEN HOMOGENEOUS AND STONY SOILS?

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Soils containing considerable amounts of rock fragments (solid particles withdiameters ≥ 2 mm) could be characterized by limited soil water retention capacity.

As a consequence smaller amount of infiltrating water is needed for increase in volumetric soil water content and related unsaturated hydraulic conductivity in such soils. This work presents the results of the comprehensive modeling study focused on the influence of rock fragments (quantitatively expressed by stoniness) on soil water dynamics and evapotranspiration. For the purpose of this study effective saturated hydraulic conductivity of stony soil was estimated using the HYDRUS-2D numerical approach (Novák et al., 2011). Furthermore, water retention curve of stony soil was reshaped using the method presented by Bouwer & Rice (1984). Obtained effective hydrophysical characteristics were used in HYDRUS 1D model. Daily amounts of potential and actual evapotraspiration were calculated for maize crop grown in hypothetical soils with different relative stoniness (0-40%).

Based on the obtained results a relationship between plant water stress and different relative stoniness was evaluated.

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NEW OPPORTUNITIES OF SOIL SPLASH MEASUREMENTS USING A COMBINATION OF IMAGE ANALYSIS AND THE SINGLE WATER DROP IMPACT METHOD

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Splash is the first stage of soil water erosion. Splash erosion can be characterised as two sub-processes: detachment of the particle from the soil surface and transport of these particles in random directions. Splash experiments may be performed either in laboratory or field conditions. A vast majority of investigations are carried out in laboratories, where various types of droplet formation systems or rainfall simulators are used for producing water drops.

Existing measurement methods are mainly based on the analysis of the soil mass that was displaced by the splash. The mass of soil transferred by a single droplet, however, is so small that it is not measurable, even by a very sensitive balance. Thus, in previous studies it was not possible to measure the splash caused by one drop.

Development of the measurement methodology and using an optical microscope to analyse the splash marks appearing on the ground as a result of the transfer of soil material by a single drop of simulated precipitation gave new opportunities to describe the initial phase of water erosion, i.e. the splash (Ryżak & Bieganowski, 2012).

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PROTOTYPE OF A MINIATURE SOIL TENSIOMETER*

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The research objective was to determine the suitability of a prototype miniature soil tensiometer in laboratory and field measurements of soils that have various mechanical composition, density and moisture. The motivation was to construct a simple to use, inexpensive to manufacture, intelligent sensor, which converts the analog non-electric quantity to digital electrical signal for further processing by the user. The design and construction of a prototype miniature soil tensiometer required the selection of the ceramic cup, pressure sensor, designing and building the electronic interface, hydraulically sealed, reliable and low-cost enclosure, and developing procedures for removing air from the hydraulic system of the prototype tensiometer.

Testing of the prototype has shown that the working pressure range is from zero for saturated soils to below -900 mbar for dry soils and the measuring system is functioning properly throughout the full operating range with repeating soil watering and drying. The applied pressure sensor, despite the high accuracy and repeatability of measurements, was not verified positively. It proved to be unstable and undergo damage during the procedure multiple removal of air from the system. Long-term tests have shown the need for a stable, preferably stainless-steel diaphragm, which unfortunately can lead to a significant increase in the cost of the prototype.

Adaptation of a Luer-lock, the commonly used tight hydraulic connection in medical equipment, increased the convenience and reliability of removing air from the system. These connections together with a polycarbonate housing, in place of the stainless steel case, resulted in reduced construction costs of the prototype tensiometer. Future work on the prototype will focus on the selection and testing a new pressure sensor.

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REFERENCE MATERIALS IN AGROPHYSICAL BROADBAND DIELECTRIC SPECTROSCOPY*

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Minimization of systematic measurement errors in indirect measurements requires calibrations to find the parameters of the measurement function and to make necessary corrections of imperfect instrumentation. The calibration measurements are done on reference materials of known and traceable characteristics.

Presented are the reference materials used in agrophysical broadband dielectric spectroscopy, i.e. time domain and frequency domain reflectometry techniques (TDR and FDR) for minimization of systematic measurement errors. It was found that apart from air, also liquids (water, benzene, methanol, ethanol, acetone and NaCl solutions) are the most convenient reference materials (Kaatze, 2007). They provide the best homogeneity and contact with the applied sensors. Also, pure liquids with traceable parameters are easy available and they are not expensive. Granular materials such as glass beads, plastic beads or plastic pellets can be successively used, especially in grain moisture meters. These reference granular materials are characterized by small frequency change of dielectric constant and negligible tangent loss in broad frequency range (Funk and Gillay, 2010). It was reported that the variability range of the measured quantity should be close to the measurement range of the applied reference materials used for the instrument calibration or parameterization of the measurement function (Skierucha et al., 2008).

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EXPERIMENT AND DEM MODELLING OF POWDER SLIP-STICK EFFECT

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Parameters of internal friction and flow properties of powders influence handling and processing operations such as flow from silos and hoppers, transportation, mixing, compaction or packaging. With increasing scale of industrial operations, there is a growing demand for information about food powder parameters to design reliable processes and efficient equipment. Slip-stick effect may be observed in spring-mass mechanical systems with frictional damping as undesirable vibrations of the system. The phenomenon poses specific difficulties for characterization of biological-based granular materials using direct shear test.

In presented project slip-stick effect was analyzed in direct shear tester and DEM modelling. Numerical simulations of the direct shear test was performed by discrete element (DEM) using the software of DEM Solutions EDEM and a free implementation of the DEM LIGGGHTS. The non-linear Hertz-Mindlin contact model for cohesive particles was applied. The results of simulations performed using EDEM software were in good agreement with the experimental data till the relative displacement of the cylinder was lower than 4%. In the next stage of shearing value of shear stress decreased in simulations while in laboratory tests shear stress was in constant level. No oscillation effect was observed in numerical tests probably due to higher speed of shearing.

Analysis of results obtained in the tests performed using the LIGGGHTS software shown qualitative agreement of numerical shear stresses with the experimental data in the first phase of the shearing, when the increase of stress was observed. After the stress reached the maximum, it decreased sharply in simulations that was not observed in the experimental tests. In the last stage of shearing, both experimental and the numerical shear stresses established in the constant level. The slip-stick effect observed in experimental tests was found during numerical shear test performed using LIGGGHTS software.

CHANGES OF CELL WALL MATERIAL COMPOSITION DURING APPLE DEVELOPMENT*

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Plant cell walls and their constitutive polysaccharides networks are vital with regards to plant organ mechanical properties like stiffness or strength. Concentrations of each constituent vary according to the origin of plants, organs and tissue. Also, amount and structure of cell wall non-cellulosic polysaccharides (pectins, hemicelluloses) changing during development and ripening and further during senescence of fruit. During development and ripening changes of cell wall properties are result of compounds synthesis, whereas during postharvest rather dominates degradation, i.e. opposite effect.

The two cultivars of apples (*Malus domestica* cv. Ligol and Szampion) harvested at 8 development stages were studied. At each stage of development the cell wall material was extracted. Additionally, standard tests of apple maturity were conducted at the each stage of development. The compositional changes of apple cell walls were investigated in terms of both chemical analysis and infrared spectroscopy.

The infrared spectroscopy combined with Fourier transform (FT-IR) was used to evaluate differences among cell wall materials during developments. Additionally, characterization of pectic substances was identified by automated wet chemical analyzer. The yield of hemicelluloses and cellulose was identified by method of van Soest (Van Soest et al. 1991). The changes in amount of hemicelluloses, cellulose and pectins were observed for both cultivars.

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IMPEDANCE SPECTROSCOPY MEASUREMENTS OF LIQUID MATERIALS – SAMPLE AGROPHYSICAL IMPLEMENTATION*

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Dielectric spectroscopy (DS), which allows determination of the frequency spectrum of complex dielectric permittivity of tested objects, is an acknowledged measurement technique with a wide range of applications in agrophysics, including soil moisture and salinity determination (Wilczek et al., 2012) and quality assessment and control of various agricultural materials and food products (Nelson, 2005). For the frequencies below several MHz, in the case of conductive liquid materials, the electrical conductivity and the electrical double layer forming on the surfaces of the electrodes may significantly influence the test results and cannot be ignored. The impedance spectroscopy (IS), commonly used in the field of electrochemistry, measures the frequency spectrum of the impedance of an examined material filling a test unit (Barsoukov & Macdonald, 2005). Through the electrical equivalent circuit (EEC) approach, IS allows separating various influencing factors and studying the chosen phenomena independently of others, thus facilitating the analysis and interpretation of the obtained results.

An experimental system designed for the IS measurement of liquid materials in the frequency range of 20 Hz – 2 MHz is described in the presentation. The tested materials include aqueous solutions of various salts and common food additives. The EEC parameters obtained for different solutions are compared. The influence of the electrode surface properties of the applied sensor on the impedance of the system is also discussed. Obtained results suggest several possible applications of IS for the quality determination of food products.

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INCREASING IMPORTANCE OF THE WATER STORAGE FUNCTION OF SOILS UNDER CHANGING CLIMATE

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The risk of extreme meteorological and hydrological events will be increasing in the future with their unfavourable economical/ecological/social consequences.

Under such conditions it is an important fact that soil is the largest potential natural water reservoir (water storage capacity) in the lowland parts of the Carpathian Basin. The 0-100 cm soil layer potentially may store more than half of the average annual 500-600 mm precipitation. This is quite contrary with the high and increasing hazard, frequency and duration of extreme hydrological events, sometimes in the same place, in the same year.

The main reason of the "large water storage capacity" – "extreme moisture situation" contradiction is that the potential water storage capacity is not (or only partly) utilized because the pore space is already saturated with water as a consequence of previous infiltration („filled bottle effect"); the upper part of the soil is frozen, so that it is not permeable for melt water or winter rains („frozen bottle effect"); there is an impermeable or slowly permeable layer either on or near the surface, which prevents infiltration („closed bottle effect"); or the water filtrates through the soil profile and is not stored in it because of low water retention („leaking bottle effect").

Consequently, the basic aim of any moisture control measure is to help infiltration into the soil; and to increase water storage within the soil in plant-available form.

On the basis of our comprehensive digital soil physical/hydrophysical database these characteristics can be quantitatively interpreted for soil layers, soil profiles; physical-geographical, administrative, farming or mapping units. The database serves as a basis for the evaluation of water storage capacity of soil; the waterlogging or over-moistening hazard and drought sensitivity; and so gives a scientific basis for rational regional or local water management activities: for the efficient use of soil as water reservoir, reducing the risk and frequency of extreme hydrological events and moisture situations; and preventing or at least moderating their unfavourable economical/ecological/environmental/social consequences.

STUDY OF VEGETABLE OIL THERMOHYSICAL PROPERTIES

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The present work deals with thermophysical properties of vegetable oil – thermal conductivity, thermal diffussivity and specific heat (volume heat capacity). The brief characterization of investigated material is presented – chemical composition and physical characterization. Comparative study of vegetable oil (sunflower, rapeseed…) thermophysical properties and the effect of temperature on thermophysical properties are introduced. Information on thermal effects in the sample subjected to temperature programme is provided by differential scanning calorimetry; the specific heat and changes in the specific heat is measured as well. Study of thermal stability and decomposition behaviour of oil by thermogravimetric analysis is introduced.

HYDRO-PEDOTRANSFER FUNCTIONS FOR PREDICTING ANNUAL CAPILLARY RISE AND ACTUAL EVAPOTRANSPIRATION ON A REGIONAL SCALE

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New hydro-pedotransfer functions for grassland are presented to calculate both annual capillary rise from the groundwater into the root zone and actual evapotranspiration for regional water balances.

The functions i.e. the procedure has two advantages. Firstly, only easily available site information is necessary for the calculation, such as the soil texture class, groundwater depth, summer rainfall and potential evapotranspiration (ET pot) according the FAO guideline. Secondly, we follow the principle dea to define the gain (G) of actual evapotranspiration (ET act) caused by capillary rise from groundwater as an effective parameter to express both, the soil and climate dependent effective capillary rise for a given site. In order to definea reference, we used the actual evapotranspirationof a site without groundwater influence but with same soil hydraulic properties and climate conditions.

In order to predict G without using the numerical model, a new hydro-pedotransfer concept was developed and tested for several regions in Germany, Europe.

EFFECT OF COHESION ON THE MECHANICAL PROPERTIES OF POLYDISPERSE GRANULAR BEDDINGS

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The large-scale application and processing of granular materials in agriculture and many branches of industry requires improved insight into the complex nature of particulate assemblies. The majority of particle packings involved in industrial and natural processes is composed of cohesive particles where cohesion determines its geometrical and micromechanical properties. Packing structure strongly affects mechanical response of granular material to external loads during shearing (Voivret et al., 2007), compaction (Bentham et al., 2007) and other modes of deformation. Microstructure characterization of particulate media, critical to understand and predict macroscopic properties of granular systems, still remain in early stage of development.

