2022

Vladimír Smutný, Vojtěch Lukas (eds.)

Trends and challenges in soil-crop management

2nd Central European ISTRO Conference (CESTRO)
and
8th International Conference of the Czech ISTRO branch

September, 6 – 8, 2022, Brno, Czech Republic
Book of Abstracts

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Acknowledgement:

CESTRO 2022 Conference is supported by the of Ministry of Agriculture of the Czech Republic, National Agency for Agricultural Research Project No. QK 1810186 entitled "Agrotechnical measures for improvement of soil structure stability and rainwater infiltration".

Editors:
Vladimír Smutný, Vojtěch Lukas

ISBN 978-80-7509-847-4

Foreword

On behalf of the Organising Committee of the Czech branch of ISTRO (ISTRO CZ), the Croatian Soil Tillage Research Organisation (CROSTRO), and the Hungarian branch of ISTRO (HUISTRO), under the auspice of the International Soil Tillage Research Organisation (ISTRO) and other supporting institutions:

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We are pleased to invite you to the International Scientific Conference that will take place in Brno, Czech Republic, September 6 – 8, 2022.

For the second time since the association's establishment of our national branches, the Czech Republic, Croatia, and Hungary will organise the 2nd Central European ISTRO Conference (CESTRO) as a joint scientific Conference. From this point of view, we have established a new platform, but on the other hand, we already have quite a long history because it is also the 8th International Conference of the Czech ISTRO branch.

This conference, created for the scientific community and experts from agricultural practice, will cope with the main goals of ISTRO. The primary objective of the conference is the promotion, development and growth of interest and knowledge about soil-crop management, exchange of ideas about trends and challenges in modern agriculture. The conference represents a unique opportunity for learning and exchanging opinions on different topics, which could help harmonise soil and plant health in agroecosystems and mutual cooperation worldwide.

The conference will take place in Brno in 2022 when the 200th anniversary of the birth of Gregor Johann Mendel is commemorated. G. Mendel, the father of modern genetics, whose ideas about inheritance were far ahead of his time, is one of the most famous scientists who lived and worked in Brno.

2nd CESTRO Conference is held under the auspice of the Minister of Agriculture of the Czech Republic Zdeněk Nekula.

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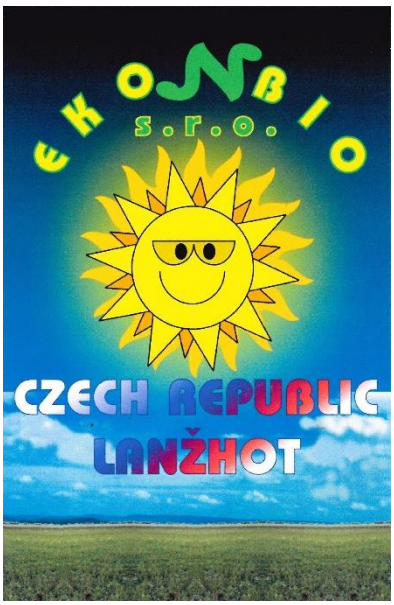

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Content

Keynote lectures

Soil is an ecosystem that can be managed to provide nutrients for plant growth, absorb and retain precipitation for use in periods of drought, filter and buffer potential pollutants leaving our fields, serve as a firm foundation for agricultural activities and provide an environment for the flourishing and diversification of soil microbes that keep the ecosystem running smoothly. Healthy soil is the foundation of profitable, productive, ecologically friendly agricultural systems.

European farmers must adapt to a changing climate, which often means changes in crop management practices and diversification of income sources. Extreme weather and climate events (including droughts and heat waves) can significantly reduce the yields of some crops. The projected increase in the frequency of such events is expected to increase the risk of crop losses, resulting in higher food prices and reduced food security. Opportunities exist to implement a wide range of farm-level measures to improve soil and water management, bringing adaptation, mitigation and environmental and economic benefits.

Long-term effects of conservation tillage on chemical, physical and biological soil properties

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Keywords: crop yield, nutrient stratification, soil structure, water-use efficiency, soil microbiota

Climatic changes increase the importance of conservation tillage practices. Lower tillage intensity can reduce the carbon footprint. Additionally, omitted mouldboard-plowing can positively affect humus, erosion susceptibility and water balance and thus improve the resilience during dry periods or extreme weather events. Effects on crop productivity as well as soil properties were investigated in a long-term field trial started 1992 in Bernburg, Germany (51°82' N, 11°70' E). The soil is a loess chernozem over limestone with an effective rooting depth of 100 cm, containing 22% clay, 70% silt and 8% sand in the ploughed upper (Ap) horizon. It has a neutral pH (7.0±7.4) and an appropriate P and K supply. The 1991-2020 annual average temperature was 10.1°C, the average annual precipitation 514 mm. The individual crops of the crop rotation (grain maize – winter wheat – winter barley – oilseed rape – winter wheat) stand side by side annually on 1.2 ha parcels. Within these, 4 blocks are plowed annually, 4 are conservation tilled. All crop residues remain on the field.

In years with average weather, yields were at a comparable level. In extremely dry years, the positive effects of conservation tillage were more frequent, with significantly lower yields overall. The absence of soil turning resulted in a significant stratification of soil P and K contents (Deubel et al. 2011). As crop residues remain, K accumulates strongly near the soil surface, reaching equilibrium within a few years. P gradients arise mainly from surface fertilization and increase in the long term. Nutrients near the soil surface are insufficiently utilized, especially during dry periods.

Bulk density and penetration resistance of top soil were significantly higher under conservation tillage, resulting in a large decline of air capacity. This can reduce root penetration, root respiration, and microbial activity. The expectation that the plow pan would loosen under conservation tillage was not fulfilled. Below 25-30 cm soil depth there were hardly any differences in soil physical properties. X-ray CT imaging was used to test tillage effects on pore continuity and soil microstructure (Schlüter et al. 2018). It was shown that at this site the higher bulk density is hardly compensated by higher bioturbation. This may be due to unfavourable conditions for anecic earthworms (limited soil depth and frequent dry periods). Although positive effects of conservation tillage on earthworm abundance and biomass have been found in several experimental years. However, the proportion of anecic species was low. There is also a lack of deep-rooting perennial crops in the crop rotation.

Although conservation tillage leaves significantly more crop residue on the soil surface, soil water measurements (using Sentek Diviner® in 0-80 cm soil depth) showed little difference in water use or water use efficiency between tillage treatments. However, a higher proportion of soil water was kept in the uppermost soil layers.

Little is known to date about the effects of different tillage practices on the soil microbiota. Modern molecular biological methods open up new analytical possibilities here. Thus, differences in the composition of fungal (Sommermann et al. 2018) as well as prokaryotic communities (Babin et al. 2018) could be detected. Effects may strongly depend on the season of sampling (Fernandez-Gnecco et al. 2022).

Conservation agriculture: opportunities and challenges for European agriculture

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Keywords: conservation agriculture, cropping system management, soil quality

Conservation agriculture (CA) covers a wide range of practices, characterized by no-tillage, soil surface covered by crop residues or cover crops and diversified crop sequences. The initial objective was to conserve soil moisture and to reduce soil erosion. But this type of agriculture could also provide other benefits, like enhancing carbon sequestration, improved soil structure or protecting soil biodiversity. However, conservation agriculture is often also associated to heavier use of herbicides than conventional farming, and could lead to reduced yields. Farmers are encouraged to adopt conservation agriculture to prevent soil degradation, to enhance soil quality and to mitigate Greenhouse Gas emissions. However, a widespread adoption of conservation agriculture in Europe requires a better knowledge, in a large range of situations, of the real effects of CA in terms of Ecosystemic Services. Enhancing the positive effects of conservation agriculture (and preventing the negative ones) implies a high level of technicity in cropping system management and innovative approaches, such as adoption of perennial mulches, mechanical control of weeds and cover crops, or controlled traffic. Considering the variation in European geography, climates, ecology, cultures, and traditions, the future of CA will be different in different parts of Europe. Yield performance and stability, operating costs, environmental policies and programs, and climate change will likely be the major driving forces defining the extension of CA in Europe.

Effect of conservation agriculture on soil quality under climate change

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Keywords: conservation agriculture, soil degradation, conservation soil tillage, climate change, soil productivity

Soil quality needs to be based on its ability to provide certain functions. Soil quality can be divided into its essential ability as a substrate for crop growth and the dynamic part, which is influenced mainly by the users. Dynamic soil quality contains soil properties that can be changed in a short period of time and are affected by human activity. Soil quality can be divided mainly into physical, chemical and biological soil quality, although these components are in constant interaction with each other, which makes them difficult to separate. Until recently, the term “soil quality” was viewed in the context of plant production and crop productivity, as a result of physical, chemical and biological soil productivity. Soil productivity is the condition of the soil that indicates its ability to provide plants with accommodation under appropriate thermal conditions, favourable water-air relations and a sufficient supply of plants with essential nutrients. Soil productivity is affected by a number of factors such as climate, relief, soil type, soil organisms, weather and applied agricultural techniques. Intensive crop production can deplete the soil to the point that future production can be threatened. Healthy soils are key to developing sustainable crop production systems that they are resistant to the effects of climate change. Conservation agriculture is a concept in support of sustainable land management, environmental protection and climate change adaptation and mitigation. It is a farming system that promotes minimum soil disturbance (which reduces soil erosion and preserves soil organic matter), maintenance of a permanent soil cover (protective layer of vegetation on the soil surface suppresses weeds, protects the soil from the impact of extreme weather patterns, helps to preserve soil moisture, and prevent soils compaction), and diversification of plant species (crop rotation). Conservation agriculture enhances biodiversity and natural biological processes above and below the ground surface, which contribute to increased soil quality. Also, Conservation agriculture help to protect the environment and to reduce both the impacts of climate change on agricultural systems (adaptation) and the contribution of the agricultural practices to greenhouse gases. Increasing degradation of agricultural soils caused by a number of natural and anthropogenic factors puts the role of conservation agriculture, especially conservation soil tillage, as a measure that is able to cope with these problems, following the principles of sustainable soil management. Applying the conservation soil tillage principles, as a part of conservation agriculture, improves soil quality, optimizes crop yields and reduces investment costs in agricultural production. Adopting the conservation soil tillage principles agricultural activity can significantly reduce the negative impact on physical, chemical and biological complex of the soil, as well as other natural processes under climate change. Accordingly, the project “Assessment of conservation tillage as advanced methods for crop production and prevention of soil degradation” is underway, which aims to determine the possibility of implementing conservation tillage as a measure to improve soil quality, especially under climate change.

Acknowledgement

This work has been fully supported by Croatian Science Foundation under the project "Assessment of conservation soil tillage as advanced methods for crop production and prevention of soil degradation" (IP-2020-02-2647).

MIP technology for a sustainable improvement of soil fertility

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Keywords: soil microbial biomass, soil activator, soil fertility, yield, profitability

As soils provide 95% of people's food, it is essential to preserve and develop their capacity to produce quantity and quality in a sustainable way.

The main function of soil is to recycle nutrients by capturing photosynthetic energy through organic matter and to allow roots to absorb minerals and water. Compacted soil, insufficient biological activity and climate change (increased temperatures and drought frequency) disrupt this vital cycle. To support soil fertility, Olmix Plant Care is developing a technology that uses the properties of trace elements to stimulate the enzymatic activities of the soil's microbial biomass (MIP® - Mineral Inducer process) and is providing this technology to farmers through a new generation of inputs: soil fertility activators like Neosol®.

A multi-year trial conducted by the Faculty of Agrobiotechnical Sciences in Osijek (Croatia) and the CROSTRO research team measured the effects of several parameters (tillage, fertilizer and soil activator based on MIP® technology) on soil structure, soil moisture content and yield. After 3 years, the results show that the soil activator has a positive effect on the physical organization of the soil compared to the untreated plots, regardless of the tillage system. The water retention capacity was significantly increased, and the chemical parameters of the soil were also modified.

Another study, which is part of the research programme "Soil protection and erosion control technologies" initiated and financed by the Ministry of Agriculture of the Czech Republic, was conducted by Agricultural Research Ltd from Troubsko (CZ) and Ing. Ivana Šindelková. Preliminary results with Neosol® soil activator were presented at the 19th International Multidisciplinary Scientific Conference GeoConference - SGEM 2019 - in Bulgaria ("Effect of soil activator use on soil properties in dry areas").

In this five-year experiment, which compared conventional ammonium phosphate fertilization and Neosol® in a no-plough system, it was also shown that soil structure and moisture content were improved by soil activation. The organic matter content increased with a higher ratio of humic components. The benefits are higher yields on the five-years test, lower fuel consumption and better profitability with Neosol and less N and P fertilizer.

Faced with the challenges of maintaining crop profitability in a context of climate change, rising fertilizer prices and the urgent need to reduce greenhouse gas emissions, the activation of soil microbial biomass by new types of inputs based on MIP® technology appears to be a credible alternative in combination with virtuous agronomic practices and appropriate ecosystem management.

Conservation tillage systems in Austria – prevention of soil erosion

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Keywords: soil erosion, no tillage systems, conservation tillage, aggregate stability, glomalin

In Austria more than 450.000 ha arable land are seriously endangered by soil erosion. Soil loss, nutrient loss, water runoff and pesticide loss are environmental risks and also danger for settlements. The same situation we find in almost every country over the world, depending from the topography. Minimum tillage (no tillage and conservation tillage) systems can significantly reduce soil erosion and all the negative consequences. In combination with effective cover crops we can introduce the system of permanent covered arable land with a maximum protection of soil against soil erosion, surface runoff, nutrient- and pesticide loss. The technical requirement and the farmer's know-how are necessary for the success of this system.

No tillage (zero tillage) research has been performed for more than half a century in many countries around the world because of the benefits of these systems. Less traffic on the arable land, less fuel consumption – less CO_2 emissions, less time for cultivation are economic advantages; ecological interests are higher microbiological activity, better C - sequestration, humus constitution and prevention of soil erosion with all its consequences.

Glomalin as a glycoprotein is very important for aggregate stability and was examined one season in long time tillage trials. It was significantly shown, that minimum tillage enlarges the C sequestration in soil, the Glomalin concentration and as a result the aggregate stability, which is important for carry the heavy weight of modern farm machines like combine harvesters or sugar beet harvesters, which weight more than 50 tons.

Soil erosion causes water runoff by a reduced infiltration rate. Are pesticides solute, high concentrations are found in the deposition zone with the result of infiltration into ground water. Pesticides are found there, usually at the end of a slope as groundwater samples from wells demonstrate.

On 5 locations in Lower Austria tillage trials are operated for more than 15 years; on 2 locations tillage trials and soil erosion measurements are arranged in cooperation with the Austrian University of Agricultural Science Vienna, Department of soil physics and rural water management for 28 years. In the tillage trials 4 different tillage methods are settled – conventional tillage with plow and cultivator; reduced tillage with cultivator and disc harrow, minimized tillage with disc harrow or light rigid – tine cultivator and no tillage. Net plot harvest allows measuring the yield.

60 m² plots for investigation of soil erosion are located in Pyhra near St. Pölten – 70 km west of Vienna and in Mistelbach 40 km north of Vienna. After every storm event the measurement is analysed in the laboratory of the University.

Minimum Tillage and no tillage are practicable and allow lower working time, lower fuel consumption, significantly reduced soil erosion and all solved nutrients and pesticides. The technical equipment is well developed but often not announced to the farmers in Europe, other continents like North and South America use these tillage operations for several decades successfully and could decrease the severe soil erosion to an acceptable amount. Yields are stabile in minimum tillage and decreasing in No tillage – but only on heavy soils and on sandy soils and with sugar beets in crop rotation. Often the bad work of drilling machines is responsible for unsatisfactory field emergency and following low yields. The right equipment like coulter discs for producing loosened soil for closing the seed slot is the key of success.

The influence of erosion on the quality of chernozem soils and crop yield

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Keywords soil, quality, erosion, yields

In recent decades, erosion processes have proven to be among the most serious degradation factors worldwide, affecting not only soil properties but also crop yield, worsening hydrological functions and other non-productive soil functions. Water erosion is a major global problem (the area negatively affected by water erosion in the EU-27 is estimated to be 130 million ha), and in the Czech Republic it threatens about half of agricultural land. The situation in CZ worsened considerably in the post-war period, when collectivization led to significant changes in land structure and the elimination of landscape elements. South Moravia is one of the most agriculturally exploited areas in the Czech Republic, but is also an area highly endangered by erosion. It was therefore selected for our research, in which the main goal was to verify the sensitivity of selected physical, chemical and biochemical characteristics to erosion processes, and to identify changes in soil properties due to erosion. Testing was performed over a period of 5 years on chernozem soil sites, where sampling areas were selected on the basis of the results of erosion/deposition models. Physical, chemical and biological - biochemical characteristics were selected to assess soil properties and to study the effects of erosion on soil quality. It is clear from the results that nutrient reserves in the depositional parts of slopes are higher compared with erosional parts. An exception was found in the case of calcium, where higher content, and also higher pH, were found in erosional parts of slopes, which relates to the soil-forming substrate – loess, reaching the soil surface. Differences were also found in characteristics concerning the content of soil organic matter and its quality, with better results in the depositional parts of slopes. These soil characteristics and ongoing erosion processes significantly affect the biological and biochemical characteristics, which can be documented, for example, by the activity of soil enzymes. The least significant differences were recorded in the case of physical characteristics. The obtained results indicate clear changes occurring on the studied land due to erosion processes.

Many studies have been published on the impact of erosion on soil properties, but much less attention has been given to the reduction in crop yield in these locations. We studied this problem in pot experiments with eroded and non-eroded soils, as well as using remote sensing and vegetation indices. For the pot experiment, we used soils from erosional and depositional sites analyzed in the above research. These paired samples were used as a substrate for growing *Festuca rubra* with various levels of N fertilization, simulating a dosage of 50 to 200 kg N/ha. The obtained results show lower yield on erosion-affected soils at the same fertilization rates, as well as lower nitrogen utilization compared with non-eroded areas.

To study the effect of erosion on yield from a regional point of view, we again used the chernozem sites of South Moravia and, over a 4-year research period with winter wheat, we studied this problem using the Enhanced Vegetation Index (EVI). During the course of this research, we proposed a method of identifying areas affected by erosion on the basis of Sentinel 2 satellite imaging and NDVI and NBR2 indices. The results showed a statistically significant linear reduction in yield depending on the level of degradation. This approach, and the results obtained, form an important basis for discussion with farmers and policy makers in planning sustainable land management.

Acknowledgement

The authors thank the Technology Agency of the Czech Republic (project No. SS02030018) and the National Agency for Agricultural Research of the Czech Republic (project No. QK1810233) for supporting this research.

Aggregate stability in agricultural soils of Danubian lowland

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Keywords: soil aggregates, stability, topsoil, agricultural soils, soil organic matter

Parameters of soil structure play an important role in functioning of terrestrial ecosystems as they significantly affect physical stability of the whole soil and its susceptibility to erosion. In this contribution we assess aggregate stability in soils of Danubian lowland, which is the area with intense agricultural production and the extent of approximately 10 000 km^2. The soils are developed on fluvial and aeolian sediments, show differences in particle size distribution, soil organic carbon (SOC) content, soil organic matter (SOM) quality, and thickness of surface horizons. Even though the majority of soils are relatively fertile, erosion is the main degradation process in hilly parts of the region. Overall, 39 topsoil samples were taken and analysed in the laboratory. Stability of soil aggregates was determined by the two methods. The first one enables to determine the weight ratio of the aggregates (with a size of 4 to 0.25 mm) that remain intact on the sieve after the sample is exposed to a simulated precipitation with known intensity (270 J/m^2 for 1 min). In the second method the aggregates are dispersed in selected solutions (sodium hexametaphosphate and sodium carbonate) by wet sieving using device from Eijkelkamp (Netherlands). The data obtained via first method showed higher variability in comparison to wet sieving. Besides aggregate stability and basic soil properties (organic C, total N, particle size distribution, pH), the contents of Ca, Mg, K, P, and Fe extracted by Mehlich III solution were determined. To obtain the information about SOM content and its thermal stability, the samples were analysed by thermogravimetry and differential scanning calorimetry (TG-DSC). It was found that stability of soil aggregates is positively correlated with SOM (SOC) content and the amount of clay fraction in samples, whereas the correlation between aggregate stability and sand fraction was negative ($P < 0.001$). TG-DSC analysis helped to elucidate the link between stability of soil aggregates and thermal properties of SOM. The results suggest that resistance of soil aggregates against disintegration is supported by diverse composition of SOM in the samples. This means that soils with more stable aggregates contained broader spectrum of organic fractions, including thermally labile, intermediate, as well as more stable SOM components. This study confirmed that besides character of climate and properties related to nature of soil parent material, such as particle size distribution and soil mineralogy, the stability of soil structure is partially controlled also by SOC content and SOM quality.

Acknowledgement

The financial support from the Slovak Scientific Grant Agency for VEGA projects No. 1/0712/20 is gratefully acknowledged.

Soil related environmental considerations of farmers in the Great Hungarian Plain

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Keywords: agrotechnology, environmental consciousness, reduced tillage, soil reclamation, organic manure

Climate change and associated environmental changes are the major sustainability challenges facing the world today. The selection of appropriate agrotechnological elements is required not only to increase the quality and quantity of food produced but as well as reducing the costs of the farmers and protecting the environment for future generations. In the Great Hungarian Plain, the adoption of recent environmentally friendly technologies is still not sufficient and the region faces various environmental challenges. This study aimed to analyse the economic and environmental consciousness of farmers in the selection of 3 agrotechnological elements (soil protective cultivation, soil reclamation/conditioning, organic manure application). A pilot study was conducted on 5 representative farmers, in which they were interviewed, and questionnaires were designed to critically analyse farmers' perceptions of the environment based on the opinions of 106 respondents. The result show that farmers are aware of the environmental impacts of selected technologies in their farms. They highlighted some of the environmental challenges they are experiencing including drought, secondary salinization, and unfavourable soil properties. However, they showed more economic than environmental consciousness, as they suggested that it was important to be familiar with economic issues and conditions to ensure higher income. The level of willingness to introduce or apply soil protective cultivation, soil reclamation/conditioning, and organic manure differed from low to high.

Lectures

Session 1

Soil health assessment

Soil quality is essential for efficient crop production and environmental health because it plays many key roles in the ecosystem. This session is based on an interdisciplinary approach involving soil scientists to characterise the dynamic and living soil–water–plant–atmosphere system. Fundamental soil properties include physical (texture, structure, available water holding capacity, water infiltration rate, bulk density, soil aggregate stability, effective rooting depth), chemical (pH, cation exchange capacity, intensity and capacity of plant available nutrients, electrical conductance and the concentration of soluble salts), and biological (soil organic carbon concentration and stock, microbial biomass carbon, activity and species diversity of micro and macro flora and fauna).

Comparing the effect of botanical species, historical and modern cultivars of barley (*Hordeum vulgare* L.) supported by mineral or organic fertilizer on soil chemical and microbial properties

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Keywords: soil, quality, soil organic matter, plant domestication

Plant domestication caused significant shift in plant traits. While effect of domestication on various aspects of plant ecophysiology has been studied, less is known about the effect of plant domestication on plant soil interaction. Here we studied three botanical species of barley in comparison with four old and four contemporary cultivars. Aboveground and belowground biomass decreased in order botanical species, old cultivars to contemporary cultivars. Aboveground biomass was higher for organic fertilizer treatment, in mineral fertilizer treatment the difference between botanical species and cultivars were more pronounced. Microbial respiration in soil do not differ between treatments supplied by organic fertilizer while in mineral fertilizers old cultivar had lower respiration that other treatments. Microbial biomass does not differ between treatments supplied by mineral fertilizer but in treatments supported by organic fertilizer perennial grasses support more microbial biomass than all barley treatment. The same pattern was observed in C content in soil. C distribution in individual soil fractions do not differ between perennial grass and barley treatments.

In general, when hotspots of organic matter were provided plants transfer this organic matter to soil, this activity was more pronounced in perennial grasses than in barley treatments. Perennial grasses have much higher root shoot ration that all barley treatment, and root shoot ration decreased from botanical species towards modern cultivar, which means that barley in general provide less belowground litter to soil and this is even more enhanced in modern cultivar, which in long term can, together with other factors contribute to depleting of cultivated soil for organic matter.

Acknowledgement

The authors thank the Technology Agency of the Czech Republic for supporting the research (project No. SS02030018).