The threedimensional discrete element simulations have been carried out for polydisperse packings of frictional cohesionless and cohesive spheres to study the influence of cohesion on micro and macromechanical response of block shaped specimen under uniaxial compression. The simplified non-linear Hertz-Mindlin contact model was applied in simulations conducted using the EDEM software. The normal particle size distribution with standard deviation of particle mean diameter (*SD*) ranging from 0% to 80% was tested.

The detailed analyses of microstructure of particulate assemblies included inter alia the void fraction, number of contacts and contact forces while macroscopic study included the effective elastic modulus, pressure ratio and Poisson's ratio.

The cohesive force resulted in increase in stiffness of particle packings and nearly twofold increase in average values of ratios between tangential and normal contact forces. The high oscillations of the effective elastic modulus were observed in cohesive granular beddings, which was due to the slip-stick effect.

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DIELECTRIC PERMITTIVITY OF LIQUIDS DETERMINED BY A PROTOTYPE TRANSMISSION PROBE*

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Dielectric properties of materials are closely related with their molecular composition. Spectra of the complex dielectric permittivity of these materials carry information about interfacial phenomena. Measurement of these spectra is one of the methods for rapid evaluation of parameters associated with the content of water and other substances.

During the presentation, frequency domain transmission method FDT (Kuek 2012) will be shown. The aim of this project was to build a prototype sensor for measurements of attenuation of sinusoidal signal transmission in the frequency range 1 MHz – 8 GHz in a certain volume of material. For this purpose, a pair of unipole coupled antennas was built. This sensor also allows to measure reflected signals (FDR – frequency domain reflectometry). The measurements were performed for liquids with known parameters characterized by the Cole-Cole model. The results allow to observe the independence of the reflected and transmitted signals, which gives possibility to make a separate correlation analysis for these two cases.

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ABSTRACTS OF POSTERS

NESTING OF BLACK STORK *CICONIA NIGRA* IN „LASY JANOWSKIE" LANDSCAPE PARK

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Analysis of landscape structure in the immediate vicinity of nests occupied by black storks in the "Janowskie Forests" Landscape Park was carried out. Ten nests with known hatching success (measured by the number of fledglings per nest) for the period of 2005-2008 were used in the study. The analysis was conducted for square areas, so-called landscape windows, with surface areas of 1 km^2, 4 km^2 and 16 km^2, with a nest situated at the central point of each window. The smallest window size (1 km^2) represents the partial protection zone for black stork, designated within a radius of 500 m. In total, 47 areas were characterised in the direction of estimation of tree species dominating in the forest stand, the age structure of the forest stands, and the structure of forest habitats. The landscape studies were based on created text maps, analysed in the program Fragstats 3.3 in terms of selected indicators. For the landscape elements analysed the Jacobs habitat selectivity index was also calculated.

In the "Janowskie Forests" Landscape Park black storks chose areas in the closest vicinity of forest stands with a domination of fir (D=0.7), mixed forest habitats BMśw+BMw (on an area of 1 km^2 D=0.66), and forest stands aged over 90 years.

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NAPL-CONDUCTIVITY OF CPC TREATED SOIL SAMPLES*

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Models (e.g. HSSM - Weaver et al., 1994) describing the transport of hydrocarbon spills require the oil conductivity of the given layer as an input parameter. Remediation of oil contaminated soils can be carried out with surfactants (e.g. Lowe et al., 1999; McGray et al., 2001).

In this investigation we examined nonaqueous phase liquid (NAPL) conductivity of four Hungarian forest soils. The samples were treated with a cationic surfactant, cetylpyridinium chloride (CPC) with static equilibrium experiments (Földényi et al., 2013). During the treatment at least one monomolecular surfactant layer on surface of soil particles was achieved with the soil becoming hydrophobic. To determine the oil conductivity Dunasol 180/200 was used, which is a distillation product (MOL Plc., Duna Refinery, Százhalombatta). The conductivity measurements were carried out after saturation in a closed system permeameter (Eijkelkamp) using the falling head method. According to our results oil conductivity was reduced caused by the surfactant treatment.

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INFLUENCE OF IRON IONS ON STABILITY OF HUMIC ACIDS SOLUTIONS*

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Properties and behavior of humic acids in soil environment are depended on many factors. Equilibrium between mobile, soluble forms and precipitated ones is determined among others by pH, ionic strength, temperature as well as by interactions with others compounds, especially with multivalence metals cations. One of the most important microelement of organic soils is iron. This element is commonly presented in soils but it also plays significant role for proper growth of plants. Chemical properties of iron cause that it has high affinity to humic acid – one of the most important soil organic compounds. In the consequence, knowledge of conditions and mechanisms of interactions: humic acids-iron is important not only from chemical side but also from ecological and agriculture point of view.

In connection with the above, main purpose of this work was to study interactions between iron ions and humic acids. Humic acids were extracted from peat-muck soils. Solutions prepared to the studies, contained constant concentration of humic acids 40 mg/dm^3 and increasing concentrations of iron from 0 to 40 mg/dm^3. Investigations were conducted at pH 5. Observations were performed by absorbance measurements as well as by determination of iron content stayed in the liquid phase. Results showed that isolated humic acids were stable in solution at low ranges of added iron concentration. However, studies presented also that at some concentration of metal, suddenly increasing of absorbance taken place. It was an evidence of coagulation starting. After this point, absorbance decreasing was observed and it said about coagulation ending and transition of humic acids to the precipitation. Simultaneously, measurement of metal content in the liquid phase showed not complete transfer of iron to the humic acid precipitation. It could be an evidence on presence of two different processes, which could affect stability of humic acids: complexation reaction by iron ions as well as interactions of humic acids with electrolyte particles. Studies showed also varied behavior of humic acids under addition of iron ions depending on chemical properties of humic acids, especially on functional groups content and surface charge of humic acids.

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RELATIONSHIP BETWEEN SELECTED PROPERTIES OF ORGANIC SOILS AND ELEMENTAL COMPOSITION OF THEIR HUMIC ACIDS FRACTION*

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Humic acids play great role in improving soil structure, water retention and sorption properties. These compounds determine mobility of mineral components and stabilize pH of soils thank to their buffer properties. These all reasons cause that knowledge about humic acids properties and in general about humus compounds is necessary to effective usage of soils, especially such soils which have high content of organic matter like organic soils including peat-muck soils. However investigations of humic acids are very time consuming. It results from the fact that isolation of pure humic acids fraction is multistep process. On the other hand, this kind of soils are rich in humic substances so the question is following: is it a possible to express properties of humic acids by some simple measurements of all soil? Is any relationship present between humic and soil? In connected with the above, goal of this work was to study relationship between selected soil parameters and properties of humic acids extracted from these soils. 11 peat-muck soils were taken from east part of Poland and water absorption capacity, humification index, carbon content and density were determined for them. From soils, humic acids were isolated using alkaline extractant. Elemental composition was determined for them: N%, C%, H% and O%. Correlation coefficients were calculated between measured properties of studied soils and humic acids isolated from them. Statistical evaluation of correlation coefficients was performed using t-student test. Results showed that only nitrogen content of humic acids did not show relationship with the studied properties of soils. It could result from small amount of nitrogen and probably higher its content in others organic compounds than humic acids. Carbon and oxygen of humic acids positively correlated with humification index, water absorption capacity and density of soils. Hydrogen content decreased with increase of above mentioned soils parameters. Such correlations are an evidence on great participation of humic acids fraction in mucking and especially in humification processes of organic soils. In this case composition of humic acids can be described by water absorption capacity, humification index and density of soil. Carbon content of soil did not show any relationships with humic acids atomic composition.

* This work was partly realized within the framework of a research project. The project was financed by the National Science Centre in Poland, on the base of decision number DEC 2011/03/N/NZ9/04239.

EFFECT OF THE PARTICLE SIZE OF RUBBLE ON THE CONTENT OF HEAVY METALS IN THE SOIL

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In recent years, scientists attention has been focused increasingly on environmental pollution and its effect on man and other creatures. Among the various pollutants, heavy metals are particularly important in their action. Urban soils are the recipients of large amounts of heavy metals from a variety of sources (e.g. vehicle emissions, coal burning waste, etc.) and accordingly the heavy metals in urban soils can be used as tracers of urban environmental pollution. The concentration of heavy metals in soils is controlled by the particle sizes. Finer particles, due to their high specific area, adsorb more heavy metals. Thus, analysis of effect of particle size fractions on heavy metal concentrations is very important in urban pollutant studies.

The aim of this study was to estimate the influence of size particles of rubble on the mobility of heavy metals in the soil. At first examined the soil. Soil samples were collected and then divided by particle diameter into five physical size fractions (in mm): 2.00-1.50; 1.50-1.00; 1.00-0.50; 0.50-0.30; 0.30-0.15; 0.15-0.10; <0.10. Concentrations of metals (Cr, Pb, Cd, Co, Cu, Mn, Hg) were determined for each individual fraction.

Then into the soil added different fractions of rubble. Fractions differed in particle size, (in mm): 2.00-1.50; 1.50-1.00; 1.00-0.50; 0.50-0.30; 0.30-0.15; 0.15-0.10; <0.10. Soil model placed in the cylinders. Into cylinders was poured a solution of heavy metals Cr, Pb, Cd, Co, Cu, Mn, Hg. Then water (pH - slightly acidic)was poured into the cylinder. In the received solution from the cylinder was measured content of heavy metals.

That most of the heavy metals were detained in the soil with rubble fractions equal or less 0.30 mm was found.

COMPARISON OF A HAPLIC CAMBISOL AND A BRUNIC ARENOSOL (DYSTRIC) STRUCTURE BY IMAGE ANALYSIS*

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According to current Polish soil classification, profiles of Cambisols and Brunic Arenosols reveal similarity of their morphology – they have the same sequence of master soil horizons, and the diagnostic *sideric* horizon is essentially analogous to the diagnostic *cambic* horizon, although the soils differ in texture. Therefore, it could be interesting to evaluate and quantitatively characterize the structure of these soils by image analysis. The research was made on 2 soils: a Haplic Cambisol (CM) developed from loess, showing the horizon sequence O-A-AB-Bw-BC-C-Ck and a silt loam texture, and a Brunic Arenosol (Dystric) (AR) developed from fluvioglacial sand, showing the horizon sequence O-A-AB-Bv-C and a sandy texture. For the morphometric structure analysis the resin-impregnated soil opaque blocks were used. For each soil and each selected horizon the following parameters: A_A (macroporosity, $cm^{-2}\,cm^{-2}$), L_A (relative length of pore/solid phase boundary, $cm \cdot cm^{-2}$), $N_{A(P)}$ and $N_{A(S)}$ (relative number of pore or solid-phase element cross-sections, cm^{-2}), $A_{N(P)}$ and $A_{N(S)}$ (average area of pore or solid-phase element cross-sections, mm^{-2}) were measured. The obtained average values were compared statistically at the significance level α=0,05. In the table below for each parameter and each genetic horizon the pairs of statistically different data were underlined.

Parameter	CM O-A	AR O	CM A	AR A	CM AB	AR AB	CM Bw	AR Bv	CM C	AR C
A_A	0.504	0.412	0.281	0.084	0.080	0.082	0.124	0.107	0.114	0.065
L_A	35.397	36.748	26.170	16.871	10.989	16.990	16.156	22.594	17.840	19.751
$N_{A(P)}$	309	360	214	316	192	345	207	398	321	480
$N_{A(S)}$	176	158	79	17	15	14	12	21	16	5
$A_{N(P)}$	0.261	0.282	0.155	0.026	0.047	0.023	0.061	0.026	0.043	0.014
$A_{N(S)}$	0.351	0.531	1.202	7.785	8.154	7.840	8.277	6.294	7.083	26.756

The O horizons of the Cambisol (CM) and the Arenosol (AR) demonstrated considerable likeness between the values of the morphometric parameters. The A and C horizons, on the other hand, revealed the most significant dissimilarity. Despite the obvious contrast in the texture of the two soils, both the transitional AB horizons and the Bw and Bv horizons were characterized with similar macroporosities (A_A) and average areas of solid-phase element cross-sections ($A_{N(S)}$). It could be stated that analogous pedogenic processes in the both B horizons caused certain uniformity of soil structure, regardless of their different texture.

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APPLICATION GIS TO THE LAND USE CHANGES ANALYSIS IN THE WEST POLESIE BIOSPHERE RESERVE

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Land use changes are a very important factor that influence on natural environment in local and global scale. These changes have impact on carbon balance, water circulation, biological and landscape diversity. All these changes reflect spatial development [Verburg et all., 2009]. The aim of presented research is analysis the land use structure and landscape diversity of the West Polesie Biosphere Reserve (WPBR), located in CE Poland on the area 139917 ha [Chmielewski ed. 2005]. Additionally, examples of land use changes in 4 catchment basins of lakes over last few decades are given. As a source research material, multispectral satellite imagery (RGB+NIR) were used (RGN+NIR). Images were captured 20 September 2009, by Deutschland satellite constellation called RapidEye. First, the geometric and radiometric correction was carried out and next the ortophotoimage raster mosaic with 5 m ground sample distance was performed.