Topsoil organic carbon content in agricultural land of Slovakia

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Keywords: soil organic carbon, Cambisol, soil management, altitude, texture

Soil organic matter (SOM) is a key component for the supply of many ecosystem services including biomass production, soil physical structure, water holding capacity, and climate regulation. Soil organic carbon (SOC), as an essential component of SOM, is very often considered as a primary indicator of soil quality in relation to agricultural and environmental soil functions and it is the principal factor in all classes of ecosystem services. Actual information about quantity (soil organic carbon, total nitrogen) and quality (fractionation of soil organic matter) of soil organic matter in agricultural soils of Slovakia is available in the database of the Partial Soil Monitoring System (ČMS-P). The ČMS-P is one of several partial systems of environmental monitoring in Slovakia. The main aim of the ČMS-P is to collect data on current state and future trends of soil development in Slovakia. Sampling of 0-10 cm topsoil and 35-45 cm subsoil layers is done every 5 years at the network of basic monitoring sites (N = 318). Along with other soil parameters, also data of SOC concentration are collected as a part of the ČMS-P. The first sampling cycle of the ČMS-P was in 1993 and the last, so far, in 2018. Monitoring sites are divided into 24 groups according soil types, subtypes, parent material and land use classes (arable soils, grassland).

The most frequent soils in the agricultural land of Slovakia are Cambisols, which are for the monitoring purposes further divided into 8 separate groups. The topsoil SOC concentration in Cambisols is highly variable and mainly controlled by land use. In the last sampling cycle (2018) substantially higher average topsoil SOC concentration in Cambisols was observed on grasslands (4.02%) compared to arable land (2.30%). The high inputs of above- and below-ground plant residues on grasslands keep the topsoil SOC stock stable. The lowest average topsoil SOC concentration has been detected for Stagnic Cambisols (Siltic, Eutric) (1.84%) and the highest for Leptic Cambisols (4,43%). No significant differences in indicators of SOM quality was observed among the Cambisols. Ratio between carbon in humic and fulvic acids - C_{HA}/C_{FA} was <1 and optical parameter $Q_{4/6}$ was >5 for all Cambisols.

SOC concentration data from ČMS-P were used for calculation of SOC stock in depth 0-30 cm. We assumed, that along the land use, as a strongest driver of SOC content on Cambisols, SOC content can be also controlled by other natural factors such as altitude (terrain factor), and soil texture (soil factor). We analyzed mutual relationships between SOC content, altitude, soil texture, and land use on a subset of 291 basic soil monitoring sites. The results suggest that SOC stock increases with altitude on all agricultural land, and also on arable land and grassland when analysed separately. There was a statistically significant correlation between the topsoil SOC content and altitude. The topsoil SOC content on arable land was significantly lower compared to grassland. The results also show an increase of the topsoil SOC content on agricultural land with soil texture gradient (clay and sand content) in order light > medium > heavy soils. Positive statistically significant correlation was found between SOC content and clay content, whereas a negative statistically significant correlation was observed between the topsoil SOC content and silt fraction. Based on the results it can be concluded that the analysis of the ČMS-P data proves the altitude, soil texture, and land use (grasslands/arable land) being statistically significant drivers for the topsoil SOC content in agricultural land of Slovakia.

Acknowledgement

This work was supported by the Slovak Research and Development Agency under the contract APVV-14-0087 and is also the result of the project implementation: „Scientific support of climate change adaptation in agriculture and mitigation of soil degradation" (ITMS2014+313011W580) supported by the Integrated Infrastructure Operational Programme funded by the ERDF.

Influence of acidification caused by ammonium sulphate application on the stability of soil aggregates

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Keywords: long-term monoculture, spring barley, management of post-harvest residues, soil pH, Fe_{ox} and Al_{ox}

Soil Aggregate Stability (SAS) is an important indicator of the physical quality of soil that significantly affects its fertility. SAS is influenced by a number of factors, including the management of post-harvest residues or the forms and doses of organic and mineral fertilizers used. Long-term excessive use of N fertilizers increases the soil acidity, which can be a factor limiting yields.

An analysis of the impact of graduated doses of nitrogen in combination with the different straw management on SAS and grain yield was carried out in the years 2018-2021. The results of the spring barley monoculture established in 1970 in Žabčice on Gley Fluvisol were used (49°01' N, 16°37´E, altitude 179 m, average annual temperature 9.2 °C and sum of precipitation 480 mm). The selected variants included a combination of harvested and incorporated straw with doses of 0, 30, 60 and 90 kg N/ha in the form of ammonium sulphate $(NH_4)_2SO_4$.

The SAS values found in all compared variants were high to very high (54-64%). The effect of the evaluated cropping measures on SAS values was overlapped by a number of influences of temporal (year-on-year and sampling terms) and spatial (differences among plot replications) nature. The results of the overall evaluation for four years showed changes in SAS for the harvested straw by about 5% between 0 N and all doses of N per ha (30N, 60N, 90N). In the case of incorporated straw, the SAS gradually increased with increasing nitrogen dose also in the range of about 5%. These differences between the evaluated variants are related to the results of geochemical and mineralogical analyses of soil samples. In addition to SOC content, aggregate stability is controlled by a combination of factors, primarily Fe_{ox} content, cation exchange capacity (CEC) and porosity. Amorphous Fe-(oxo)hydroxides play an important role in aggregation, although their contribution to soil mass is small. The coating of Fe-(oxo)hydroxides facilitates interactions between larger mineral particles and organic matter and prevents dispersion of these particles. As the pH value decreased, the influence of Al_{ox}+Fe_{ox} (oxalate extractable Al and Fe, including Al and Fe from short-range-ordered minerals - amorphous and poorly crystalline (oxo)hydroxides and alumosilicates, and Al-, Fe- organo-metal complexes) increased, and the influence of exchangeable calcium (ex. Ca^{2+}) on SOM stabilization and aggregate stability decreases. The application of N fertilizers with ammonia, result in a decrease in CEC, a decrease in saturation with basic cations (base saturation) by decreasing the content of ex. Ca^{2+} (exchangeable Ca^{2+}) and ex. Mg^{2+}. With a relatively high content of Fe_{ox} (5200 ppm) and Alox (2000 ppm) in the soil of Žabčice locality, their influence on the increase of SAS values with decreasing pH was detected. As the dose of fertilization increased, the pH decreased (from pH=5.9 to pH=5.3), and the acidification increased. Thus, the SAS values increased with decreasing pH at increasing ammonium sulphate dose, despite decreasing the ex. Ca^{2+} content. At lower pH, the effect of Fe_{ox} + Al_{ox} on soil organic matter stabilization increased at the expense of the effect of content ex. Ca^{2+}.

In the variants with incorporated straw, barley grain yields were highly significantly higher although the SAS value in the case of fertilization doses of 30N and 60N was lower than in the case of variants with harvested straw. This indicates an important role of organic matter in influencing soil processes and soil fertility. The use of post-harvest residues, including straw, is in accordance with the Green Deal EU plans and with the current increase in the prices of nitrogen mineral fertilizers, which is a significant opportunity for solving the problems of current agricultural practice. SAS is an important indicator in the assessment of soil quality and fertility, nevertheless, SAS should always be assessed in relation to other soil properties.

Acknowledgement

Supported by the Ministry of Agriculture of the Czech Republic, Project No. QK1810186.

Measurement of stability of soil aggregates by optical methods

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Keywords: soil physical properties, soil structure, smart technologies

The resistance of soil aggregates to destruction in water is an important parameter of soil quality. Procedures that quantify the soil aggregate stability (SAS) are based on either a direct approach that determines the weight loss of a predefined aggregate load during periodic movement of the screen with the aggregates in the water, or by the action of water droplets impinging on soil aggregates under predefined experimental conditions. Another set of methods is based on an indirect approach in which we observe and measure the area occupied by a soil aggregate crumbling after placement to water. However, these methods are burdened by the subjective error of the observer and provide rather indicative results.

Soil slaking assessment using image recognition was proposed by Fajardo et al. (2016). A soil aggregate crumbling is recorded by a digital camera, and an image recognition software and subsequent image processing quantifies the water stability of soil aggregates and calculates "slaking index". More stable aggregates give lower slaking index. The method was implemented into a mobile phone app SLAKES for Android and IOS platforms. We comprehensively tested the method and the app. We developed a supporting device that improves problematic aspects of the method arising from inappropriate light conditions. The improved measuring set consists of a mobile phone (with SLAKES app) and a LED panel, which backlights the bowl with soil aggregates during the measurement.

Soil samples from 7 long-term field experiments were evaluated: experiment with different crop rotations (Hněvčeves), fertilization experiment VOP (Čáslav, Lukavec, Ivanovice), experiment with application of digestates ÚKZÚZ (Lípa, Svitavy and Jaroměřice), from spring and post-harvest samplings. The samples included various experimental treatments as well as permanent grasslands in the vicinity of the experiments. For SLAKES method, we used aggregates of a size 3-5 mm. The reference method for determining the stability of soil aggregates was the wet sieving method according to Kandeler (1994), using aggregates of a size 1 – 2 mm.

The study showed a significant negative correlation between the two methods ($R = -0.64$). The correlation was higher ($R = -0.76$) for more stable aggregates (SAS above 40 %) and for sandy soils (Lípa and Lukavec, $R = -0.8$). Both methods indicated significant differences between treatments of field trials. The highest stability of soil aggregates was found in permanent grasslands (low values of slaking index, high values of SAS), the lowest on treatments fertilized only by mineral fertilizers and on the unfertilized treatments. Based on these experiences with the optical method of soil aggregate stability measurement, we developed a unique simple measuring device for aggregate stability assessment. The device is based on a photocells and enables simultaneous separate SAS measurement of 9 aggregates.

It can be concluded that optical methods of soil assessment enable farmer and public users measure and evaluate quality of their soils. Slaking index provide a good indication of the soil aggregate stability in a variety of soils. The LED backlighting substantially increases measurement stability and reproducibility. Comparing with the apparatus for wet sieving, the set of a mobile phone with LED panel is inexpensive and can be used in home conditions. Innovation and the development of simple soil assessment methods can further increase interest in soil quality and health, and can increase farmers' efforts to improve it.

Acknowledgement

This work was supported by the Ministry of Agriculture of the Czech Republic, project No. QK1810186.

Effects of biogas digestate on soil aggregate stability and water infiltration

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Keywords: field experiment, soil physical properties, organic fertilization, digestate

Digestate is a by-product from anaerobic digestion in the biogas plants. Due to the lack of organic fertilizers and rising prices of mineral fertilizers, digestates are increasingly applied directly to agricultural land as a fertilizer. Many works deal with the impact of digestate amendments on soil fertility, expressed by the content of plant-available P, K and mineral N in soil, crop yields or microbial activities. However, the effect of long-term application of digestate on soil physical characteristics is still rather unexplored field of research. Moreover, recent studies dealing with the digestate impact on soil characteristics often show conflicting results. The main goal of our research was to understand the long-term effect of digestate application on soil characteristics compared to mineral and compost fertilization through investigating soil physical and chemical properties and their interactions.

The research was based on the long-term field experiment carried out since 2011 in three localities in the Czech Republic. Field trial management included conventional tillage and a 6-year crop rotation in sequence potatoes/winter wheat/silage corn/spring barley/oilseed rape/winter wheat. The design was based on 10.82×3.74 m experimental plots in 12 replicates (four replicates per locality). Five treatments of fertilization were evaluated: control unfertilized treatment, mineral fertilized treatment (mixture of ammonium nitrate and finely ground limestone – LAV, 27% N), digestate I (input materials for digestion: corn silage and cattle slurry), digestate II (input materials for digestion: corn silage, pig slurry, farmyard manure and hay). The basic dose of N fertilization depending on the crop grown was 120-150 kg N/ha for LAV and digestates and 300 kg N/ha for compost, from which N is released slowly. Soil samples for analysis were taken for 4 years, in spring and summer after harvest.

Statistically significant correlations between the stability of 1-2 mm soil aggregates and hydro-physical soil properties, such as soil bulk density (strong negative correlation), porosity (strong positive correlation) and water infiltration (positive correlation) were shown. Type of fertilizer significantly affected soil aggregate stability, where significantly lower stability was observed on unfertilized plots and mineral fertilized plots in comparison with organic, both digestate and compost, fertilized plots. Addition of organic fertilizers also significantly decreased soil bulk density, increased porosity and partly influenced the pore-distribution, with a larger proportion of capillary pores. The improvement of the above-mentioned soil physical properties after addition of organic fertilizers resulted in an increase of water infiltration into the soil. In agreement with other studies significant seasonal variability of soil physical properties, such as soil bulk density, porosity and soil aggregate stability, was confirmed. In addition, actual field conditions significant impact on water infiltration. This variability must be taken into account when assessing the effect of fertilization on the soil characteristics.

Our findings confirmed digestate as a valid fertilizer, which is important especially in the context of the development of the agricultural biogas sector in the European Union.

Acknowledgement

This work was supported by the Ministry of Agriculture of the Czech Republic, project No. QK1810186. Thanks are expressed to Dr Michaela Smatanová from the Czech Republic's Central Institute of Supervising and Testing in Agriculture.

Session 2

Soil management

Soil management is an integral part of land management. It focuses on differences in soil types and properties to define specific interventions that are aimed to enhance soil quality and fertility. Specific soil management practices are needed to protect and conserve soil resources. There are also particular interventions to increase the soil carbon content to mitigate climate change. Reversing the degradation of soil, water and biological resources and enhancing crop and livestock production through appropriate land use and soil management practices are essential elements for achieving food and livelihood security. There are various farming system approaches which differ in productivity and environmental impacts. Conservation agriculture, as a promising direction for the future, has three main goals: minimising soil disturbance, maintaining permanent soil coverage and diversifying crops. Conservation tillage is a suitable approach that leaves the previous year's crop residues on fields, reduces soil erosion and runoff, or brings other benefits such as carbon sequestration. Cover crops play an essential role in this system as well.

Model calibration for simulating soil organic carbon in long-term field experiments in the Czech Republic

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Keywords: HERMES2Go, model calibration, long-term experiment, soil organic carbon, fertilization

In recent years, exceeding efforts were directed to reducing greenhouse gas emissions stemming from agriculture. Carbon dioxide is one of the greenhouse gases which increases with improper soil and agricultural management. In the long-term, farmers can influence the amount of soil organic carbon (SOC) stored in the soil by moderating tillage practices or by employing post-harvest crop residues. The amount of SOC varies throughout the year, hence systematic, continual long-term monitoring is paramount for understanding the implications of different management practices (e.g., crop rotation, tillage, and fertilizer application dates and amounts) on soil physical properties, as well as for the ongoing mitigation and adaptation strategies. Process-oriented agroecosystem models represent an appropriate tool in this regard.

Accordingly, the HERMES2Go model was employed and set-up with soil, weather, crop, and management data from three long-term field experiments (LTE) in the Czech Republic. All experiments were primarily focused on different fertilization practices. First and longest experiment (1961-2018) was established at Ruzyně (N: 50.09°; E: 14.30°, 345 m altitude, soil type: Orthic Luvisol). Next LTE with available data was at Hněvčeves (1979-2017, N: 50.31°; E: 15.71°, 265 m altitude, soil type: Luvisols). The last LTE employed by this study was at Trutnov (1965-2010, N: 50.56°; E: 15.89°, 417 m altitude, soil type: Cambisols).

All locations have applied the same four fertilization treatments and similar tillage practices, but different crop types and crop rotations adapted to soil-climatic conditions. First fertilizer treatment was a control (untreated) variant without any fertilization. Second treatment was focused only on the use of organic fertilizer – farmyard manure. It was usually applied every three to four years, most often in the amount of 30-40 t/ha. Another treatment used only mineral fertilizers, of different compositions and quantities, according to the cultivated crops. Last treatment presumed a combination of manure and mineral fertilizers.

The main objective of this study was to test the ability of HERMES2Go to simulate the implications of different fertilization treatments on SOC. The model primarily simulates soil-plant-atmosphere processes with a focus on nitrogen dynamics, and SOC is derived by assuming a constant C/N ratio. Prerequisite was calibrating the HERMES2Go model for crop phenology and biomass, then validation was performed against observed SOC. For the HERMES2Go model input data in percent was recalculated for organic carbon stocks in topsoil (Corg) and results from the model were transformed back to percentage using bulk density detected for each locality. Results confirm the ability of the HERMES2Go model to describe the SOC under different fertilization treatments with satisfying accuracy from calibrating solely against crop phenology and biomass and highlight its potential to estimate possible future developments of SOC for long-term simulations under similar conditions.

Acknowledgement

The research was financially supported by the SustES project – Adaptation strategies for sustainable ecosystem services and food security under adverse environmental conditions (CZ.02.1.01/0.0/0.0/16_019/0000797).

Evaluation of the influence of mulching materials on soil moisture in the inter-row of vineyards

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Keywords: soil erosion, mulching materials, soil moisture, vineyards, grapes

Climate change is a serious problem from the point of view of viticultural production. According to climatological models, in the conditions of Central Europe, an increasing frequency of extreme weather events is expected, which includes longer periods of drought, rainy seasons, late frosts and hail storms. All these factors can significantly affect viticultural production, where it will be reflected in a decline in yields and a reduction in the quality parameters of grapes. The main risks in this context can be considered a continuous increase in air temperature and a decrease in soil moisture. Therefore, operational practice is looking for effective adaptation measures, with the possibility of fast and efficient implementation. One of these measures can also be the mulching of the soil surface. The paper presents the results of experiments carried out in the period 2018 - 2020, in the wine village Velké Bílovice, which is located in the region of South Moravia in the Czech Republic. The experiments verified the effects of different natural mulching materials (cereal straw, wood chips, compost), which were applied to the soil surface in the intermediate row of vineyards. The evaluated parameters of this experiment were soil moisture, yield and quality of grapes in the Pinot Gris variety. The weather station and soil moisture sensor VIRRIB were used to measure the course of meteorological conditions at the site and soil moisture for individual variants. The results indicate a positive effect of the used mulching materials on the soil moisture and quality of grapes. Based on these results, the use of mulching materials can be described as an important agrotechnical measure for viticultural practice.

Acknowledgement

This paper was finalized and supported by the project CZ.02.1.01/0.0/0.0/16_017/0002334 Research Infrastructure for Young Scientists, co-financed by Operational Programme Research, Development and Education.

Influence of locality, year and sampling term on the stability of soil aggregates under different tillage

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Keywords: direct sowing, loosening, ploughing, winter wheat, spring barley

The choice of suitable soil tillage systems is important to ensure yields and the economy of cultivated crops, as well as to maintain the soil in good production condition with high soil aggregates stability (SAS %). Although usually conventional tillage (ploughing) reduce SAS, and contrarily, minimum and no-till systems increase SAS via increasing soil organic carbon content, this may not be the rule. SAS is the result of processes influenced by a number of factors, the importance of which depends on soil, climate, course of weather and cropping practices. Therefore, there are differences in SAS values and their explanation requires more complex approaches

This was the reason for evaluating the effects of direct sowing (NT), loosening up to 15 cm (MT) and ploughing up to 25 cm (CT) on SAS in long-term stationary small-plot field trials with four replications at the locations of Žabčice and Ivanovice in 2018-2021. The SAS evaluation was performed in crop rotation of winter wheat after lucerne (WW) and spring barley after sugar beet (SB). Soil samples were taken from the surface layer of the soil (0-5 cm) in two dates: turn of April and May, and August.

In the Žabčice locality (49°01´ N, 16°37´E, altitude 179 m, average annual temperature 10.3 ºC and the sum of precipitation 491 mm), the soil type is Gleyic Fluvisol, the soil texture is clay loam. In the Ivanovice locality (49°19' N, 17°05 'E, altitude 225 m, average annual temperature 8.8 ºC and total precipitation 549 mm), the soil type is degraded Calcic Chernozem (Loamic), the soil texture is loam soil developed on loess.

The average SAS value (over 4 years) was higher in Žabčice (60.17%) than in Ivanovice (54.52%). In both locations for both crops (WW, SB), SAS was higher with ploughing compared to direct sowing, although the soil organic carbon content was lower in the ploughed variants. When growing winter wheat after lucerne, the highest SAS values were found in the variant with ploughing in both locations, and they clearly differed from loosening, which showed the lowest values. During the cultivation of spring barley after sugar beat, a trend of increasing SAS values with the intensity of tillage (from direct sowing to loosening and to ploughing) was found in both locations. Ploughing showed significantly higher stability of the aggregates compared to direct sowing and loosening. In the overall evaluation (for all four years), the mutual positions of individual variants as well as the differences among them were similar in both locations, however, patterns of interrelationships between variants differed among years and the sampling dates. In both locations, especially in Ivanovice, the interaction year x sampling term contributed considerably to the variability of SAS values.

Significant differences were found out among localities, years, sampling dates and their interactions, as well. These results show a high sensitivity of SAS to various factors with temporal and spatial influences. These increase the variability of SAS values, which overlaps the differences between the variants of the evaluated cultivation measures and makes stricter their statistical verification, which requires a multi-year (at least three-year) evaluation. As mentioned above, the impacts of processes affected by cultivation measures on SAS has to be assessed comprehensively, taking into account all available information.

Acknowledgement

Supported by the Ministry of Agriculture of the Czech Republic, Project No. QK 1810186.

Soil protection technologies for growing maize on sloping lands

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Keywords: maize, strip-till, ploughing, pits, erosion

Silage maize is widely grown in the Czech Republic on sloping land threatened by water erosion. Various methods of soil tillage and stand establishment with the aim of improving water infiltration into the soil and limiting water erosion were verified in field trials in the Czech-Moravian Highlands region (potato production area, around 600 m above sea, Cambisol).

In Lukavec in the period 2015-2017 four variants of soil tillage methods applied into barley or rye stubble were analysed: Autumn Strip-Till (AST), Spring strip-till (SST), Spring ploughing with seedbed preparation in form of narrow strips 0.15 m depth (SP) and Autumn Ploughing with spring seedbed preparation (compactor) i. e. conventional tillage (CT). The width of tilled strips was 0.20-0.25m and depth 0.20 m, depth of ploughing was 0.20 m. The P fertilizer was banded into soil under strip-till techniques or surface continuous applied before ploughing. Nitrogen fertilizer was subsoil banded on both sides of rows at seeding, the same for all variants. The anti-erosion efficiency was tested using the rain simulator. It was measured in growth stage of 6th leaf, 20% field cover. The experimental sprinkling of the naturally dry soil was done twice in succession and the operating period of the first and second sprinkling was 30 and 15 min, respectively with 15 min break. The intensity of precipitation was 1.2 ml/min.

Surface runoff always began first at CT (after 140 – 240 s). In some year also rough surface of only ploughed soil (SP) absorbed more water and delayed the beginning of runoff (even up to 880 s). The most effective were both strip-till methods. Runoff began after 770 – 1200 s in individual years. Post-harvest residues and stubble at AST and SST limited runoff and much more significantly soil loss, which was 0.04 – 0.12 t/ha. Fifteen times higher soil loss was measured at SP (1.85 t/ha). The unevenness of the surface showed itself favourably here. The soil carried away with the runoff sediments in the depressions of uneven surface, especially at the beginning of the runoff. The highest soil losses were always found on CT reaching about 1.0 t/ha, in the extreme year more than 6 t/ha. The higher ability of the soil at AST and SST to retain water resulted in higher soil moisture during vegetation by 1.3-1.7% compared to the CT. In drier years this difference was also decisive for the yield of silage maize, which reached 37.1 – 48.6 t/ha and 41.9 – 55.1 t/ha of fresh mass in 2015 and 2016 resp. and increased in the order CT < SP < AST < SST. Under favourable rainfall conditions, yields for all methods were similar. The highest one was achieved at SP. Higher mineralization of nutrients from the soil supply after ploughing contributed to this. This was reflected in the highest uptake of nitrogen by plants at SP both in a given year and in the average of whole trial period (231 kg N/ha).

Various methods of anti-erosion treatment of inter-row space were tested on slightly sloped fields (3.9 – 5.3°) in Věž in the period 2019-21 Three variants of hoeing were compared with conventional tillage (CT): shallow hoeing (up to 5 cm) with V-shaped sweep in the middle between the rows (SH), deeper hoeing (up to 7cm) with chisel sweep on both sides of the rows (DH), DH combined with formation of pits in the inter-row space (DHP). Hoeing was done in the 6th leaf stage. The anti-erosion efficiency different hoeing methods was tested using the rain simulator 7 to 10 days later.

The highest runoff was always found at Ct (up to 70 mm). Disturbing the soil surface and loosening the soil improved water infiltration and reduced runoff by 35-53% on SH and DH respectively. Only in 2021 the differences among these three variants were small (on the level of units of percent), because the soil was already considerably saturated with water after natural precipitation before the simulation. The pits in the space between the rows allowed to retain the largest amount of water in all years and reduced the surface runoff at DHP to the level of 10% of the CT. It is important that the pits retained the eroded soil and reduced its loss by up to 97% compared to CT. Silage corn yields on average in 2019-21 reached 46.5-56.5 t/ha and always increased with the intensity of tillage (CT < SH < DH < DHP) as well as nitrogen uptake (175 – 219 kg N/ha). This was due to better availability of nutrients and namely water for the plants. Chisel hoeing along both sides of the rows brought water to the roots of the plants.