The land use structure was prepared by supervised classification method in ArcGIS software; additionally the CLC 2006 database was used. Basing on land use map structure, the Shannon Diversity Landscape Metric (SHDI) was estimated with moving window approach enabled in Fragstats software [McGarigal et all. 2002]. For a example of changes occurring in 4 lakes catchments' basins (Moszne, Uściwierz, Białe Włodawskie and Orchowe Lakes), the retrospection land use changes analysis were executed, using archival airborne photos taken in 70` and 90` of XX ct.

Conducted research has showed that land use structure of WPBR is differential and can be simply described by selected landscape metrics. The authors are trying to convince that moving window approach is better for landscape description rather than conventional landscape metric calculated on landscape level. The highest level of land use diversity showed by SHDI metric was identified in West part of WPBR, what is strictly connected with a big scale of peatland drainage as well as agricultural and recreation activity in these subregion. Conducted here retrospective land use analyses has proved that character of land use structure from last 4 decades has dramatically changed. In conclusion, the authors proposed 10 principles of landscape spatial structure management, which should be implemented into local sustainable development program.

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THE INFLUENCE OF REHYDRATION PARAMETERS ON THE VOLUME INCREASE OF APPLES DURING REHYDRATION*

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Drying is one of the most common ways of biological materials preservation. The removal of moisture during drying has, however, detrimental effects on the physical attributes of the material. Biological materials with a high initial moisture content undergo shrinkage and deformation during hot-air drying. When water is removed from such materials, a pressure unbalance is produced between the inner of the material and the external pressure, generating contracting stresses that lead to material shrinkage or collapse, changes in shape and occasionally cracking of the product (Mayor & Soreno, 2004).

Rehydration is a complex process aimed at restoration of raw material properties when dried material is contacted with water. During absorbtion of water the volume of dry material increases. On the other hand, simultaneously, the leaching of solubles occurs. Pre-drying treatments, subsequent drying and rehydration *per se* induce many changes in structure and composition of the biological material tissue, which result in impaired reconstitution properties. Hence, rehydration can be considered as a measure of the injures to the material caused by drying and treatments preceding dehydration (Lewicki, 1998). These injures cause that dry product does not reach after the rehydration the features of raw material prior to dehydration, indicating that the dehydration procedure is irreversible (Krokida & Marinos-Kouris, 2003).

The objective of this work was to investigate the influence of rehydration parameters (temperature, immersion medium, and the shape of product) on the volume increase of apples during rehydration.

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STUDY ON SPATIAL DISTRIBUTION OF POLYSACCHARIDES IN PLANT CELL WALL BY RAMAN MICROSPECTROSCOPE

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The plant cell wall is kind of the cellular skeleton that controls cell shape and determines the relationship between turgor pressure and cell volume. The cell wall is composite of many different natural polymers, mainly cellulose, xyloglucan, pectins and also lignin for secondary cell wall which forms after cell growth. Proteins, lipids, enzymes, aromatic compounds and water are another components of this part of plant cell (Taiz & Zeiger, 2002).

It is thought that percentage of components of plant cell wall has an important influence on mechanical properties of fruits and vegetables. Therefore research on content and spatial distribution of each component of these part of cells are extremely important in studies of quality of fruits and vegetables (Agoda-Tandjawa et al., 2012). So far many analytical and microscopic methods of investigation of plant cell wall was developed. Nevertheless, none of this methods gives data relating to accurate distribution and amount of individual substances in micro-scale. Raman microspectroscopy can resolve this problem without necessity of staining section of plant tissues.

In brief Raman microscope is connection of microscope and Raman spectroscopy. It allows to collect spectra at each points of sample. In this way map of spatial distribution of sample's components can be obtained.

In this work we would like to discuss the methodology of measurement using Raman microscopy and present Raman images obtained for several plant tissues. Examples of spatial distributions of main cell wall compounds will be depicted.

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IN SITU DETECTION OF ARBUSCULAR MYCORRHIZAL COLONIZATION BY ELECTRICAL IMPEDANCE AND CAPACITANCE MEASUREMENTS

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Electrical impedance (EI) and capacitance (EC) methods are capable to provide an assessment about root mass or active root surface area without plant damaging. The arbuscular mycorrhizal fungal (AMF) colonization is known to initiate morphological alterations in the root system and to enhance the permeability and area of plant–soil interface. The present work was designed to test whether EI and EC measurements were adequate for distinguishing AMF-colonized maize plants [AM(+)] and non-AM counterparts [AM(–)].

Maize (*Zea mays* L.) seeds were planted into pots filled with pumice medium. Half of the plants received AMF inoculum containing *Glomus mosseae* and *G. intraradices* AMF species. By measuring root EI and EC values (with a HP 4284A LCR-instrument), root development was monitored eight times during the growing period. On experiment day 40, plants were destructively sampled: the root systems were washed off the pumice medium and were subjected to scanning and image analysis for assessing root length, average root diameter and root surface area. AMF colonization was microscopically investigated.

Inoculation with AM fungi reduced the root EI and increased the root EC over the non-inoculated control. The difference between the compared groups proved to be statistically significant at each sampling time. Microscopic examination of harvested roots showed 100% frequency and 91% intensity of fungal colonization. Mycorrhizal status had no effect on shoot dry mass, root dry mass and root/shoot ratio, but AMF colonization significantly increased the average root diameter (by 23%) and decreased the root length (by 33%) and the root surface area (by 17%).

The smaller EI and higher EC readings of AM(+) plants compared with those of AM(–) controls indicated the expansion of the absorbing root–soil interface caused by the hyphae network of the AM fungi. These changes in electrical properties could be due either to the increased area of plant root surface or to the enhanced absorption surface area by extraradical fungal hyphae (possibly to the complex interaction of the two phenomena). Since the investigation of harvested roots revealed a significant reduction of the root surface area by AMF colonization, results of the electrical measurements refer to a direct EI-decreasing and EC-increasing effect provoked by AMF colonization. Our results suggest that the introduced non-destructive and simple EI and EC measurement is an adequate technique for *in situ* monitoring of arbuscular mycorrhizal fungal colonization and function. The method may partially substitute or complete the intrusive and time-consuming conventional techniques used in mycorrhizal research.

EFFECT OF DIFFERENT TILLAGE SYSTEMS ON SOME SOIL PROPERTIES UNDER CONTINUOUS WINTER WHEAT*

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The aim of this research was to determine the effects of different tillage systems on soil properties. The properties studied were physical (bulk density, water content, soil stability in water), chemical (OM, pH) and microbiological (soil enzymatic activity, microbial biomass C and N content).

The research was done using soil samples collected from the long-term field experiment on a private farm at Rogów (Lublin voivodeship) on a silt-loam soil, at the IUNG-PIB Experimental Station in Grabów (Mazowieckie voivodeship) on a sandy soil in 2006-2012, and at Krasne (Podkarpackie voivodeship) on a silt soil in 2009-2012. At all of the experimental sites, winter wheat was grown under two tillage systems: conventional tillage (CT) based on the mouldboard plough (to 25 cm depth) and reduced tillage (RT) based on a rigid-tine cultivator (to 15 cm depth). The soil surface was mulched with chopped wheat straw on both the CT and RT treatments.

The effects of the different tillage systems on the values of the physical and microbiological properties of the studied soils were significantly different at the $P<0.05$ level. The results showed that the RT system in comparison with the CT system, created a more-friendly environment for improvement of soil physical properties and microbiological activity (soil enzymatic activity, microbial biomass C and N content).

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EFFECT OF COPPICE WILLOW *SALIX VIMINALIS* ON SOME PHYSICAL PROPERTIES AND ON THE MICROBIOLOGICAL ACTIVITY OF SOIL*

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This study was aimed at assessment of some physical and microbiological properties of soil under coppice willow (*Salix viminalis*), in comparison with a control treatment comprising permanent pasture.

Analyses of physical and microbiological properties of soil were performed on the long-term experimental fields (started in 2003) at the Osiny Experimental Station of the Institute of Soil Science and Plant - State Research Institute in Puławy (Lublin voivodeship) in Poland on heavy black earth soil (4.6% organic matter content). Soil samples were taken from the experimental fields after harvest. The following soil physical properties were measured: particle size distribution, bulk density and soil stability in water. Soil stability was measured in terms of the content of readily-dispersible clay (RDC) in the soil samples. The microbiological analysis of soil included evolution of CO_2, microbial biomass content and the enzymatic activity of soil dehydrogenases. Statistical analyses were made using the ANOVA method. The differences were taken as statistically-significant at $p<0.05$.

The obtained results showed the values of studied physical and microbiological properties of soil under long-term growth of coppice willow (4.1% organic matter content) and under permanent pasture (5.4% organic matter content) were significantly different. During the three-year studies the soil water content ranged from 36 to 41%, v/v and bulk density from 1.1 to 1.6 $Mg.m^{-3}$. Soil stability in water under coppice willow was lower in the surface soil in comparison with the control soil (permanent pasture). We found that grasses produce OM with lots of –OH and –COOH chemical groups, and that this type of OM is better at stabilizing the soil structure. The intensity of evolution of CO_2,microbial biomass content and activity of dehydrogenases were 1.5-2.0 times smaller, on average, in soil under coppice willow than in the control soil (pasture).

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PHYSICAL AND MICROBIOLOGICAL PROPERTIES OF SOIL UNDER DIFFERENT TILLAGE INTENSITY*

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The aim of this research was to determine the effects of different tillage intensity on changes of chosen parameters of soil properties: physical (bulk density, water content and stability) and microbiological (microbial biomass C and N content, soil enzymatic activity).

Analyses of physical and microbiological properties of soil were performed on the long-term field experiment on a private farm at Rogów (Lublin voivodeship) on silt soil and at the Experimental Station of the Institute of Soil Science and Plant Cultivation - State Research Institute at Grabów (Masovian voivodeship) in Poland on sandy soil. According to FAO classification soil in Rogów was Haplic Cambisol and in Grabów - Eutric Fluvisol. Both experiments were started in 2002. At both experimental sites winter wheat was grown under two tillage systems: conventional tillage (CT) based on the mouldboard plough (25 cm depth) and conventional soil tillage equipment with the field surface mulched with chopped wheat straw, and reduced tillage (RT) to 10 cm depth with the surface mulched with chopped wheat straw based on soil crushing-loosening equipment and a rigid-tyne cultivator. The soil physical and microbiological properties were measured twice a year for soil samples taken from experimental fields before and after harvest of winter wheat.

The significant effects of different tillage intensity on the values of physical and microbiological properties of studied soils were observed at $P<0.05$. The 10 years of application of reduced tillage affected positively on soil environment by increasing soil stability in water and soil physical quality. That was reflected in 20-30%, on average, higher values of all measured parameters of soil microbial activity with comparison to conventionally tilled soil. The results showed that the reduced tillage in comparison with the conventional tillage, created a more-friendly environment for improvement of soil physical properties, which increased in response to the increased activity of native groups of soil microorganisms.

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SOIL ORGANIC MATTER'S IMPACT ON THE PHOSPHORUS SORPTION IN SANDY SOILS

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Soil organic matter, as one of the most important indicators of arable soils' fertility, has considerable impact on the way the soil sorptive properties are shaped and, in doing so, on the protection of the nutrition base for plants. The sorption of anions in the soil of our climate constitutes a small fraction of the sorptive processes that take place there, yet this issue is worth undertaking due to the significance of phosphorus being an important macrocomponent occurring in soils as well as an element problematic from the point of view of the environment and its protection. The article presents the findings of the research on the mechanism of phosphorus sorption process in light texture soils depending on the organic matter content. The investigation was to present the impact the organic matter content has on the course of the phosphorus sorption process in sandy soils. The research was based on two types of analyses: the comparative analysis of phosphorus adsorptive isotherms, carried out on different soil horisons of the profiles under scrutiny that were characterised by naturally diversified organic matter content, and also on the comparison of the reaction of the same material from the upper horison with organic matter and after its removal. After the sorptive experiments had been carried out, the results were interpreted based on Langmuir and Freundlich isotherms as well as on simple statistical tests. The findings point at a very important role played by organic matter in the phosphorus sorption process in the soils under study. The removal of this matter from the soils' surface horisons resulted in a considerable decrease of the sorptive ability of the soil material in all the examined cases. This can also be confirmed by the comparison of the isotherms obtained for the surface levels and bedrock of the same origin where the biggest sorptive abilities were registered for the surface levels. After the organic matter had been removed from the soil, the course of phosphorus sorption became dependent on soils' other properties whose influence had to a certain degree been obscured by the organic matter. The occurrence of phosphorus desorption process of a stronger type than the one from before the removal of the organic matter from the soil material was also observed. The experimental results obtained have proven better adjusted to the shape of the isotherm being in accordance with rather Freundlich assumption than the one by Langmuir.

SOME PHYSICAL AND MICROBIOLOGICAL PROPERTIES OF SANDY SOIL UNDER VIRGINIA MALLOW *SIDA HERMAPHRODITA* (L.) RUSBY*

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The objective of this work was to compare some physical and microbiological properties of sandy soil under cultivation of virginia mallow (*Sida hermaphrodita* L. Rusby) and uncultivated soil (under permanent pasture).

Measurements of physical and microbiological properties of soil were performed on the long-term experimental fields (started in 2003) at the Osiny Experimental Station of the Institute of Soil Science and Plant Cultivation - State Research Institute in Puławy (Lublin voivodeship) on a sandy soil. Soil samples were taken from the experimental fields during growing season. Determination of physical and chemical properties included the particle size distribution, bulk density and soil stability in water. Soil stability was measured in terms of the content of readily-dispersible clay (RDC) in the soil samples. The microbiological analysis of soil contained evolution of CO_2, microbial biomass content and activity of soil dehydrogenases. Statistical analyses were made using ANOVA method. Data recorded each time were pooled for statistical analysis to determine the significance of variance ($p<0.05$).

The obtained results showed the values of studied physical and microbiological properties of soil under long-term cultivation of virginia mallow (1.31% organic matter content) and uncultivated soil (pasture – 1.45% organic matter content) were significantly different. During three year studies the soil water content ranged from 11.7 to 28.3%, v/v and bulk density from 1.72 to 1.86 Mg m^{-3}. Soil stability in water under virginia mallow was lower especially in the top soil in comparison to control soil (pasture). The intensity of evolution of CO_2, microbial biomass content and activity of soil dehydrogenases were 1.3-1.5 time lower, on average, in soil under the virginia mallow in relation to control soil.

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THE INFLUENCE OF ORGANIC MANAGEMENT ON SOIL MICROBIAL ACTIVITY

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In conventional agriculture chemical plant protection and fertilization are said to be one of reasons for soil degradation. If it is possible chemical should be replaced by biological methods, which are not only safe for the environment, but also improving the ecological condition of the soil. The organic cultivation methods may include the use of positive organisms preparations, such as EM- Farming Technology (EM), natural microelement fertilizers, e.g. basalt meal and organic fertilizers such as manure. EM consists of the mixture following five groups of microorganisms: lactic acid bacteria, yeasts, *Actinomycetes*, photosynthetic bacteria and fermentation fungi. Furthermore, EM effectively colonize the soil environment supplanting the pathogenic species. They are causing the optimization pH of the soil, enhance the effectiveness of mineral fertilizers by release components related with minerals. Additionally, particular groups of so called positive microorganisms are known to produce bioactive substances such as vitamins, hormones, enzymes, antioxidants and antibiotics that can directly, or indirectly enhance plants growth and protection. It is recommended to use mineral fertilizers such as basalt meal, which is obtained by crushing natural rock, as a complement to the use of EM. It is the source of elements such as manganese (Mn), zinc (Zn), cooper (Cu), molybdenum (Mb), boron (B), iron (Fe), selenium (Se), which are important for growth plants, while organic substances are supplied to the soil with manure.

The aim of this study was the assessment of soil microbial activity under organic cultivation of hops. The study included the following treatments: 1) soil fertilized with basalt meal, 2) soil fertilized with basalt meal and manure, 3) soil amended with EM and manure, 4) control – without any fertilization. The following analyzes was performed: total number of bacteria and fungi, respiratory activity, microbial functional diversity evaluated by Biolog EcoPlate® assay.

The data obtained show that the organic cultivation has a positive effect on the microbial functional diversity in soil. The best results were obtained in treatments with probiotics inoculants in combination with organic fertilizer (manure). The use of organic cultivation method could be a beneficial and environmentally safe alternative to the use of chemicals.

INFILTRATION INTO STONY SOIL: WHAT ARE THE DIFFERENCES BETWEEN HOMOGENEOUS AND STONY SOILS?

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Mountainous soils usually contain a large number of rock fragments (particle diameters ≥ 2 mm) strongly influencing the soil physical and hydrophysical properties such soils. Rock fragments as a part of stony soils are significantly decreasing retention capacity as well as hydraulic conductivity of stony soils. Stones are simply decreasing effective cross – section of highly conductive fine earth of soil; as well as its retention, assuming stones hydraulic conductivity is negligible. This work presents results of the study of rock fragments (quantitatively expressed by stoniness) influence on water infiltration and percolation through stony soil.

Infiltration process was simulated by the model HYDRUS 1D. Input data were measured in the field and in laboratory; so called effective parameters were estimated, using Darcy´s approach. To do this, all the stony soil characteristics were evaluated using the representative elementary volume (REV), which depends mainly on size of the rock fragments. For stones about 10 cm of diameter REV was estimated 1 m^3. To use this volume as a soil sample and to measure characteristics on it is technically extremely difficult, therefore saturated hydraulic conductivity was estimated by numerical experiment simulating classical Darcy´s approach, using simulation model HYDRUS 2D (Novák et al, 2008).

It was shown infiltration front penetration velocity is higher in the soil with relatively higher stoniness, if the rain intensity is lower than soil infiltration capacity. The stony soil of low stoniness and thus higher retention capacity is accumulating water in upper layers of soil, and thus slowing down infiltration front penetration. The initial soil water content is also important; low water content soil is of higher retention capacity and lower hydraulic conductivity. Percolation through stony soils is usually quick and subsurface runoff can be significant.

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THE EFFECT OF CLEAR-CUTTING ON THE PROPERTIES OF ORGANIC MATTER IN THE LOWLAND AND MOUNTAIN PARTS OF LOWER SILESIA

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Forest ecosystems are an important source of carbon and play a major role in the global C cycle. The average C content of forest soils is about 120 t/ha when the mean of all ecosystem soils is about 80 t/ha (Hedde et al., 2008). Hugh looses of C in the forest ecosystems can be caused by harvesting. Thus in the last decades scientists have been trying to evaluate what is the effect of various disturbances, on carbon stocks. Clear-cutting alters carbon cycle through inducing changes in organic matter decomposition (Falsone et al., 2012; Ussiri & Johnson, 2007). In the paper the effect of clear-cutting on the properties of soil organic matter in the Oborniki Sl. – lowland part of Lower Silesia and Ladek Zdr. Inspectorates – East Sudety Mountains, has been reported. Plots situated on cleared areas and undisturbed respectively were chosen. Soil profiles in the Sudety Mts. were described as Dystric Cambisols and the type of forest stand was mountain coniferous forest whereas in the lowlands investigated soils represented Brunic Arenosols and the plant cover was coniferous mixed forest. Results of the analysis indicate that effect of clear-cutting was similar both in mountain and lowland conditions and led to accelerate of organic matter decomposition what was expressed by lower C/N ratio, particularly in Oa horizons, but in mineral horizons as well. Similarly, removing trees in the study areas influenced on increase of mobility of low molecular humic substances and decrease of non hydrolyzable carbon mostly in Oa horizons.

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TROPHIC SOIL INDEX OF THE FOREST RUSTY SOILS AFFECTED BY CLEAR-CUTTING

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Monitoring of terrestrial ecosystems needs synthetic indicators which can easily describe fertility of the stands and assist in the proper management of natural resources (Ponge & Chevalier, 2006; Schoenholtz et al., 2000). The trophic soil index (SIG) developed for the forest areas is one of the most important tool in proper forest management, particularly in the selection of tree species in forest renewal (Lasota et al., 2011). It can be used as a correlate of stand and soil properties. Forest harvesting affects dynamics of nutrients in soil. Removal of trees results in changes of soil moisture and the amount of plant residues returning into soil. It also modifies the availability of nutrients following by fluctuations of the soil reaction. In the paper the influence of cutting forest management on the fertility of rusty soils from the Spała Inspectorate, expressed as a trophic soil index, has been described. Soils in the study area were covered by coniferous forests, coniferous mixed forest and broadleaf mixed forests. Two sampling areas in each forest stand were chosen: the harvested (1, 3 and 5 years before sampling) and undisturbed. All soil profiles were described as Brunic Arenosols developed from loose quartz sand. Clear-cutting done one year before sampling the most affected decrease of pH and an increase of hydrolytic acidity particularly in upper layers of O horizons. CEC in organic horizons of the soils after clear-cutting was significantly lower in comparison to those from undisturbed forest stands. A significant decrease of organic carbon after clear-cutting, particularly 1 and 3 years after harvesting was observed. All those parameters which are components in the process of SIG calculating influenced on the lower values of the trophic soil index in the forest stands after clear-cutting in comparison to the natural stands although they are within the SIG ranges for the Małopolska (VI) natural forest region.

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ASSEMBLY COMPOSITION AND ABUNDANCE OF PROTOZOA UNDER DIFFERENT CONCENTRATION OF NITROGEN COMPOUNDS AT "HAJDOW" WWTP DEVICES

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Realized through bacterial activity, the processes of utilization of organic matter contained in domestic sewage run with the help of a large number of prokaryotic organisms; the most abundant among them are Ciliata, Amobea, Flagelata, Rotifera, Nematoda, and Tardigrada (Martín-Cereceda et al., 2001). Among the organisms listed, the highest level of development is achieved by protozoa; at the same time, they remain the required component of the activated sludge biocoenosis. Protozoa are of primary importance throughout all stages of sewage treatment, starting from the process of formation of activated sludge flocks (Jaromin et al., 2010). The work includes studies show protists notably ciliates and testate amoebas as well as nitrogen removal efficiency in the conditions of the modernized wastewater treatment plants "Hajdow" in Poland, Lublin city (Babko et al., 2012). Sampling took place in 2010 year, the paper presents selected results of the summer months. Research shows an increase in the efficiency of the process of removing ammonia nitrogen in the presence of the domination of sessile bacterivorous forms was observed. Moreover, authors also noted the connexion between variations in quantity of some protozoa populations and changes in concentrations of some nitrogen compounds in activated sludge.

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THE INFLUENCE OF REHYDRATION PARAMETERS ON THE MASS AND DRY MASS CHANGES DURING THE REHYDRATION OF APPLES*

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Dried apples can be consumed directly or treated as a secondary raw material, since dried apples form important components in numerous prepared food including snack preparations, integral breakfast foods and other varieties (Vega-Gálvez at al., 2008). Dehydrated products often need to be rehydrated before consumption or further processing. Three main processes take place simultaneously during rehydration: the imbibition of water into the dried material and the swelling and the leaching of solubles (Moreira et al., 2008). In the rehydration process, two main crosscurrent mass fluxes are involved, a water flux from the rehydrating solution to the product, and a flux of solutes (sugars, acids, minerals, vitamins) from the food product to the solution, and the kinetics depends on the immersion medium (Giraldo et al., 2006). Physical and chemical changes that take place during drying affect the quality of the dehydrated product, and by a simple addition of water, the properties of the raw material cannot be restored (Krokida & Maroulis, 2001).

The objective of this study was to investigate the influence of rehydration parameters (temperature, immersion medium, and the shape of product) on the mass and dry mass changes during the rehydration of apples.

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BIOGAS YIELD DURING THE ANAEROBIC DIGESTION PROCESS IN DIFFERENT CONDITIONS OF TEMPERATURE

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Global energy demand is rapidly increasing. Alternative energy sources such as biogas should be developed. The process of anaerobic digestion is widely used for the production of biogas in the renewable energy sector. Large-scale biogas installations, where the process is conducted, allow the processing of organic compounds in biogas, as well as utilization of onerous waste from agriculture and the food industry.

The aim of this study was to determine the yield of biogas produced from different feedstock at two different temperatures. Optimization of biogas production in agricultural biogas plants should focus not only on increasing the quantity of biogas, but also on the maximum distribution of organic compounds.

Biogas is a renewable gas. It contains methane, which is produced when biological material is broken down by microorganisms in an anaerobic environment. Biogas digestion process consists of different groups of bacteria that work in sequence. Like any living organism, methanogenic bacteria need the relevant conditions for their growth and proper functioning. Parameters which specifically affect the vitality of methane bacteria are potential of hydrogen (pH) and temperature. Variations in the ranges of pH can cause severe and sometimes irreversible changes in the process. In contrast to the ranges of pH, temperature ranges are not as restrictive. The study was conducted in two temperature ranges, namely 37°C ± 2°C and 52°C ± 2°C. The methane fermentation processes were performed with two different substrates: silage maize and grass silage. The periodic and mesophilic fermentation was carried out in BioStat B-plus Sartorius bioreactors of 2 liter capacity. The process was performed in three independent replications. Before the fermentation process each substrate was subjected to physical and chemical analyses: pH, dry matter and the organic matter, total nitrogen, ammonium nitrogen and total organic carbon (TOC).