Acknowledgement

Acknowledgement to the Ministry of Agriculture of the Czech Republic for financial support, Project No. QK1910382 and MZE-RO0417.

Soil management for potato production: multiple operations and consequences

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Keywords: potatoes, compaction, soil structure, LLWR, aggregate stability

Globally potato production exceeds 364 million tonnes and is increasing. Productivity varies greatly with western European and North American nations and typically exceeding 40 t/ha, while the global average is less than 17 t/ha. To achieve high yields producers in Europe take the soil through multiple operations. Typically, in the UK, this includes: primary and secondary cultivation; bed-tilling or rotary cultivation, bed-forming, de-stoning (typically in which the entire top 25 cm of soil is lifted and stones and clods greater than 45 mm placed into the interrow spaces) and then planting. During crop growth it is usual to spray fungicides every 2-3 weeks to control pathogens. Prior to harvest the crop is sprayed with 2 applications of knock-down herbicide to kill off the plant tops. Harvesting involves lifting the entire soil beds, separating the potatoes and replacing the soil. Harvester sizes vary but can be amongst the largest agricultural machines. Even when harvesting is done at optimum soil water status, soil adheres to the tubers and is removed from the field.

This paper focusses on the consequences of potato production for soil structure using a range of indexes of soil physical quality such as Least Limiting Water Range and Water Stable Aggregation and leads to discussion of options to minimise soil disturbance.

Acknowledgement

Support from AHDB is acknowledged.

Effect of different soil tillage practices on CO_2 emissions under different weather conditions

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Keywords: soil, tillage practice, CO_2 emissions, temperature precipitation

The minimum or no-tillage practices are increasingly used in the world and also in the Czech Republic. Their main advantage is gentler tillage associated with the sequestration of carbon, water and soil nutrients. Minimum tillage decreases the mineralization of soil organic matter due to the lower oxygenation and in consequence causes lower CO_2 emissions from soil.

The long-term field experiment is conducted at Prague-Ruzyně since 1995 when three tillage practices (CT – ploughing to 20-23 cm; MT – minimum tillage with chiseling to 8-10 cm and NT – no-tillage with direct sowing into mulch) were applied after the harvest of preceding crop. The postharvest debris remain at the site and according to the used tillage practice they are more or less incorporated in a soil. The soil rotation consists of changing of the winter wheat with oilseed rape or pea. The CO_2 emissions in the long-term field experiment were measured by means of LI-COR 8100 equipment after crop harvest from August 18 in 2020 and August 25 in 2021 to the end of October.

The period between August and October 2020 was characterised higher average air temperatures in August (20.5 °C) and 64.7 mm of precipitation. The average air temperature in September and October 2020 was 15.9 °C and 10.2 °C, respectively. Total precipitation was 54.1 mm in September and 76.1 mm in October 2020. Year 2021 was characterised with lower average air temperature in August (17.5 °C) and higher precipitation (73 mm). The September and October 2021were characterised by higher average temperatures (16.9 °C and 12.8 °C) and by low precipitation (12.9 mm in September and 9.3 mm in October).

The average CO_2 emissions in August 2020 reached the highest values under CT (10.0 µmol $CO_2/m^2/s$), whereas under RT they were 8.4 µmol $CO_2/m^2/s$ and under NT 5.3 µmol $CO_2/m^2/s$. The CO_2 emissions decreased during the further autumn period when in September the CO_2 emissions were 5.3, 3.1 and 2.5 µmol $CO_2/m^2/s$ under CT, RT and NT. No significant differences in CO_2 emissions were observed in October 2020 (2.3 µmol $CO_2/m^2/s$). The August 2021 was characterised by colder temperature and higher precipitation affecting the CO_2 emissions. CO_2 emissions at turn of August and September were 5.2, 5.5 and 3.9 µmol $CO_2/m^2/s$ under CT, RT and NT. The CO_2 emissions in warmer September 2021 were 5.9, 3.8 and 2.5 µmol $CO_2/m^2/s$ and in October 2021 4.5, 2.3 and 1.0 µmol $CO_2/m^2/s$.

The second field experiment was conducted in August-September 2020 and 2021. The treatments were: chiseling to 10-12 cm, shallow chiseling to 5-6 cm and intact soil with straw mulch or stubble with mulch. The winter wheat was grown in 2020 and pea in 2021. The CO_2 emissions under chiseling to 10-12 cm were during first three weeks in August 2020 almost 50 % higher (9.8 µmol $CO_2/m^2/s$) in comparison with other tillage practices (5.0 µmol $CO_2/m^2/s$). The colder and rainy weather in the August 2021 did not show so great differences in CO_2 emissions among tillage practices. The CO_2 emissions under chiseling to 10-12 cm were higher of about 33 % (8.8 µmol $CO_2/m^2/s$) in comparison with other tillage practices (6.0 µmol $CO_2/m^2/s$). Thereafter the CO_2 emissions decreased in both years.

The obtained results showed that different soil tillage practices affected CO_2 emissions from soils. Warm summer weather with average temperatures exceeding 20 °C together with higher precipitation can increase significantly the CO_2 emissions. The summer soil tillage necessary for sowing of oilseed rape is usually performed in middle August. This period is the most risk for CO_2 emissions from a soil. However, the ongoing climatic change can in future affect also autumn temperatures and CO_2 emissions can remain higher also in this period. Timing of soil operations is important for CO_2 emissions and losses of soil organic carbon. The soil tillage should be carried out later at lower temperatures as it can decrease CO_2 losses in comparison with tillage immediately after harvest in summer. Remaining stubble with straw or straw mulching can be a good practice for mitigation of CO_2 emissions in summer period up to about 50%.

Acknowledgement

The research was supported by grant of Ministry of Agriculture of Czech Republic No: MZE-RO0418.

Impacts of the conservation and traditional agriculture on soil properties and corn production in Junín - Peru

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Keywords: conservation and traditional agriculture, soil physical and biological variables, natural resources

Intensive soil tillage systems are characteristic of traditional agriculture (TA), commonly used in crop production in the Peruvian highlands, which are expensive, tedious and harmful to natural resources. United Nations Environment Programme, ICCI, CARE-PERU and INIA - Peru developed the "Black Carbon Mitigation Project" with the aim of reduction crop residues burning, applying the practices of conservation agriculture (CA) as sowing in no-tilled soil and comparing both agricultural systems, TA and CA. A monitored plot for sowing corn was divided on two parts, where the practices of TA and CA were applied in each divided plot, respectively. The experimental plot was located in Chupaca province, Junín department, and monitored for one year. The parameters of the soil were measured as the following: electrical conductivity (EC) = 0.09 dS/m, pH = 8.11, soil organic matter = 0.94%, extractable P (Olsen) = 39.3 mg/kg, extractable K = 231 mg/kg, cation exchange capacity (CEC) = 25.6 cmol/kg. Bulk density (Db), volumetric water content (θv), erosion (erosion pin method), earthworm population and crop yield were sampled 20 times, in each divided plot with both systems TA and CA, and their averages were analyzed through the Student's T-test. A completely randomized design with three replications of 50 erosion pins in each divided plot was arranged and the averages were compared through Tukey's HSD test for soil erosion. The soil D_b was more constant under CA than TA; CA soil earthworm population showed 84 per m^2, while these in TA showed 8 earthworms/m^2. CA soil θ_v had 36 m^3/ha more than TA at 0-10 cm depth and corn yield was 21.3% more in CA; soil erosion was 50% more in TA than CA. These variables showed significant statistically difference. Corn production cost in TA was 36.6% more than CA. The results showed that practices related to conservation agriculture are more beneficial than traditional agricultural practices on natural resources and corn crop production.

The effect of cover crops and different soil tillage on yield of grain maize

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Keywords: cover crops, strip tillage, grain maize, yield

Farming systems without animal production is currently common and widespread in the Czech Republic. A characteristic feature is the narrow structure of cultivated crops (with prevailing cash crops such as cereals and rapeseed). With such way of farming, there is a lack of soil improving crops and the potential of crop rotation is not utilised. More than 50% of the arable land in the Czech Republic is potentially endangered by water erosion, because of the rugged terrain with sloped fields. From literature is known, that cover crops replace the annual fallow period, which is beneficial for the soil in many aspects. In addition to an increased carbon input, cover crops have shown an increase in biodiversity as well as in reduction of soil erosion and drought stress in the following crop when used as mulch cover in water limited systems. The potential of cover crops to increase soil organic carbon and thus to mitigate climate change has been highlighted in a very limited number of studies.

The aim of our study was: a) to compare the yield of above-ground biomass produced by different cover crop species and b) to evaluate the effect of different soil tillage in interaction with cover crops on yield of grain maize. The small-plot field trial was carried out in two years (2020 and 2021) in Žabčice locality (South Moravian region, Czech Republic, 49°01´ N, 16°37´E, altitude 179 m, average annual temperature 10.3 °C and the sum of precipitation 491 mm, Gleyic Fluvisol Clayic soil type and clay loam soil texture). Ten variants of cover crops were evaluated: four variants consisted of one species only (pea, oat, white mustard, phacelia) and six were mixtures (2 or 3 components) of various species (crimson clover, oil radish, vetch, camelina etc.). Cover crops were sown after stubble breaking (winter barley as a pre-crop) in second half of August. At the beginning of November cover crop above-ground biomass was manually sampled from area of 0.25 m^2 in four replications. All plant samples were weighed and dried in oven to constant weight. After the sampling three variants of soil tillage were used: chisel loosening and strip-till (in both variants to the depth of 25 cm) and no-till. In April, following year, the nitrogen was applied (160 kg N per hectare) prior to sowing grain maize. The variety SY ORPHEUS was sown using precise drilling machine KINZE 3500 with the density of 80,000 seeds per hectare.

The production of cover crop biomass was affected by year. The amount of dry above-ground biomass was higher in 2021 (2.65 t/ha) than in 2020 (2.12 t/ha). The highest yield was in variant with white mustard and mixture of white mustard and camelina (3.16 and 2.78 t/ha, respectively). All other variants varied between 2.0-2.5 t/ha. Similar results were obtained in variant with one species (pea, oat and white mustard). Almost all mixture variants were less affected by year, except for the mixture of two species of phacelia (*Phacelia tanacetifolium* an *P. congesta*) and *Trifolium vesiculosum.* This particular mixture produced significantly higher yield in 2021 (3.07 t/ha) than in 2020 (1.54 t/ha). The yield of grain maize (evaluated year 2021) was affected by soil tillage, when significantly higher yield was in strip-till and no-till variants (13.71 and 13.45 t/ha) than in chisel loosening (12.95). Yields by strip-till and no-till after all cover crop variants were comparable (13.24–14.00 t/ha), after chisel loosening were lower (12.56–13.33 t/ha). In variant without any cover crop, significantly highest yield was after strip-till (14.00 t/ha) than no-till (12.54 t/ha) and chisel loosening (12.28 t/ha).

From obtained results we can conclude, that cover crops are important source of biomass, even in dry areas. Early sowing after cereal harvest in essential for production of above-ground biomass. Cover crop mixtures bring stable production which is less affected by year than pure species. The selection of suitable species in mixtures of cover crops must be related to crop structure in crop rotation and date of sowing (early sowing date is important for clovers). Strip-till is a perspective conservation tillage system applicable with cover crops followed by growing of maize.

Acknowledgement

Acknowledgement to the Ministry of Agriculture of the Czech Republic for financial support, Project No. QK1910334 and the Ministry of the Environment of the Czech Republic, Project No. SS02030018.

Simplification in soil tillage on farms located in North-Eastern Poland with particular emphasis on organic farming – farmer's perspective

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Keywords: soil tillage, tillage simplification, farming systems, North-Eastern Poland

The research was done in 2020-2022 by the method of sounding measurement using a survey of 24 questions, among farmers in North-Eastern Poland. The aim was to evaluate the scale of simplification in soil tillage, taking into account farm acreage, farming systems (intensive conventional, extensive conventional, integrated and organic) and farmer's expectation while deciding to resign from ploughing.

In the study, over 45% of farms were run in the intensive conventional farming system, 36% in the extensive conventional system, 9% in integrated and 10% in organic one. Family farm dominated in the study and the acreage of the farms ranged from 18 to 314 ha, but few bigger farms (from 500 to 2000 ha) were also subject to the study.

The non-tillage system was practised sporadically, and only on the part of farm acreage. The non-ploughing soil tillage was practised by 84% of the intensive conventional farms, usually on ca 50% of farmland. Just 16% of the farms practised soil tillage without ploughing on the entire farm acreage. Almost none of the extensive conventional and the integrated farms resign completely from ploughing, but most of them applied some degree of soil tollage simplification. 32% of the organic farmers resigned from ploughing and 1/3 of them (37,5%) only on limited acreage at that.