The average time of biogas production from maize silage at 37°C was 27 days and from grass silage it was 34 days. Temperature 52°C resulted in shortening the duration of the fermentation process by an average of 4 days for both corn silage and grass silage.

Biogas production in both substrates took place without interference. Temperature 37°C affected the length of the fermentation process of samples, while temperature 52°C generated the degree of organic matter decomposition. The fastest decomposition of the substrate was recorded for maize silage at 52°C. Also, corn silage at 37°C had the highest rates of biogas yield.

ANALYSIS OF NANOSTRUCTURE AND MECHANICAL PROPERTIES OF XYLOGLUCAN (TAMARIND) BY ATOMIC FORCE MICROSCOPY*

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Three general groups of polysaccharides consist of the primary cell wall of plants: cellulose, hemicellulose and pectins. These compounds build of internal structure, maintain strength and flexibility of the wall which determine a shape of a cell. Hemicelluloses bind and crosslink the fibers of cellulose. The formed network is embedded in pectin matrix. The one of heterogeneous biopolymer forming hemicelluloses is xyloglucan, which is the most abundant in tamarind seed (Simi & Abraham, 2010). It has a backbone of 1,4'-D-glucose monomers and its side chains contain always xylose, rarely galactose and fucose. This study focuses on geometrical and nanomechanical properties of pure xyloglucan extracted from tamarind seed. To achieve the goal, atomic force microscope was used. It is an perfect tool for imaging of single fibers or molecules of biomaterials in nano or micro scale. It also may be used to nanoindentation (Butt et al., 2005). It provides data to determine the elastic modulus of sample elements. The specimen of the polysaccharides on the mica surface was prepared. Height images and force curves (in butanol) of xyloglucan fibers were obtained. Subsequent, quantitative data of length, width, high and Young's modulus were determined. The findings allow to characterize nanostructures and mechanical parameters of tamarind xyloglucan.

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REACTION OF YELLOW- AND BLACK-SEEDED RAPE PLANTS TO THE SOIL COMPACTION STATE*

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Different end-uses of rape (*Brassica napus* L.) are the main reasons of developing of its several types. Seeds with yellow coats have thinner hulls and thus less fiber and more oil and protein than varieties with black seed coats. Moreover, yellow-seeded rape lines contain low level of erucic acid as well as low glucosinolate level in comparison to black-seeded one. It makes this line very attractive for oil production as well as for the production of forage – rapeseed meal. However, still yellow-seeded rape have not been registered for breeding in Europe. The most important reasons are lower crop yields, smaller cold-resistance as well as more difficulties with storage and higher susceptibility for pathogens because of thinner hulls in comparison to dark-seeded one. It is known that the effective use of a potential of cultivated plants is possible only when the soil in which they grow has the proper structure.

Plant reactions to physical soil conditions differ between plant species or even between varieties among one plant species. Significant soil compaction changes physical, chemical and biological soil properties and causes many negative phenomena.

Considering the mentioned facts, the aim of investigation was to determine the differences between growth and water uptake of two yellow-seeded lines and one popular black-seeded cultivar of rape in different soil compaction states (1.2, 1.4 and 1.6 g cm^{-3}). The experiment was conducted in greenhouse for 80 days. Rape was grown in high soil columns: 60 cm height and 15 cm diameter, composed of four layers: 0-10, 10-20, 20-40, 40-60 cm. Layer from 40 to 60 cm was taken undisturbed from the soil (Haplic Luvisol) profile. Soil in layer from 0 to 20 cm was compacted to different states. The key findings are that medium compaction of the soil seems to creates the most favorable conditions for the growth of all of the investigated rapeseed types, and that yellow-seeded forms of rape are more sensitive to the changes of the compaction state, which was revealed in higher cumulating of roots in the top 10 cm of the soil in relation to the total soil column – when the soil bulk density increased from 1.2 to 1.4 g cm^{-3}. Additionally, irrespective of the rape type, the correlation between leaf temperature and its stomatal resistance depend on the soil compaction state, with the smallest determination coefficient for plants growing in highly compacted soil.

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THE EFFECT OF LIGHT INTENSITY AND NITROGEN DEFICIENCY ON THE GROWTH AND CHLOROPHYLL FLUORESCENCE OF CHLORELLA PROTOTHECOIDES

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The microalgae have recently been regarded as an alternative source of biomass for biofuel production. The production of biomass of microalgae depends on species-specific characteristics and the physical and chemical properties of growth environment. The most important factors involve the intensity of photosynthetically active radiation, availability of CO_2 and nutrients which control metabolic processes. Effect of culture conditions and stress factors on growth of microalgae can be monitored using chlorophyll fluorescence (Jiang et al., 2012). The procedure of fluorescence measurements offers the possibility of rapid detection of physiological nutrient stress-induced changes in cells.

The aim of the study was to recognize the *Chlorella protothecoides* cell response to nutrient stress and different light irradiances based on the chlorophyll fluorescence and selected growth parameters.

Chlorella protothecoides was grown in batch cultures exposed to different light conditions and the N- deficiency stress. The biomass concentration of the culture was monitored by optical density measurement using a spectrophotometer every 24 h. In order to analyze how photosynthetic apparatus responds to different growth conditions parameters F_v/F_m, rETR, NPQ and qP were determined.

Depending on different light intensity the initiation of stationary (growth) phase was observed from the fourth to the sixth day of cultivation. Culture exposed to medium light intensity (130 µE m^{-2} s^{-2}) showed the highest biomass density as compared to the other cultures studied (35 µE m^{-2} s^{-2} and 380 µE m^{-2} s^{-2}), in the stationary growth phase.

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IDENTIFICATION OF EXTREMAL WATER REGIME SITUATIONS IN THE LOCAL MATHEMATICAL SIMULATION MODEL

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In hydrological cycle, within the closed system of atmosphere – plant cover – unsaturated soil zone (UZ) – groundwater, significant problem is the impact of meteorological factors on the water regime in the unsaturated soil zone. The UZ represents a source of water for biosphere and as such it is known as the 3rd water source of a given location (Farkas & Majerčák, 2007), next to surface water (1st source) and groundwater (2nd source). During the vegetation period, the III. water source continually provides water for the plant cover (Gusev et al., 2008). Recent knowledge are not permitting us to prognoze its future trend. The aim of the subprograms implementation in the complex mathematical simulation model is to have the possibility to make forecast of availability of the water in UZ and impact of extremal meteorological conditions on the III. water source expressed in form of quantification of assurance of water that is available for the cropcover.

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AGRO-PHYSICAL ASPECTS OF MECHANICAL WEED CONTROL

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Despite the long period of formation of the scientific basis of agriculture, the theory of mechanical weed control has not been adequately developed. Before the advent of herbicide weed control consisted of a number of traditional empirical methods. In the course of history, mainly the sources of energy for their implementation were changing: muscular strength of people, of animals, energy of external and internal combustion engines.

The theoretical approach is based on the assessment of impact of a wedge moving in the soil upon the dynamic processes of the cultivated layer and its agro-physical parameters after the passage of the wedge due to the formation of new competitive relationships between crops and weeds at the early stages of their development.

In this process a number of significant differences between crops and weeds are taken into account:

- difference in the size of seeds and seedlings: seeds and seedlings of most field crops exceed the dimensions of seeds and seedlings of weeds tens of times, hundreds of times and, sometimes, thousands of times;
- difference in spatial position with respect to the soil aggregates: seeds and seedlings of crops are located in the soil between soil aggregates, and those of weeds - mainly in soil aggregates;
- difference in the nature of links of seedlings with soil: in crops it is labile, in weeds it is dense;
- difference in growth of sprouts in dense and loose media: crop seedlings in both media reach the surface in the shortest way. Weed seedlings bypass aggregates and do not pass through the large pores in soil due to the lack of lateral support;
- difference in response to dynamic changes in the cultivated layer during the movement of the wedge: seedlings of crops having labile links with aggregates are less damaged than small weed seedlings with rigid links with soil particles;
- difference in response to the aggregate state of the cultivated layer: in the process of cultivation predominance of large aggregates and cloddy soil composition are desirable, which provide for better conditions for competitive ability of crops compared to weeds.

Three stages of formation of competitive relationships between crops and weeds have been determined:

1) initial static stage: the formation of crop and weed sprouts before sprouting or at early stages of their development after germination;

2) dynamic stage characterized by drastic change in the structural and aggregate state of the cultivated layer with spatial changes between soil aggregates and sprouts;

3) static stage characterized by competitive relationships between crops and weeds in the newly formed soil medium. During this stage, the major positive role belongs to the drying of the upper 5 cm layer where germination of weeds is blocked.

Scientific agenda for further research in this area is proposed including a joint study of physical parameters of the cultivated layer, of seeds and seedlings for weeds and crops to ensure competitive advantages of crops.

THE EFFECT OF DROUGHTS ON SPRING BARLEY ROOT SYSTEM*

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Stress adaptation through retention of imprints of previous stress exposure has been recently described in plants (Ding at al., 2012, Goswami et al., 2010). Environmentally induced epigenetic states can be passed to the progeny, successive, stressed plant generations have increased potential to adaptation (Mirouze & Paszkowski, 2011).

The growth chamber experiment was conducted on spring barley (cv. Sebastian) to observe the effect of water stress on plant root system and transpiration. In the experiment seeds obtained from plants that were growing at optimum soil water potential (O) and plants that have passed water stresses (S) were used. Both plants with different stress history were grown at optimum soil water potential (C) or water potential corresponding to drought stress (D).

Results shows significant differences between plants growing at optimum and low water potential in most root parameters and plant functions. Additionally we observed some differences between plants of different stress history. Plants with water stresses in their history (S) growing in dryer soil (D) had longer roots that absorbed more water from dryer soil than (O) plants. Plants with stress history had also higher contribution of fine roots (<0.20 mm) than O plants at both optimum and lower soil water potential levels. General plant response to water availability resulted in lower water use by unit of plant dry mass by plants with water stress history (S) than O plants.

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REED CANARY – COMPARISON OF BIOGAS PRODUCTION FROM WILD AND CULTIVATED VARIETIES

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Reed canary grass (*Phalaris arundinacea*) is one of perennial grasses, belonging to the Poaceae family. It occurs in natural grass stands, most commonly in the vicinity of water (Strašil, 2012). It is also cultivated, mainly for fodder. Due to the high yield per hectare, it is considered as a potential energy plant, both for combustion and biogas production (Kandel et al., 2013).

This paper compares the chemical composition and efficiency of biogas production in the methane fermentation process of two silages: wild and cultivated varieties of reed canary grass. An attempt was made to answer the question, how habitat of plants affect chemical composition and biogas yield.

The cultivated species (Swedish variety Bamse) was obtained from a field experiment located in the medium soil in Osiny, Experimental Station IUNG-PIB (51°28´N, 21°39´E). Naturally occurring variety originated from unused meadow communities *Ch. Ass. Phalaridetum arundinacea* in the valley of Wieprz-Krzna Channel in Lublin Province.

The results show that two varieties differ essentially in their physical and chemical properties. The cultivated variety characterized by higher biogas yield (430 $Ndm^3\ kg^{-1}$ ODM), than wild one (100 $Ndm^3\ kg^{-1}$ ODM), which is probably related to the chemical composition of plants. It is supposed, that high content of indigestible crude fiber fractions has significant impact on reducing the biogas quantity and quality (Triolo et al., 2011).

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THE EFFECT OF ECOLOGICAL PRODUCTION SYSTEM ON THE SOIL MICROBIAL QUALITY UNDER HOPS CULTIVATION

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It is well known that the ecological system of crop production, as far as conventional one, may influence soil microbial populations functionality. It may result in changes of soil enzymatic activity, regarded as soil microbial quality. Then it is the first indicator of changes in the mechanisms responsible for facilitating the access of nutrients by crops and determining prospect effect on crops production. The research gist concerns the aim of choosing the best method of hops cultivation through prospect productivity improvement by probiotic inoculants, basalt meal or horse manure application. The role of microbial components of beneficial microorganisms preparation (suggested by producers) is to enhance organic matter decomposition. On the other hand basalt meal as a fertilizer has a positive effect on soil structure, creating better living conditions for beneficial soil microorganisms. The primary role of the basalt meal is to enrich depleted soils in a number of minerals.

The scientific goal of our study was to evaluate the activity of soil enzymes such as: dehydrogenases, protease, acidic and alkaline phosphatases and β-glucosidase under selected treatments of the ecological hop production system in experimental field.

The plots were established on brown soil in Jastków and comprised hop plantations (Marynka variety) under ecological cultivation within one year of the following treatments: a) probiotic inoculants (EM-Farming™ preparations) and horse manure (EMHM), b) basalt meal and horse manure (BMHM), c) basalt meal (BM), d) the control - with no treatments (C). The soil samples for the research were collected after the cone harvest and included rhizosphere soil.

In enzymatic activity evaluation we found significant differences in β-glucosidase activity among treatments. EMHM was significantly higher than BM and BMHM, however there was no significant differences compared to C. As far as dehydrogenases activity it was revealed that BMHM reached C soil and BM and EMHM were significantly lower than in control. The opposite situation was met in acid phosphatase activity evaluation: in BM and EMHM treatments the values of were at the same level as in control soil, while BMHM was lower than the above mentioned treatments. When alkaline phosphatase and protease activity taken under consideration, there was no significant differences revealed among treatments.

TDR PROBES LOCATION IMPACT ON THE SOIL MOISTURE MEASUREMENT*

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Nowadays, due to its advantages and wide applicability range, reflectometric methods used for soil moisture measurements have become more and more popular. This technique has been constantly developed and improved, resulting in many new questions and doubts. Some of them seems to be particularly important, as the probe rods have spatial dimension (length) and the medium in which these rods are inserted is usually heterogeneous. Firstly, is the commonly accepted assumption that moisture measurement performed by TDR (Time-Domain Reflectrometry) probes shows the average value of the soil water content in the soil sample correct? Secondly, if so, is it an arithmetic mean? Above questions have been related to the possibility that the moisture measurement will be dependent on the placement of the TDR probe. If such a dependence occurs, another two questions emerge. Namely, is there any specific probe placement, in which moisture measurement will be characterizing the entire sample? And whether the above will change during dynamic processes of wetting and drying, which are typical in, for example, soil hysteresis measurements? In this paper, studies addressing the above issues have been presented. Soil samples with different physical properties, undisturbed and also disturbed, were used. Our results show not only that the soil moisture measurement depends on the placement of the TDR probe in the sample, but also that (within the measurement error) the TDR probes were measuring arithmetic mean of soil moisture in the soil sample, also during water content changes. This result was general and does not depend on the analyzed sample.

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MEASUREMENTS OF ELECTRICAL PARAMETERS OF CARBOHYDRATES' AQUEOUS SOLUTIONS*

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Impedance spectroscopy is a useful and sensitive tool for analysing electrical properties of agrophysical materials. Direct analysis of the data from a measuring instrument does not allow the clear identification of electrical parameters of a tested material. Electrical properties depend on the frequency of an applied electrical signal. Interpretation of frequency spectra requires a theoretical model which enables finding physical interpretation of considered parameters, which are functions of concentration of examined substance and may be related with foods qualitative factors.

The purpose of the study was to investigate differences among electrical parameters of aqueous solutions of monosaccharaides (glucose and fructose) and disaccharide (sucrose) of various concentrations. The experimental setup consisted of an LCR meter Agilent E4980a and a prototype sensor. The measurement frequency range was 20 Hz – 2 MHz. Data analysis was performed using the Powell algorithm in the EIS Spectrum Analyser. The program fits an impedance spectrum of an electrical equivalent circuit (EEC) to the experimental data. The equivalent circuit consisted of three elements: capacitance, resistance and a constant phase element (CPE). Values of physical parameters of these elements can be connected with carbohydrates solutions' concentrations.

The next stage of the research will be attempting to correlate the experimental data with electrical parameters of honeys to assess their quality.

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ESTIMATION TOMATO FRUIT COMPONENTS USING HYPERSPECTRAL REFLECTANCE DATA BY HANDHELD PORTABLE SPECTROMETER

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Processing tomato represents a large amount of the processed vegetables in the world. Its important quality characteristics are fruit soluble solids, lycopene and other antioxidants content for the food industry. Analytical quantification of these components is destructive, time and labour consuming. That is why researchers try to develop a non-destructive and rapid method to assess the fruit quality. Present study reports the suitability of a portable handheld visible near infrared (VNIR) spectrometer to predict soluble solids content (SSC) of tomato fruit puree. Spectral ranges of 325-1075 nm were directly acquired on fruit puree of five different tomato varieties using a FieldSpec HandHeld 2™ Portable Spectroradiometer. Immediately after spectral measurement, each fruit sample was analysed to determine soluble solids, lycopene and other antioxidant content. Partial least square regressions were carried out to perform linear models of prediction between spectral data and the values obtained from the chemical analyses. The accuracy of the predictions was discussed according to the correlation coefficient value (R), the root mean square error of calibration/cross-validation (RMSEC/CV). Such analyses resulted in calibration equations with R^2 = 0.96 (SSC), 0.96 (lycopene), 0.95 (polyphenols); standard error of calibration = 0.20 (SSC), 0.86 (lycopene), 3.23 (polyphenols); standard error of cross-validation = 0.20 (SSC), 0.86 (lycopene), 3.25 (polyphenols).

SOIL BULK DENSITY FROM GRASSLANDS IN THE MAGALLANES REGION, CHILE*

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In the Magallanes region, southern Chile, animal production is extensive and the main vegetation communities are: tussock grassland – mainly *Festuca gracillima*, valley greens (vegas), dwarf shrub heath - mainly *Empetrum rubrum*, bushes, prairies and forest. As part of a major project to develop and implement a dynamic system of monitoring grasslands, it soil differences between communities have been measured and classified. The Information on soil bulk density can then be used to soil characterization, sowing, irrigation and to base decisions on fertilization application. The integration of this information will enable grassland condition to be classified and assessed.

To determine soil bulk density (BD), soil samples were taken by driving a cylinder (of known volume) vertically into the soil to different depths following Rowell (1994). Soil samples were dried at 105°C to constant weight, and the samples reweighed (Blake and Hartge, 1986). The main findings were that BD values (in ascending order) were: vegas with 0.28 g cm^3 (range 0.20-0.39 g cm^3); *Empetrum rubrum* 0.54 g cm^3 (ranged between 0.50-0.57 g cm^3). The BD in prairies was 0.66 g cm^3 (range 0.55-0.84 g cm^3); *Festuca gracillima* tussock 0.71 g cm^3 (range 0.58-0.87 g cm^3); bush 1.04 g cm^3 (range 0.82-1.44 g cm^3).

These results will help those involved in land use decision-making to better manage the soil resource, and BD integrated as a workable index with other parameters could be useful in classification of vegetation communities.

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DYNAMIC SYSTEM OF MONITORING ON GRASSLANDS IN THE MAGALLANES REGION, CHILE*

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In the Magallanes region, southern Chile, there is a need to optimize the management of the grassland resource, by providing a scientific basis to underpin decisions on stocking rate, timing and duration which will be environmentally and economically sustainable. This project aims to develop and implement a dynamic system of monitoring grasslands. Where, a web platform will be used to check grassland condition with a high update frequency throughout the year. This tool can then be used to base decisions on pasture utilization. The inputs and support to the system will be from remote sensing images and climatic data from field-based automatic sensors.

The integration of this information will enable grassland condition to be assessed and a dynamic analysis of trends carried out during each year and between years.

The development of this tool will help those involved in decision making for better livestock management, and could potentially affect the grazing patterns of more than two million sheep in this region. The project will have wider benefits which will impact on the private, public and scientific communities. The project output will help develop an ICP (grassland index condition), whereby the condition of each paddock in the farm can be compared with its historic condition. This index integrates parameters such as potential evapotranspiration (based on methodology of Allen et al., 1998), hydric stress, NDVI (Normalized Difference Vegetation Index) and livestock value. The validation of this index in the field will be based on the methodology of Chuvieco (2002).

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DISTRIBUTION AND STORAGE OF SOIL ORGANIC CARBON IN AN AGRICULTURALLY USED SMALL CATCHMENT OF THE LUBLIN UPLAND, POLAND

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The response of carbon stocks to climate change is assessed by treating soils as a spatial distribution of homogeneous units, each with a characteristic vertical profile. In the undulating loess landscape, soil erosion and deposition have a significant influence on the vertical and horizontal distribution of carbon pools. The purpose of the studies was to characterize distribution and storage of soil organic carbon within a small agricultural catchment.

Studies were carried out in a loess catchment (5.7 ha) of the Lublin Upland, Poland. The catchment has remained under agricultural land use from the beginning of the 19th century and comprises from 11 parcels with wheat, barley, potatoes, and sugar beets. Samples for soil organic carbon (SOC) analysis were collected from 138 locations of a grid 20x20 m. Samples were taken from plow layer (0-30 cm), subsoil (30-50 cm), and deeper layers of depositional soils in the autumn 2005. In each of sampling points, pedon structure was characterized on the basis of description of intact soil cores. From 138 locations, profiles of non-eroded soils represent 30, eroded soils – 45, and depositional soils - 25% of pedons. SOC was determined by wet combustion with dichromate solution (Tiurin's method).

SOC concentration ranged from 6.0 to 14.2 g kg^{-1} in plow layer, and from 1.2 to 13.4 g kg^{-1} in subsoil. The former characterized a normal distribution with a mean of 9.7, and the latter – lognormal with mean of 4.5 and median of 3.6 g kg^{-1}. In plow layer, the largest SOC concentration of 10.9 and 10.0 g kg^{-1} was found in depositional and non-eroded soils, respectively. Then, SOC concentration gradually decreased with soil truncation. In subsoil, the largest SOC concentration was found in depositional and non-eroded soils with mean of 7.6 and 3.9 g kg^{-1}, respectively. With soil truncation, a tendency to decrease of SOC was observed also in subsoil. Studies showed that differences between SOC concentration in parcels of the catchment were small, and ranged from 9.1-10.5, a from 3.1-5.8 g kg^{-1} in plow layer and subsoil, respectively. Spatial distribution of SOC was best described by spherical isotropic models with a range 44 m (plow layer) and 34 m (subsoil).

The studies showed that SOC distribution is closely related to the processes of erosion and deposition in the catchment. Higher SOC concentration was found in closed depressions located in different parts of catchment plateau and in the locations where temporary flow met the barrier as ridges that depart the parcels.

THE EFFECT OF MODIFICATION OF PEDON STRUCTURE ON REDISTRIBUTION OF SOIL WATER WITHIN A FIELD OF LOESS PLATEAU (E POLAND)

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Long-term tillage and water erosion in loess areas have resulted in modification of structure of Haplic Luvisol. Review of field experiments in the Lublin Upland showed that the average decrease of cereals yield due to pedon truncation was up to 25% (Rejman & Iglik, 2010). The yield decrease is predominantly explained by insufficiency of available water in eroded soils. The purpose of the studies was to evaluate the effect of pedon modification on soil water content.

The studies were carried out in a field (0.72 ha) located in the loess plateau (Lublin Upland, E Poland) in the years 2007-08. Soil water content (SWC) in the near-soil surface (2-7 cm) was determined with portable time domain reflectometer (TDR), (EasyTestCo, Lublin) during vegetation of spring barley (May–August). Measurements were performed in 9 periods each year, in 72 points of a grid 10x10 m. During the last measurement, soil samples were taken to determine the density. Pedon structure, texture and soil organic carbon were determined in each of sampling points. Rainfall was registered with a standard gauge of weekly recording, located at the distance of 50 m from the field.

Average SWC at near soil surface was 0.15 and 0.20 m^3m^{-3} during vegetation period of barley in 2007 and 2008, respectively. The values well corresponded to the rainfall amount of 113.9 in 2007 and 179.3 mm in 2008. SWC was highest at the beginning of measurements (0.25 on 5th June 07, and 0.29 m^3m^{-3} on 20th May 08) and then follow the rainfall distribution. The lowest SWC was recorded on 3rd July 07 (0.07) and 24th June 08 (0.12 m^3m^{-3}). Spatial distribution of SWC within the field was best described by isotropic spherical models with the range of 17-50 m. Two patterns of soil water response to pedon structure was observed during the studies. Differentiation of pedon structure slightly affect the SWC at the beginning of vegetation period (May-June) and has started to differ water content from July. Then, higher SWC was found on eroded soils of plough layer developed from the Bt1, Bt2 and BC horizons, that represented slightly, moderately and severely eroded soils, respectively, and lower on non-eroded and depositional soils. The average difference of SWC between these two groups of soils was 0.02, and 0.04 m^3m^{-3} in 2007 and 2008, respectively.

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INNOVATIVE PRESS FOR SLEEVE SILAGE*

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Silage technology of plant materials with high dry matter content have undergone substantial development in recent decades. Round baler are currently available on the market, that facilitate harvest of crops such as straw, hay or corn stover with simultaneous compaction and binding into bales resulting in more convenient handling and transport. Application of these presses resulted in improvement of efficiency of production and quality of the product, but numerous problems concerning optimization of equipment and technology remain to be solved.