There was no difference in acceptability of soil tillage simplification between the stock and the stockless farms. The bigger the farm acreage and the more intensive farming system, the higher proportion of farmers accept soil tillage simplification, including strip-till system.

Some farmers (8%) deciding to simplify their soil tillage system expected exclusively a yield increase, but most of them (92%) expected more advantages as they wanted to save time, fuel, soil water resources (mitigate drought) or in a broader sense mitigate the climate change problems.

Organic farmers (38%) deciding to simplify their soil tillage system expected a yield increase, but almost all of them (92%) expected more advantages as they wanted to save time, fuel, soil water resources (mitigate drought) or in a broader sense mitigate the climate change problems.

Some farmers, especially organic, after the period of enthusiastic adoption of simplified soil tillage system, in the course of time found some disadvantages of non-ploughing soil tillage. Moreover some of them (8%) after a period of practising non-ploughing soil tillage came to conclusion, that their machinery or just a tractor are not good / strong enough to successfully using non-ploughing soil tillage. There is also a group of farmers which decided to go back to ploughing.

Session 3

Sustainable crop production adapted to climate change

Sustainable intensification of crop production is defined as the integration of biological and ecological processes into crop production, optimising the use of non-renewable inputs and improving farmers' knowledge. It is particularly confronted with the threats posed by climate change. The implementation of climate-resilient crop production systems intersects with a range of interventions already being implemented in the crop production sub-sector toward the goal of healthy agro-ecological systems.

These include:

- Increasing genetic diversity at the farm level to improve resilience. Farmers have good potential to adapt crop management practices to changing climatic conditions.

- Integrated pest management (IPM) is an agricultural system that deals with the effective protection against diseases, pests and weeds, which ensures a stable yield and production of quality agricultural products while at the same time reducing the impact of pesticides on human health and the environment. IPM includes preventive tools (crop rotation, soil tillage and seedbed preparation, nutrient management and fertilisation, choice of suitable varieties), monitoring and forecast of harmful organisms and direct methods (biological, mechanical and chemical) based on the determination of thresholds that can cause economic damage.

Grain protein deviation in winter wheat varieties tested in the Czech Republic over the period 2018-2021

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Keywords: winter wheat, grain protein deviation

Nitrogen is currently one of the major production costs for wheat growers and may also have a significant environmental footprint when applied at high levels. The level of nitrogen fertilization must therefore be viewed against this economic and environmental background.

In terms of the value for cultivation and use (VCU) of wheat variety, grain yield and bread making quality are traits of major importance. The level of these parameters is strongly influenced by the amount of nitrogen available in soil. Grain protein content is a parameter strongly correlated with bread-making quality, therefore is used for determination of wheat quality in trading. An ideal variety has both high grain yield and high protein content, but this is difficult to achieve as grain yield and protein content are negatively correlated.

However, some cultivars showed reproducible deviation from negative relationship between yield and grain protein content. Grain protein deviation (GPD) is defined as the residual of the regression of protein content on grain yield. The GPD enables the identification of genotypes that show a higher than expected protein content at a given yield level. Positive GPD is therefore of considerable interest in relation to reducing the requirement for nitrogen fertilization for producing wheat for breadmaking.

The study is based on data from the winter wheat variety field trials carried out in 2018-2021 in the UKZUZ testing sites. Our objectives were to compare different statistical approaches to determine the GPD and their usefulness for evaluation VCU in the context of variety registration and variety recommendation procedure.

The three approaches are as follows:

A. First step: Computation of GPDs for every environment (combination year x location).
   Second step: Evaluation of such GPD values by methods for series of trials.

B. First step: Evaluation of trial series for yield and trial series for protein content.
   Second step: Determination of the negative relationship using the variety estimates obtained in the first step.

C. This approach is similar to approach B, the only difference is that in the second step we use Deming (or orthogonal) regression instead of a classical regression.

These different approaches lead to different results.

Challenges to crop production and ways to solve them

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Keywords: food security, biodiversity, nanotechnologies, C4 plants

Steady population growth and consumption will mean that global demand for food will continue to grow. Stabilization of agricultural production, land use efficiency and innovative cropping practices are interdependent. The reasons for the inefficiency of crop production in recent decades, in addition to purely economic factors, often lie in the structural imbalance of production, commodity resources and their consumption. Growing competition for land, water and energy will affect human's ability to produce food, as well as the urgent need to reduce the environmental impact of the food system. Global changes in the structure of plant raw materials use are exacerbating the problem of food security in the world. In addition to traditional uses of crop products - food, feed, technical processing, there is a powerful consumer of plant materials - bioenergy.

Uncontrolled increase in crop production, which meets the needs of the world's population, causes a number of problems. Loss or inefficient use of plant species cause the need to preserve and restore *plant biodiversity*, expansion of crop diversity, including growing of plants with C4 type photosynthesis with enhanced use of CO_2. Biodiversification of the field crop structure leads to the need for comparison of the productivity and resource loads of management practices of crops with different types of photosynthesis.

Protection of natural ecosystems will ensure the biodiversity conservation. The latest crop management practices require an increase in consumption of energy and resources per unit of output, which leads to negative impacts on the environment.

Main subject of our research is crops biodiversity enriching in artificially created biocenoses, based on analysis of weather changes in the Right–bank Forest–Steppe and Steppe of Ukraine and identification of crops, the biological and technological properties of which are suitable for introduction. This investigation was conducted in the stationary field trial of Plant Science Department of the National University of Life and Environmental Sciences of Ukraine "Agronomic Research Station", v. Pshenychne, Vasylkivsky district of the Kyiv region in the Right–bank Forest–Steppe of Ukraine. In the zone of Forest–Steppe, field trials were conducted on typical black soils, in the zone of Steppe on southern black soil (chernozem), which is typical black soil usual for Ukrainian Forest-Steppe and Steppe. The distribution of precipitation and temperatures during vegetation period are not even and significantly varies year by year.

In the field trials, the following investigations were carried out: (i) determination of plasticity and stability of new crops in terms of yield formation in fluctuating abiotic environmental factors, (ii) identification of varieties and hybrids in terms of productivity in different zones of Ukraine, (iii) the establishment of adaptive crop management measures which are limiting for yield formation of the rare field crops.

Growing crops in accordance with the principles of adaptive crop management has to be carried out in accordance with the requirements of sustainable development of agriculture and environmental protection. Intensification of crop management practices significantly affects the biodiversity of soil microflora.

Introduction of industrially valuable rare plants into the cropping system and multifunctional use of their raw materials in food production and in industry should be accompanied by the development of adaptive crop management practices. This will ensure the conservation and enrichment of biological resources, improve their quality and safety, expand biodiversity, and have a positive impact on the sustainable development and on the competitiveness of crop production in Ukraine.

For this purpose, the latest forms of fertilizers have been investigated. Their application allows long-term and targeted use of nutrients as the basis of the plant nutrition system. Great potential has the use of nanofertilizers synthesized specifically for the controlled release of nutrients and minimizing their losses depending on the needs of crops.

Results of experiments in soil cultivation and irrigation

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Keywords: soybean, winter wheat, irrigation, minimum soil cultivation, conventional soil cultivation

Irrigation ensures stable crop yields in the dry north-eastern part of Austria. Since 2018, experiments at the LFS-Obersiebenbrunn aim at investigating mutual effects of irrigation and soil cultivation on yield and soil characteristics.

Considering crop yield of soybean and winter wheat, soil cultivation has shown minor influence when using drip irrigation.

Minimized soil cultivation led to optimal yield in combination with drip lines and a moving irrigation boom. When irrigating with a solid-state sprinkler system, conventional soil cultivation promoted yields best. On the other hand, reduced soil cultivation seemed the best choice under rainfed conditions.

Largest yield per litre water was observed when irrigating with the boom. Considering exclusively the effect of irrigation water applied, boom irrigation was most efficient, followed by drip irrigation and sprinkler irrigation.

Sustainable agriculture and the role of intercrops

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Keywords: sustainability, crop rotation, erosion, catch crops, intercrops, soil temperature, roots

Sustainability is currently a topic for all disciplines. How to maintain sustainable agriculture is a very broad and complex question, and the role of intercrops can help us. Intercrops improve the crop rotation, they suppress weeds, diseases and pests. By intercropping, we use the intergrowth period, when the soil would otherwise remain without cover. Possible erosion would have a negative effect on soil, and due to high temperatures, a loss of water and drying of the soil, which limits life in the soil and degrades soil and its fertility, occurred.

Our experiments focused on two factors, firstly on soil protection with cover crops to reduce soil erosion and drying and conservation of soil moisture. It has been done in 2018 at the experimental plant production station in Lukavec, located in the foothills of the Českomoravská vrchovina Highland located at around 610 m above sea level. The soil is Skeletic Cambisol.

As part of this experiment, we measured the temperature of the soil on the surface and in a depth of 10 cm. Sowing was carried out on 24.7.2018. Measurement were performed on 22.8. (after 30 days) and 18.9. (after 57 days). The following variants were used: 1. soil without any cover, 2. mixture of mustard (*Sinapis alba L.*) and oil radish (*Raphanus sativus L.*), sowing rate 6 + 2 = 8 kg/ha and 3. Variant was a mixture of two phacelias (*Phacelia tanacetifolia Benth.*) and (*Phacelia congesta Hook.*), sowing rate = 4 + 8 = 12 kg/ha. The results clearly show the positive effect of intercrops on reducing soil temperature compared to the variant of soil without cover when variant 1. without soil cover had higher surface temperature in the 1st term of measurement (22.8.) 35.1°C compared to variant 2. 32.0°C and variant 3. 31.2°C, and also in the 2nd term of measurement (18.9.) 30.5°C compared to variant 2. 24.0°C and variant 3. 22,8°C.

Similar results showed also measurements in the depth of 10 cm. Variant 1. without soil cover had higher temperature in the 1st term of measurement (22.8.) 26.3°C compared to variant 2. 25.1°C and variant 3. 24.2°C. And also in the 2nd term of measurement (18.9.) 19.0°C compared to variant 2. 18.0°C and variant 3. 16.5°C.

Secondly, we focused on the yield of root mass and length of catch crops. The effects of rooting (root penetration of soil) and improving physical conditions of the soil, reducing the soil compaction and also depositing organic matter in the soil were evident. The following species were tested: *Sinapis alba L., Camelina sativa L., Phacelia tanacetifolia L. Phacelia congesta L., Trifolim vesiculosum L., Trifolium incarnatum L., Raphanus sativus L.* The measurement was done in 7 different terms. A significant effect was showed especially by oil radish (*Raphanus sativus L.*) with the longest roots (35 cm, term 18.11.). The fastest root growth showed mustard (*Sinapis alba L.*) with root length 16 cm compared to oil radish (*Raphanus sativus L.*) with root length 11 cm (term 10.9.) but on the next measurement term (26.9.), oil radish had already longer roots than mustard (25 vs. 19 cm).

Sustainability of agriculture should be mainly based on local production and local consumption and on the use of positive effects of intercrops to improve soil fertility.

Acknowledgement

Many thanks to the experimental plant production station in Lukavec for running the experiments, namely Mr. Václav Veleta for his professional approach.