A response for some of those inconveniences stored was introduction of plastic sleeves to contain ensiled crops. This method of production of silage ensures high quality of produced forage with minimum loss of nutrients. Within proposed solution, additionally innovative solution was adopted. During compression of material namely, possibility of simultaneous addition of excipients improving process of ensiling will be possible. Application of presses to fill the sleeve ensures an adequate level of density of processed material. Using of plastic sleeves allow to protect sealed material from influence of air and rainwater, which is crucial from the point of view of maintaining quality of the final product. The innovative technology used in the new prototype press will assure high quality of silage with improved nutritional value.

The main advantages of use of sleeve silage are:

a) Immediately shut off oxygen (to avoid spoilage)
b) Stability of the silage mass
c) Reduction in waste production
d) Negligible impact on the environment (elimination of leakage to groundwater)

The aim of presented project is to elaborate, design and produce prototype of innovative silage press (global level of product innovation). During the research phase (industrial research and development) a number of innovative design solutions that are based on innovative concepts will be proposed to enable filling plastic sleeves with such materials as: fodder from corn, grass, alfalfa, clover, pulp and roots from sugar beet, beverage waste, dead leaves, municipal waste of plants residues etc. Addition of supplementary components to silage during the process of filling the plastic sleeve will be enabled.

* This work has been done in the frame of project „ Development of technological advanced silage press construction with high level of innovative". This work has been supported by National Center for Research and Development (NCBiR) Poland as the project INNOTECH In-Tech, in years 2013-2014.

INFLUENCE OF TEMPERATURE, MOISTURE CONTENT AND PRESSURE ON MICROBIOLOGICAL QUALITY OF RAPESEED STORED AT ANAEROBIC CONDITIONS

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The aim of the presented work was to determine the effect of pressure, temperature and seed moisture content on the quality of rapeseed stored without oxygen. The storage conditions of rapeseed were simulated in compression chambers, which allowed to simulate extreme values of pressure and temperature. The pressure which seeds were subjected in the chamber were 20, 40 and 60 kPa (pressure levels at experiment correspond to the real levels of pressures in the silo), temperatures 25, 30 and 35°C. Each experiment was conducted for four levels of seed moisture content: 7, 10, 13 and 16% (w.b.).

After 28 days of storage the assessment of mould contamination of rapeseed was carried out. For this purpose the number of colony forming units (CFUs) of moulds was used as a measure of development of fungi. During microbiological analyses CFUs of moulds per 1 g of grain were counted according to PN-ISO 7698:2004 and fungi colonizing seeds were identified. The level of CFUs of moulds in sample of rapeseed with moisture content of 7% stored at 20°C at aerobic conditions (reference sample) was 2.0×10^3 cfu·g^{-1}. In samples stored in the silo rapeseed contamination with filamentous fungi varied depending on the storage condition. The maximum levels of CFUs of moulds in stored samples of rapeseed were influenced by seed moisture content. An increase in value of applied pressure in the silo caused that the maximum level of fungal microflora was observed in samples with higher seed moisture content. In consequence, the highest level of the CFUs of mould in rapeseed stored at pressure of 20 kPa was observed for seeds with moisture content of 10% (1.8×10^5 cfu·g^{-1}), regardless of the storage temperature. In samples stored at pressure of 40 kPa the greatest value of CFUs of moulds was obtained for rapeseed with moisture content of 13% (5.0×10^5 cfu·g^{-1}), while for the highest applied pressure the most intensive growth of moulds occurred in rapeseed with moisture content of 16% (6.4×10^5 cfu·g^{-1}). In samples of seed with moisture content of 7%, development of moulds was limited and CFUs did not exceed 2.0×10^3 cfu·g^{-1} at each temperature and at each applied values of pressure. Among the moulds presented in the seed were mainly storage fungi of the genus *Aspergillus* (spp. *flavus, niger, versicolor* and *candidus*), *Eurotium* spp., including *E. amstelodami*, and *Penicillium* spp. Moreover, fungi from the genera *Fusarium, Alternaria* and *Cladosporium* occurred.

DYNAMICS OF UPPER LAYER SOIL MOISTURE AS INFORMATION ON INTENSITY OF EFFECTIVE NON RAINFALL

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The objective of this paper is to present a method permitting the determination of the diurnal distribution of the intensity of effective non rainfall. The method presented is based on the application of the TDR technique and of impermeable to water aluminium barriers placed beneath the surface of the soil. Those barriers cause that, after the adoption of certain assumptions, the moisture content of the top horizon of the soil is related only to the effective non rainfall. It was found that the application of TDR technique for the determination of diurnal dynamics of the intensity of effective non rainfall (E^R) requires the introduction of a temperature correction during the determination of volumetric moisture. Its absence may cause that the value of E^R will be estimated with an error of as much as 26%. In addition, an analysis of the effect of changes in the temperature on the soil surface during periods of 0.5, 1, 2, 3, 4, and 5 hours was performed. It was found that the intensity of effective non rainfall is determined to the greatest extent by the rate of temperature drop during the period of 3 hours preceding the determination of the E^R value. The agreement of E^R values calculated with the method proposed with values obtained from a collector was better for periods with dew than for periods with hoarfrost.

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CALCULATION OF FRACTAL DIMENSION OF SOIL ON THE BASIS OF PARTICLE SIZE DISTRIBUTION MEASURED WITH THE LASER DIFFRACTION METHOD

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One of the methods used in calculations of fractal dimension is analysis of particle size distribution (PSD). For many years, PSD has been measured with sedimentation methods (based on Stokes' law). Over the past few decades, laser diffraction has been developing as a new PSD measurement method. One of the main differences between those techniques is that sedimentation methods are very limited in the case of particle size classes (fractions), while modern laser diffraction software produces practically unlimited size classes. The aim of this work is to evaluate a possible impact of the number of size fractions and intervals between them on fractal dimension calculations based on PSD.

The PSD measurements presented in this study were conducted on material with a broad spectrum of granulometric fractions. A Malvern Mastersizer 2000 laser analyser of diffraction particle size (measuring the range from 0.02 μm to 2 mm) was used in PSD measurements.

The soil fractal dimension calculations were based on the fragmentation concept modified to suit volumetric particle size distribution from laser diffraction.

The impact of different calculation algorithms (linear and logarithmic), the size measurement range, and the number of intervals were evaluated. Three different measurement ranges were used for calculations. The impact of 10, 100 and 1000 size intervals on the volume/radius ratio and fractal dimension was evaluated (Bieganowski et al., 2013).

The conclusion of this paper is that both the number of size classes and the division method used to determine them alter the calculated fractal dimension (Bieganowski et al., 2013). Therefore, any procedures that employ such calculations should be standardized.

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TESTING OF PRINCIPAL COMPONENT ANALYSIS FOR IMPROVING SOIL WATER CONTENT DETERMINATION*

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The Principal Component Analysis (PCA) is one of statistical methods, which allows analyzing a data set consisting of a certain number of observations and variables. The aim of PCA is to determine the correlations among variables and reduce their number, transforming the original multidimensional coordinate system of a considered data set into the one with fewer variables (Jolliffe, 2002). The new variables (coordinates) are called the principal components, which are ordered according to the amount of information they carry about the data. One of the possible application of the PCA method in agriculture is to differentiate samples on account of a selected feature, e.g. to distinguish damaged wheat grains from healthy ones (Hiller et al., 2008).

The objective of the work is to derive a calibration function connecting volumetric water content with other soil parameters, such as refractive index (measured by the TDR – time domain reflectometry method), bulk density, porosity, solid phase density, carbon content and soil texture. The calculations were performed using the *Statistica* software.

It has been determined that the calibration function obtained using the PCA method gives the values of soil water content comparable to the values computed from the multiple linear regression for a given set of soil parameters.

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IMPACT OF WASTEWATER APPLICATION ON METALS CONTENT AND MAGNETIC SUSCEPTIBILITY IN MINERAL AND ORGANIC SOILS

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Irrigation with municipal wastewater is a practice which can resolve certain environmental problems mainly related to an excessive or unbalanced supply of nutrients and the introduction of pollutants to ground water. An accumulation of undesirable chemical constituents such as heavy metals has potential to restrict some soils functions and to cause plant toxicity and food chain contamination.

The aim of this work was determination of heavy metals content and magnetic susceptibility in peat-muck and mineral-muck soils.

Soils were irrigated for four consecutive years, 10 times per year with low dose (optimum NPK for plants, 60 mm), and high dose doubled (120 mm) under field conditions. Control soil had never received wastewater. Elemental concentrations in powder soil samples were determined with the desktop XRF crystal diffraction scanning spectrometer SPECTROSCAN MAKC-GV. Measurements of specific magnetic susceptibility (MS) was carried out using a meter KT-6 Kappameter.

The sum of heavy metals were the highest in soil irrigated with low wastewater dose. Mineral-muck soil showed significantly higher content of Al, Fe, Cr and Cu, while lower content of Mn and Pb than peat-muck soils. Magnetic susceptibility was differentiated by soil-plant system, soil depth, as well as by wastewater dose. The relationship between the value of the magnetic susceptibility and the content of the sum of the analyzed heavy metals, iron and aluminium, and organic matter content was observed.

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SURFACE AREA OF MINERAL AND ORGANIC SOILS TREATMENT WITH MUNICIPAL WASTES

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The specific surface can be used as a measure of surface activity and it is significantly related to various chemical and physical properties of soils. In relation to processes taking place at solid-gas phase boundaries, the specific surface is viewed as the surface accessible to gas molecules. It encompasses the external surface of a solid body as well as its internal surface produced by its porosity.

The aim of this work was analysis of the specific surface area of the peat-muck and mineral-muck soils irrigated with wastewater.

The study was carried out on mineral and organic soil irrigated with municipal wastewater. Plots with peat-muck soil was planted with *Populus spp*. or *Salix spp*. and mineral muck soil was covered with grasses. Soil samples were collected from four depths: 10, 30, 50 and 70 cm.

The surface area of investigated soil samples was evaluated from adsorption isotherms in the BET range of relative water vapor pressure according to the procedure described by the Polish Standard PN-Z-19010-1 for measuring the surface area of soil.

The values of specific surface area in soils were differential and were related to soil type and soil depth as well as plant cover. An increase in the specific surface area of the upper layers of the organic soil were observed. The differences were more visible for the higher dose for plot planted by willow and for lower dose for plot covered by poplar. The specific surface area for mineral muck soil for both doses also increased, except for the depth of 10-30 cm for both doses and for the depth of 50-70 cm for higher dose.

OXYGEN AVAILABILITY EFFECT ON METHANE FORMATION IN PEAT SOILS

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Methanogens are representatives of *Archaea* domain, for which exposure to oxygen provide to stress or it is lethal for them. Generally this group of microorganisms inhabit anaerobic environment, like peatlands, where reduce CO_2, formate, methanol, or acetate to methane.

Ability of peat soils to methane formation after exposition of atmospheric oxygen and in anaerobic conditions were investigated. Peat samples originated from three sides, differs in properties, vegetation and water supply, characteristic for Polesie Lubelskie Region: (1) Garbatówka and (2) Orłowskie peatlands represented a fens and transitional bog properly and (3) woodland, surrounding Moszne Lake, from surface to 80 cm depth, were taken. During laboratory incubations (at 5, 10, 20°C) microdiffusion of oxygen (ODR) in peat soils and concentration of CH_4, CO_2 and O_2 in headspace of samples in each variants of incubations were controlled. The highest activity in methane formation was determined at 20°C, in Garbatówka, where reached maximally 3.31 and 17.06 mg CH_4 kg d.w.$^{-1}$ d^{-1}. Methane production took place when ODR was below 35 μg O_2 m^{-2} s^{-1}, that is in hypoxia and anoxia states.

Results indicated that peat soils are highly heterogenic, and presented of water film on the surface of soil aggregates and in pores can slower diffusion of gases into soil, what results aerobic and anaerobic sides co-exist together. The information about the activities of methanogens after oxygenated periods and its survivability oxygen stress are strongly limited except three reported cases: rice paddy soil, oxygenated water column and desert (Yuan et al., 2009; Angel et al., 2011; Grossart et al., 2011).

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DEHYDROGENASE ACTIVITY AND TOTAL DNA LEVEL IN *MOLLIC GLEYSOL*

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The aim of the study was to determine the relationship between activity of some of the most important intracellular soil enzymes – dehydrogenases, carrying out bio-oxidation of organic compounds and being the respiratory intensity indicators of soil bacteria metabolism, and the concentration of soil e-DNA in the *Mollic Gleysol* profile. Moreover, the relationship among dehydrogenase activity (DHA), e-DNA content and soil physicochemical parameters, such as: pH, redox potential (Eh), organic carbon content (TOC) and bulk density, directly influenced on soil biological activity, were also determined.

For our study, we selected a floodplain area (Kosiorów Village, 51° 13' N; 21° 51') in SE Poland along Chodelka River. To make possible an estimation of the effect of different way of land use on DHA and e-DNA level we selected two neighbouring agricultural meadows located close to river, that show clear differences in fertilization practice. One of them was systematically cultivated and mineral fertilized, whereas the second was deprived of any effect of anthropogenic activity, and was used as a control. Soil material was taken from three layers of profiles: surface (0-20 cm), subsurface (20-40 cm) and subsoil (40-60 cm).

We demonstrated that both DHA level as e-DNA content reached higher values in cultivated soil. Moreover, DHA showed a directly proportional, significant correlation with e-DNA concentration, what was confirmed by correlation coefficients: $r=0.77^{*}$ for cultivated meadow and much higher $r=0.99^{***}$ for control site.

So far in literature database, relationship between DHA and e-DNA level have not been documented nor confirmed by statistical analysis. The optimal conditions under which the processes conducted with dehydrogenases occurred the most intensively were defined by determining significant positive correlations with TOC, and negative with pH, Eh and soil bulk density.

Comparison of microorganisms biodiversity isolated from the subsurface layer of cultivated meadow (with 93% of identity) revealed that *Enterobacteriaceae* is the dominant family, with representatives of the following genera: *Hafnia alvei*, *Obesumbacterium proteus, Serratia symbiotica* and *Pectobacterium carotovorum*.

Finally, it was possible to conclude that moderate human agricultural practices improves and stimulate microbial DHA and DNA presence in the *Mollic Gleysol*.

IN SEARCH OF THE CARBON DIOXIDE ORIGIN

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Isotope ratios of carbon in carbon dioxide emitted by soil are strongly correlated with the isotopic composition of Soil Organic Matter (SOM). Exudates secreted via roots and plant residues are the main part of SOM, which is a source of carbon for soil microorganisms. SOM deriving from different types of plant C_3 and C_4 differs in terms of the amount of carbon isotopes. When microbes use carbon for their vital activity, the isotopic composition of the substrate is imprinted in the isotopic composition of their biomass and products of their metabolism (Kristiansen et al., 2004 and Blagodatskaya et al., 2011). Carbon dioxide is one of many products of microbial vital activity - it is formed during oxygen respiration, is a direct product of gaining energy from carbon compounds, and is a simple indicator of SOM origin.

The analyses of the isotopic composition of carbon dioxide were carried out using a Thermo Electronics DELTA V Advantage continuous-flow mass spectrometer for determination of stable isotope ratios (IRMS – Isotope Ratio Mass Spectrometry). The IRMS technique allows determination of the stable isotope ratio. Knowledge of isotope mass ratios of a given substance facilitates identification of the substance origin and/or processes in which it has participated (Benson et al., 2006). In our experiment, we used two types of sucrose: one from sugar beet (C_3 plant) and the other from sugar cane (C_4 plant). These easy available C-compounds were added to the soil and tightly closed in incubation containers. We measured the concentration and isotopic composition of CO_2 during its production and imbibition. The $\delta^{13}C$ provided information about the processes of carbon changes in soil.

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THE ROLE OF THE CELL WALL IN SHAPING OF ION-EXCHANGE PROPERTIES OF PLANT ROOTS

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Introduction: The main function of plant roots are: uptake and transport of water and ions. The root surface is dominated by negative charges. Most often used in the literature important indicator characterizing the downloading of cations through the plants root the Cation Exchange Capacity (CEC) of roots. The negative charge comes mainly from dissociated carboxyl groups of the cell wall of the root. In addition, a negative charge of root is determined by the dissociated carboxylic groups of proteins and phosphate cytoplasmic membrane phospholipids.The main factor determining the CEC of the roots are carboxyl groups of pectin cell walls.

The aim of the study was to: Identify the role of cell wall pectin's roots of monocotyledonous and dicotyledonous plants, in shaping the CEC of the roots of these plants.

Material and Methods: The research was carried out on cell wall isolated from root of plants: rye, wheat (monocotyledonous) and lupine, clover (dicotyledonous). The cell wall of roots was isolated as alcohol-insoluble residue (AIR). The Continuous Flow Analyzer *(*CFA) SanPlus was used to determinate tree fractions of pectin (in triplicate):

WSF- fraction the water-soluble fraction (WSF – pectin that is loosely associated with the cell wall)

CSF - fraction the CDTA-soluble (pectin that is enriched in bound ions)

NSF - fraction the Na_2CO_3 soluble (pectin that is enriched in covalently bound ions).

The total content of pectin in cell wall of roots of plants was the total sum of the three fractions of pectin. The potentiometric titration was used for cation exchange capacity **(**CEC) cell wall of roots.

Results: The research showed the cell wall of roots of monocotyledonous contained 3-7 μg · mg dry mass of pectin. The Cation Exchange Capacity (CEC) of cell wall, isolated from roots of rye and wheat were 139 and 145 $mmol \cdot g^{-1}$ dry mass. The cell wall taken from roots of lupine and clover contained 30-40 μg · mg dry mass of pectin and characterized by a larger CEC; lupine – 205 $mmol \cdot g^{-1}$ s.m and clover – 371 $mmol \cdot g^{-1}$ s.m. The highest content in percentage contained the fraction the CDTA (pectin that is enriched in bound ions) - 42 -65%. The fraction WSF contained about 13% for cell wall of lupine roots and 29% for cell wall of wheat roots. The fraction NSF was between 22% (lupine) – 36% (clover) with regard to the total content of pectin. The Pearson correlation coefficient R describing the degree of linear relationship between two sets of data: CEC and the total contect of pectin in cell wall. In this case the Pearson correlation coefficient was R = 0,83. Fraction of pectin WSF was the highest correlation coefficient (R = 0,99) with regard to CEC .

THE EFFECT OF MOISTURE CONTENT ON THE THERMAL PROPERTIES OF PEAT, MARSHY AND MINERAL SOILS IN POLESIE AND BIEBRZA WETLANDS*

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The study was performed to evaluate temporal and spatial distribution of the soil thermal properties (thermal conductivity, heat capacity and thermal diffusivity) in relation to soil wetness and bulk density in a soil wetlands on Polesie and Biebrza. The thermal properties were determined based on soil textural and mineral composition, water content and bulk density at each wetness status, together with temperature. Thermal conductivity was measured using KD2Poro Decagon probe and calculated by the physical-statistical model (Usowicz, et al., 2006) and heat capacity – with empirical formulae, and thermal diffusivity from the ratio of thermal conductivity and heat capacity. It was shown that the thermal conductivity was considerably lower in peat and marsh soils compared with mineral soils irrespective of soil water status. Maximum thermal conductivity of the organic wetland soils of different bulk density did not exceed the value of the thermal conductivity of water whereas in mineral soils it was approximately 3-5 times higher. The heat capacity of the soils increased linearly with moisture content. Soils richer in organic matter and thus of lower densities show the minimum heat capacity in the dry state and highest and almost equal to the water heat capacity at saturation with water. Characteristic extremes of the thermal diffusivity were observed. In the case of organic soils the diffusivity was lower, by almost one order of magnitude, compared with mineral soils. Soils with a higher content of organic matter exhibit both minimum and maximum, while mineral soils – only maximum. The maximum diffusivity at the same moisture content was greater for the higher densities and tends to move toward the lower moisture content for higher densities. The studied soils in Polesie and Biebrza wetlands, higher in organic matter exhibit smaller temporal variation of the thermal diffusivity compared to soils lower in organic matter content in response to changes of water content. Mineral soils had similar thermal diffusivities in both sites.

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DIELECTRIC PERMITTIVITY OF POROUS MEDIA IN RELATION TO WATER STATUS: MODELING APPROACH*

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The dielectric permittivity of porous media is the property responsible on the electromagnetic (EM) propagation constant. Reaction on the EM wave on presence of water is deserved by non symmetry of water molecules having large polarization momentum. Usually, the dielectric permittivity is measured in-situ by TDR, or remotely by radar or radiometer techniques. Any measurement technique requires specialized design of hardware dependent on evaluating effects by modeling. The permittivity of the media substantially depends on the texture, the mineralogical composition, but also on the contents of gas and liquid compounds. All that aspects involve fundamental dependence on the temperature, the pressure and other environmental parameters determining possible transport of mass and energy. A dependence of the permittivity on these forcing environmental conditions, create a need of building a model as a well organized hierarchy of particular physical relations, being ordered to one common principle enabling a statistical use of it. Such model was firstly proposed by (Usowicz et al., 2006) and developed for thermal properties of soils, in particular respecting the porosity. The organizing principle was defined as a mesh of elementary electric resistors and capacitors, representing physical soil media by substitute of electrical analogs and measures. The model may be modified for representing different kinds of target properties like thermal and dielectric properties individually, or modified by adding new elements for introducing other parameters determining different forcing conditions. This study on the dielectric permittivity of various porous media (mineral and organic terrestrial soils, glass beads and snow) was successfully done for calibrating TDR measurements in a wide range of input parameters for predicting properties of soils using the statistical-physical model. Achieved results prove well the sensitivity on presence of the water in soil, within good ability on calibrating the model. Currently it is aimed for employing the model in interpreting soil moisture data for Poland from Soil Moisture Ocean Salinity (SMOS) mission.

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METHANE OXIDATION IN MINERAL SOILS – KINETIC PARAMETERS

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Methane (CH_4) is one of the strongest greenhouse gases, being 30-fold more radiatively active than carbon dioxide (Jang et al., 2006). Methanotrophs play a significant role because of their ability to oxidize CH_4 from atmosphere.

Knowledge about the kinetics of an enzyme reaction with its substrate is centrally important to biochemists. Methane oxidation has been shown to follow Michaelis-Menten kinetics (Saari et al., 2004; Steenbergh et al., 2010). Kinetic parameters include the maximum reaction rate, V_{max}, and the Michaelis constant, K_m which is defined as the substrate concentration at which the reaction achieves half the maximal rate ($V_{max}/2$).

The kinetic parameters of methane oxidation in three mineral soils (Mollic Gleysol, Haplic Podzol and Eutric Cambisol) were measured under laboratory conditions. Methane was added to obtain initial concentration of 0.5, 1.0, 1.5, 3.0, 5.0, and 10% (vol.). All soils showed methanotrophic potential but differed in the intensity of the consumption of added substrate. The Eutric Cambisol showed higher than other soils affinity to methane, characterized by relatively low K_m and V_{max} values of 5.98 μmol and 0.137 μmol g^{-1} h^{-1}, respectively. The Mollic Gleysol oxidized added methane most rapidly with a low affinity activity characterized by a high apparent K_m=30.7 μmol and V_{max}=0.550 μmol g^{-1} h^{-1}. Haplic Podzol and, especially, the Mollic Gleysol showed CH_4 oxidation kinetics similar to those observed in organic soils (Gulledge et al., 2004; Saari et al., 2004). By quantifying the kinetics parameters, it could be determined whether a soil was exposed only to atmospheric and sub-atmospheric concentrations of CH_4, with high affinity methanotrophic activity then dominating.

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IMPACT OF PRE-SOWING 4-HYDROXYPHENETHYL ALCOHOL TREATMENT OF BARLEY (*HORDEUM VULGARE*) SEEDS ON SOIL RESPIRATION UNDER DIFFERENT SOIL MOISTURE – POT EXPERIMENT

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The 4-hydroxyphenethyl alcohol (4-HPEA) is a phenolic compound and characterized as a nonpurine cytokinin-like substance. It has been shown that 4-HPEA stimulates plant growth in the juvenile phase. Soil respiration, provides the main carbon efflux from terrestrial ecosystems to the atmosphere. Denitrification is the special case of nitrate respiration in which N_2 and other nitrogenous gases are produced. *The aim of the study* was the determination of CO_2 and N_2O release from the soil cultivated with barley seeds pre-sowing treated with 4-hydroxyphenethyl alcohol under different soil moisture.

Barley seeds treated and untreated with 4-HPEA were planted into the soil of three different moisture contents – 18, 35, and 75% (w/w). After the 32 days growth of plants, the soil from pots was placed in the incubation vessel, hermetically sealed and was incubated at 20°C. The concentration of N_2O and CO_2 in the headspace gas was determined with a gas chromatograph (Shimadzu GC-14, Japan) fitted with an electron capture detector and thermal conductivity detector.

The amount of CO_2 evolved ranged from 35 to more than 50 mg CO_2-C kg^{-1} of soil depending on the humidity of the soil. Very intensive N_2O releasing was observed at 3 days of incubation, and ranged from 37 to 5 mg N_2O-N kg^{-1} of soil cultivated with seeds treated with 4-HPEA and 20 to 10 mg N_2O-N kg^{-1} of soil with the seeds untreated depending on the humidity of the soil.

Conclusions:

4-HPEA seeds treatment had no significant effect on the release of CO_2.

4-HPEA seeds treatment significantly reduced the amount of N_2O evolved under flooded conditions.

The tested soil has a high capacity to sink of N_2O.

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