The response of soybean yield to different cropping pattern in a long-term experiment on chernozem

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Keywords: crop rotation, monoculture, climate conditions, yield, chernozem

Considering the area and global production of the soybean, a relatively small number of papers address different aspects of its cultivation patterns and place in crop sequences. This leads to a lack of knowledge on the role and significance of soybean in different European cropping systems (CS). There is a consensus that soybean is favourable preceding crop and alongside soybean yield increases in crop rotations, however, the length and cropping patterns significantly affected the "rotation advantage" of soybean cropping systems. On the contrary, soybean monoculture has been widely used in practice despite potential adverse effects and higher risk of production. Therefore, the aim of this study was to assess yield differences of selected soybean cropping patterns in relation to the temperate climatic condition for 2008-2016 period. Analysed CS foreseen growing soybeans with maize (M), winter wheat (W) sugar beet (B) and soybean (S) as follows: (i) unfertilized 3-year rotation (MSW), (ii) 3-year rotation (MSWf), (iii) 3-year rotation + cover crops (MSWccf), (iv) 4-year rotation (MSWBf), (v) monoculture SSSf and (vi) 3-year rotation with manure (MSWam). The trial was part of the long-term experiment "Plodoredi" on the experimental station Rimski Šančevi of the Institute of Filed and Vegetable crops Novi Sad established on Haplic Chernozem. Regular tillage operations were used including mouldboard ploughing in autumn, compactor for levelling furrows in spring, multi-tiller for seedbed preparation and sowing in April. Inter-row cultivation and plant protection were done in May. Fertilization was not applied for soybean directly but for other crops in rotation with respect to soil chemical properties and anticipated yield. During 10 years period leading soybean varieties was grown with addition of biological fertilizer Nitragin. In average, a significantly higher yield was obtained at the 3-year fertilized rotation (3.25 t/ha) and the lowest at the monoculture (1.7 t/ha). Among the investigated years, a higher yield was obtained in 2013. and the lowest at 2017. A highly significant correlation with soybean yield was found for rainfall ($r=0.78^{**}$ $p<0.01$) and a significant correlation for the temperature ($r=0.74^{*}$, $p<0.05$) during the vegetation period (April-September). Climatic data evaluation reviled that a significant effect on soybean yield for the temperature was found for August. For monthly sum rainfall, a significant effect on yield was found for the June compared to other months. Our study demonstrates that soybean in 3-year rotation benefited from crop sequence compared to monocropping. In addition, animal manure used for maize has not significantly affected soybean yield as well as growing soybean in a 4-year rotation. Main disadvantages in monocropping are weed control and less efficient plant protection. Long-term unfertilized soybean demonstrated the adaptability of grown verities to low input systems and showed potential of sustaining yield in favourable years but the crop yield largely depends on the performance of winter wheat and maize.

Acknowledgement

Realization of the research was provided by the Ministry of Education, Science and Technological development of the Republic of Serbia (agreement 451-03-68/2022-14/200117) and Institute of Field and Vegetable Crops Novi Sad

Gregor Mendel and his legacy to agriculture

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Keywords: G. Mendel life and education, achievements

Gregor Mendel was born on 20 July 1822 in a family of German-speaking peasants in a small village near the Moravian-Silesian border. Since childhood, he had been trained in farm work, including beekeeping and orchard management. When his exceptional academic talent was recognised, he was sent to a boarding school in Lipník and Bečvou and later in Opava. During his studies, he suffered from severe financial setbacks and nervous breakdowns and his decision to join the Augustinian Order in Brno at the age of 21 was a rational way to resolve his difficult economic situation.

Mendel's formal studies at the monastery also included lectures on agriculture, pomology, and viticulture at the Brünn Philosophical institute. Unable to serve as a parish priest, he was dispatched to Znojmo to teach mathematics and Greek at a high school. His failure at the examination for the teacher certificate allowed him to spend two years at the University of Vienna attending various lectures on mathematics, physics, botany and other natural sciences, which showed to be very important for his scientific development.

Mendel's extensive plant experiments started in 1856 and ceased by 1873 when he had to neglect them due to various duties connected to his position as a prelate. Apart from his experimental work, he tended plants in the monastery garden and greenhouse and cared for the fruit orchard and beehives. He was active in many local scientific societies and committees, wrote articles on various agricultural subjects, promoted new methods in agriculture and horticulture, and supported agricultural education in elementary schools. He died in January 1884 due to kidney failure and heart disease and was buried in Brno. The importance of his work was discovered in 1900, after being ignored for 34 years.

His interest in hybridisation led him to study the occurrence and combination of differing traits in the progeny of hybrids. His interpretation of the results was based on the existence of hereditary elements that undergo segregation when reproductive cells are formed, and unite again through fertilisation. Although he was not aware of the existence of genes, alleles and chromosome pairing and disjunction during meiosis, his theory explaining the fundamental principles of inheritance has remained valid.

Mendel revolutionised the study of heredity also in a methodological way by demonstrating the necessity to assess character by character and trait by trait while paying careful attention to genealogy and the numerical ratios of contrasting traits in each generation. The further remarkable idea was to verify the phenomenon of genetic segregation valid for pea by performing extensive hybridisation experiments with other species.

Mendel's work is often considered the starting point of modern natural sciences, particularly genetics. Understanding heredity and its application to breeding programmes enabled the development of new cultivars and contributed significantly to the rapid increase of crop yields. Without this knowledge, the current world population, which is estimated to be close to 8 billion, could probably not be supplied with food adequately. The identical impact of genetics can be found in animal breeding. This illustrates that Gregor Mendel's legacy is still relevant for the development of modern agriculture.

Session 4

Precision agriculture

Precision agriculture (PA) or precision farming is a modern farming management concept using digital technology to monitor and optimise agricultural production processes. The crop management practices are adapted to the spatial variability of soil and crop requirements in the form of variable application of fertilisers, pesticides, sowing rate and soil tillage. PA methods promise to increase the quantity and quality of agricultural production while using fewer inputs (water, energy, fertilisers, pesticides, etc.). The aim is to save costs, reduce environmental impact and improve food quality.

Assessment of the effect of optimized field plot size on the crop yield

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Keywords: yield map, soil erosion, precision agriculture, GIS

In the presented research, the effect of changes in the size of plots on the crop yield was studied. Three plots were chosen in a company engaged in conventional agriculture, on which the yield was monitored from 2019 using the yield maps. In 2020, the plots whose initial size was > 30 ha were divided into various parts sized < 30 ha. In 2021, these newly arisen parts of the plots were harvested. The division of plots was necessary because a condition for drawing EU subsidies stipulated in the Good agricultural and environmental conditions (GAEC) implemented in the Czech Republic bans the growing of crop monocultures on an area > 30 ha. Thus, new and smaller parts came to existence within the original land boundaries. Changes in the yield of grown crops were analysed using yield maps acquired by the harvesting machines. Relative yields (%) and absolute yields (t/ha) were determined on all experimental land parts arisen from the division of the initial plots. The values were then compared with yields recorded before the division of individual plots using zonal statistics. Measured values of relative yield clearly show ($P < 0.05$) that the division of plots resulted in the increased heterogeneity of crop yields. On the initial plots as well as on the newly arisen plots, the relative yield was divided into the following categories: < 70%; 70 – 85%; 85 – 95%; 95 – 105%; 105 – 115%; 115 – 130% and > 130%, with the value of 100% representing average yield. The analysis of measured yield data showed that the division of plots into smaller parts resulted in an uneven yield distribution because if a divided plot was heterogeneous in terms of yield levels, a cumulation of “higher yield levels (> 100%)” could have occurred in one specific newly arisen plot at the expense of another one. Moreover, new marginal parts of lands came into being during the division of larger soil complexes, and hence zones with the potentially reduced yields.

Acknowledgement

Acknowledgement to the Ministry of Agriculture of the Czech Republic for financial support, Project No QK21020243 - Rational sowing area on soil blocks within setting conditions of GAEC to support sustainable management in the Czech Republic.

Modification of tillage technologies for wide row crops

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Keywords: zonal preparation, water infiltration, root system, energy demand, yield

Cultivation systems and technologies ensuring efficient water management and limiting soil degradation processes will be the basis for efficient land use, achieving the required crop yields and contributing to the long-term and sustainable use of soil and landscape.

Cultivation systems based on intensive soil cultivation, combined with plowing, or systems based on loosening, without turning the soil, followed by full-scale soil preparation and sowing, are currently widely used. With the growing demand to limit the risk factors associated with the degradation of the soil environment due to erosion, deteriorated infiltration conditions and compaction of the upper soil layer during individual operations, there is a re-evaluation of the classic crop establishment procedures, based on full-scale soil treatment in separate operations. From this point of view, systems for belt tillage without pre-sowing preparation are also coming to the fore, which are also connected with zonal applications in the form of depositing fertilizers and auxiliaries.

Systems for establishing maize with significantly modified pre-sowing preparation were verified in 2019 and 2020. In accordance with the overall effort to increase work efficiency and limit the adverse effects and impacts of intensive tillage, the following aspects were verified:

- establishment of stands without full-scale pre-sowing preparation,

- impacts on the energy intensity of tillage and reduction of fuel consumption,

- ensuring moisture conditions in the soil and efficient management of water in the soil,

- use of optimization and merging of passes,

- leaving larger soil aggregates on the soil surface, which will ensure more effective protection against water and wind erosion,

- creation and support of preferential infiltration zones,

- targeted application of fertilizers and auxiliaries to the root zone of plants and thereby limiting surface application,

- impacts on yield and biometric indicators of stands.

The results demonstrate the possibilities of alternative approaches to the traditional procedures of pre-sowing preparation and establishment of maize stands. A positive trend of reducing the intensity of tillage and the effect of zonal loosening on the development of the stand and yield was found.

Acknowledgement

The presented outputs were obtained with the support of project TH04010494 "Research and development of smart farming technologies for small and medium-sized farms”

Mapping the spatial heterogeneity of arable fields from crop yield records and remotely sensed data

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Keywords: precision agriculture, yield mapping, satellite imaging, vegetation indices, spatial variability

The development of harvesting technology nowadays offers the possibility of whole area mapping of the crop yield. Crop yield maps are an important input information for description of soil productivity in precision agriculture. The aim of this study was to evaluate spatial variability of the arable crop yields and its estimation by remote sensing. The study was realized during the years 2017 to 2019 from the results of two field trials with an area of 78 and 41 ha managed by farm enterprise Rostenice a.s. in cadastral area Bosovice (Vyskov, Czech Republic). In 2017 – 2019 crop yield maps of oilseed rape, spring and winter barley were mapped by grain flow sensors installed in combined harvesters. Data were processed in GIS for elimination of the erroneous records, including merging records from two harvesters on one field with differences in sensor calibration. As the result, reliable point records were obtained and after spatial interpolations technique (Empirical Bayesian Kriging), the final product was a raster layer of grain yield values with a spatial resolution of 5 m per pixel. The absolute values of the yield are then converted to the relative yield within each plot, which allows a comparison of the achieved productivity of areas regardless of the crop grown and the range of yield achieved. A statistical evaluation of these map layers was performed by correlation and regression analysis, including digital elevation model (DMR4G) and vegetation indices from multispectral satellite imagery of Sentinel-2 (NDVI, EVI and NDMI). The results showed that both experimental fields reached similar heterogeneity of the crop yield, as ranged from 32 to 168 %. An important factor influencing crop yield is the relief of the terrain and the associated changes in the soil environment. Although visual comparison of crop yield maps and vegetation indices showed coincidence in spatial patterns, correlation analysis have proved only middle level of relationship, mostly for year 2018. However, capturing multiple-years trends in the spatial patterns of vegetation from satellite data allows to delineate crop yield levels and to use of this information as a basis for decision-making in site-specific crop management in precision agriculture.

Acknowledgement

The study is supported by the national research project NAZV QK21010247 “Management optimization of unbalanced fields by means of digital soil mapping and soil moisture changes monitoring in order to stabilize the achievable yield” and QK1810233 „Quantification of the impact of farming management on soil erosion, soil quality and yields of crops with proposals of the environmentally friendly cultivation technologies“

Poster session

Assessment of rice nitrogen uptake using UAV multispectral imagery

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Keywords: UAVs, plant sampling, vegetation indices

Nowadays, Unmanned Aerial Vehicles (UAVs) are actively used as crop health monitoring, nitrogen assessment and estimation of yield which it can be applied in many crops and also in rice. The aim of this study is to analyse the relationship between N uptake of rice and vegetation index from multispectral UAV images. The study area was located in Muang Sakon Nakhon District, Sakon Nakhon Province, Thailand. The survey was conducted on 20 paddy fields of farmers who planted Khao Dawk Mali 105 rice. Nitrogen (N) fertilizers were applied with different rate (the rate of 21.8-98.7 kg N/ha). The rice at the booting stage was collected at four different points on each plot for N-uptake analysis. The multispectral images data were acquired with DJI PHANTOM 4 MULTISPECTRAL (P4M). The vegetation indices (GNDVI, NDRE, NDVI and OSAVI) were calculated at each sampling point using the buffer zone (5 m, 10 m, 20 m). The results showed that N uptake and biomass have relationship with vegetation indices from UAV. Buffer zone of UAV data showed sampling size of 20 m. has higher correlation to the estimate accuracy than other sampling sizes (5 m and 10 m). The NDRE has a highest correlation with N uptake. On the other hand, the vegetation index OSAVI has a highest correlation with rice biomass.

Acknowledgement

This work was financially supported by the Office of the Ministry of Higher Education, Science, Research and Innovation; and the Thailand Science Research and Innovation through the Kasetsart University Reinventing University Program 2021 as the research project PRP6305031840.

Dynamic of selected physical, chemical, and biological parameters as affected by water erosion

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Keywords: soil organic carbon, soil degradation, erosion, physical and biological parameters

Intensive agriculture is the main factor of decreasing soil quality and soil degradation. The maintenance of soil organic matter can reduce these negative consequences and increase the stability of agro-ecosystems. The rate of soil organic matter accumulation depends on particle size distribution and soil chemical and biological properties. Soils high in soil organic matter are supposed to be more resistant against water erosion and have better water retention and sorption capacity. This study is aimed at the assessment of changes in selected soil properties in the transect control site (Calcic Chernozem (Loamic)) – erosion site (Calcaric Regosol (Loamic)) – accumulation site (Colluvic Calcaric Regosol (Loamic)). The soil types were classified according to the IUSS Working Group WRB (2014). The particle size analysis, porosity, density, bulk density, aggregates stability, total organic carbon and nitrogen content, humic substances content, nutrients content, microbial biomass and basal soil respiration were evaluated during the period 2018–2022. The selected parameters were determined by standard analytical methods according to Zbíral et al. (2016). Results were processed by one-way ANOVA analysis and Fisher test ($p<0,05$). Results showed that erosion statistically significantly affected aggregates stability, total organic carbon and nitrogen content, and humic substances content. Soil biota was under the stress and the degrease of microbial biomass and basal soil respiration was determined.

Acknowledgement

The work was supported by the project QK 21010124 „Soil organic matter – evaluation of selected indicators" (MoA, NAZV, Czechia), project SSO2030018 „Centre for Landscape and Biodiversity" (MoE, TAČR, Czechia), and project QK 1810233 „Quantification of the effect of agricultural management technology on erosion, soil quality, and yields with a proposal of environmentally friendly soil management technology" (MoA, NAZV, Czechia).

Weediness of maize in conservation tillage systems under climate change conditions

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Keywords: weed occurrence, *Zea mays* L., conservation tillage, climate change

Different conservation tillage systems play an important role in mitigating the negative impacts of climate change on crop productivity and preventing soil degradation. By changing a number of soil conditions, conservation tillage affects the change in weed levels. Weeds are the dominant biotic factor that most often negatively affects the performance of maize yields during the growing season, and especially in the critical period of weediness. Fertilization can increase the competitive ability of maize which causes a reduction of weeds occurrence and change in the composition of weed flora. Weed species amount, density and biomass play a significant role in maintaining the biodiversity of agroecosystems. The aim of this study was to investigate the impact of conservation tillage and fertilization on weed infestation in maize. Field experiment was performed in year 2021 at experimental site Čačinci (Stagnosol soil type) in Croatia (17.86336 E, 45.61316 N, 111 m a.s.l.) as a split plot experimental design in three replicates with soil tillage as the main factor and fertilization as subfactor. The soil treatments were as follows: CT (conventional, plowing), CTD (conservation, loosening with a minimum of 30% of crop residues on the surface) and CTS (conservation, shallow tillage with a minimum 50% of crop residues on the surface). Fertilization treatments were: FR – control treatment (according to the recommendation in amount of - NPK 170: 150: 225 kg/ha), FH (50% of the recommendation), GFR (according to the recommendation + GeO2 - biophysiological soil activator, 300 kg/ha), GFH (50% of recommendation + GeO2). Weed sampling and determination of weed species were performed twice during the maize growing season (growth stages V10 and R5). The applied chemical weed protection was uniform for all soil tillage and fertilizations treatments. Individual weed species were counted within the square of 0.25 m^2 in four replicates per experimental plot to determine the weed density and cut off from the same square at ground level to determine aboveground biomass. At the same time, weed coverage was established on the same surfaces with visual assessment. The most numerous weed species were: *Calystegia sephium* (L.) R. Br., *Ambrosia artemisiifolia* L., *Setaria viridis* (L.) P. Beauv. and *Convolvulus arvensis* L. Tillage significantly affected the total number of weeds, weed aboveground biomass, number of weed species and weed cover in the first observation (V 10 – critical weed-free period for maize). All investigated indicators in average were the highest at the CTS treatment with statistical significance ($p \leq 0.05$) in relation to conventional tillage (CT). The total weed number (12.33/m^2) on CTS treatment was almost four times higher compared to CT (3.34/m^2). Fertilization did not significantly affect the level of weediness, and the average values of all studied indicators were the lowest on the treatment GFH. The impact of tillage and fertilization on the total weed number in the second sampling (growth stage R5) was statistically significant ($p \leq 0.05$). Significant interaction between tillage and fertilization was found, and the highest total number of weeds was recorded on control fertilization treatment FR for all tillage treatments. Treatment GFH in average resulted in more than 50% fewer weeds compared to FR (22.3/m^2) with statistically significant difference. The highest total weed number was recorded on CTD tillage treatment (21.25/m^2). The highest weed aboveground biomass (183.83 g/m^2), number of weed species (2.75/m^2) and weed cover (81.75%) in second weed observation were recorded on CTS tillage treatment with a significant statistical difference in relation to CT treatment. The results of this study indicate an increase in weediness of maize on conservation tillage systems and the positive effect of reduced fertilization with the addition of biophysiological soil activator to reduce weed levels in the later developmental stages of maize. The suitability of soil conservation systems and optimal fertilization in terms of weed management needs to be further investigated.

Acknowledgement

This work has been fully supported by Croatian Science Foundation under the project "Assessment of conservation soil tillage as advanced methods for crop production and prevention of soil degradation – ACTIVEsoil" (IP-2020-02-2647)

The quality of organic matter under cereals stands in the long-term field experiment

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Keywords: long-term field experiment, monoculture of cereals, different management of organic fertilization, quality of SOM

The content and quality of soil organic matter (SOM) is a measure of the fertility and production capacity of arable soils. This fact is, without a doubt, closely related to the overall method of management in agricultural enterprises. For the good content and quality of SOM, in addition to the influence of good habitat conditions, the supply of high-quality organic fertilization to the soil, the method of soil cultivation and crop rotation are of great importance. The effect of some mentioned agrotechnical factors was evaluated on the basis of the results obtained from a long-term field experiment in Ivanovice na Hané, specifically from a cereal monoculture with different variants of organic fertilization. The long-term field experiment was established in 1965 in the Ivanovice na Hané locality (49°19' N, 17°05 'E, altitude 225 m, average annual temperature 9.17 °C and total precipitation 548,1 mm), the soil type is Luvic Chernozem Loamic, the soil texture is loam soil. The following variants of organic fertilization are carried out and was evaluated: straw harvested; straw harvested and sowing of catch crop; straw incorporated; straw incorporated and sowing of catch crop; straw burning; straw harvested and manure application (10 t/ha). The main aim was determine content of SOM and its quality, expressed by content of humic substances (HS, %) and by ration of acids (HA/FA). This assessment was done after 53-55 years since the establishment of this experiment. The results achieved during years 2018-2020 were evaluated by ANOVA analysis (StatisticaCZ14 software) and post-hoc Tukey test ($p \leq 0.05$). Results of ANOVA evaluation was significant. In summary, the highest values for both mentioned parameters were achieved on the variant with straw incorporated and sowing of catch crop. References to literature with describing of previously period exist.

Acknowledgement

The work was supported by the project No. SS02030018 (TAČR) and project No. QK1810186 (NAZV).

The grain yields of cereals in the long-term field experiment in Žabčice

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Keywords: long-term field experiment, soil tillage, crop rotation, yields of spring barley, yields of winter wheat

The aim of this contribution is to evaluate the various systems of soil tillage, crop rotation and the effect of years on grain yields of winter wheat and spring barley growing in long-term field experiment in Žabčice. The long-term field experiment was established in the autumn of 1969, and the first harvest was conducted in 1970. In the current form of long-term field experiment, monocultures of winter wheat and spring barley and one crop rotation (based on the principles of the Norfolk rotation) are conducted. Unique to this experiment is a monoculture of spring barley (*Hordeum vulgare* L.) established in the spring of 1970 and the contribution especially with grain yield results of spring barley growing under monoculture were presented during the last ISTRO Conference. The long-term field experiment was established in Žabčice at the Experimental Stationary of Mendel University in Brno. The mean annual air temperature is 10.3 °C, and the mean annual precipitations are 491 mm. The contribution shows the results of the evaluation of the soil tillage and crop rotation effects on the grain yields of winter wheat and spring barley in last two decades (2003-2020). For both crops, year was the key factor, when the share of influence was higher than 50 % for both crops. Assessment of two other experimental factors show, that the effect of the crop rotation was significant than soil tillage.

Acknowledgement

The work was supported by the project No. SS02030018 (TAČR) and project No. QK1810186 (NAZV).

Acid soils CO_2 respiration under conservation tillage, different fertilization and liming

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Keywords: CO_2 respiration, conservation tillage, fertilizer, liming, acid soil

Good microbial activity plays a crucial role in soil health status and it is important for decomposition of organic matter, cycling of nutrients (especially P and N), formation of humus and stabilization of soil aggregates. It is known that Conservation tillage can positively affect higher accumulation of organic matter especially in the surface soil which can lead to a higher soil microbial activity. This activity can be measured through CO_2 respiration from soil. Hence, the main objective of the study is how improved land management practices can affect evolved CO_2-C which represents microbial activity as one of the most important soil health indicators. Two experiments were established in Croatia on two soil types Stagnosol and Gleysol both with acid soil reaction. Cultivated crop was corn and the treatments were: ST-Standard Tillage (deep mouldboard ploughing), CTD-Conservation System Deep (without ploughing and with minimum 30% of surface covered with plant residues), CTS-Conservation System Shallow (tillage up to 10 cm and minimum 50% of surface covered with plant residues). Liming CY-treatment with applied lime (according to recommendation) and CN-treatment without liming and fertilization, FR-according recommendation (NPK), FD-fertilization decreased by 50% compared to recommendation, GFR-fertilization according recommendation + 300 kg ha^{-1} Geo2 (biophysiological soil activator), GFD-fertilization decreased by 50% + 300 kg ha^{-1} Geo2. Soil samples were taken at two soil depths (0–15 cm and 15-30 cm). Measurement of evolved CO_2-C is done by using commercial soil health test 24h Solvita CO_2-burst test. CO_2 respiration was significantly affected by tillage, fertilization and liming on both localities. Highest evolved CO_2-C was measured on 15 to 30 cm on Gleysol (treatment CTS, CN, GFD) 193.00 CO_2-C kg^{-1}. On 0 to15 cm on both soil types the highest evolved CO_2-C are recorded on CTS tillage treatments with liming and GFD fertilization (Stagnosol 95.37mg CO_2-C kg^{-1}; Gleysol 62.63 CO_2-C kg^{-1}). On both depths and localities, the lowest measured evolved CO_2 was on ST. Concentrations of evolved CO_2-C measured in CTS treatment confirms the positive influences of Conservation tillage on increasing microbial activity on acid soils especially in surface soil (0-15 cm) and also good applicability of Solvita CO_2-burst test.

Acknowledgement

This work has been fully supported by Croatian Science Foundation under the project "Assessment of conservation soil tillage as advanced methods for crop production and prevention of soil degradation" (IP-2020-02-2647.

Effect of long-term digestate application on soil quality of permanent grassland

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Keywords: plant biomass yield, soil enzymes, basal respiration, injector, pH

The increasing number of biogas plants is producing more and more waste material, digestate, which needs to be used in a meaningful way. Digestate has a high content of plant-available nutrients and could therefore replace mineral fertilisers used on both arable land and permanent grassland.

In a field experiment, the effect of repeated application of digestate on soil quality and plant biomass yield of permanent grassland was investigated. Permanent grassland was fertilised with digestate twice a year for three consecutive years, always after the first and second mowing. Digestate was applied into the soil using an injector in doses 80+0 m^3/ha; 40+0 m^3/ha; 40+40 m^3/ha; 20+20 m^3/ha; 0+40 m^3/ha; and 0+80 m^3/ha; or conventionally on the soil surface using a standard hose applicator in dose 20+20 m^3/ha. The control variant was not fertilised with digestate. Each year 3 mowings were carried out. Plant biomass yield was determined as the sum of all mowings during the whole experiment. Soil samples were taken in the third year after the third mowing.

All variants with digestate application increased total plant biomass yield by 7% (hose applicator 20+20 m^3/ha) to 14% (40+40 m^3/ha) as compared to unfertilised control. On the other hand, long-term digestate application led to decreased soil pH in all variants. The most considerable decrease in soil pH occurred after the application of digestate on soil surface (-15%), followed by application with injector after second mowing, 0+80 m^3/ha (-14 %) and 0+40 m^3/ha (-13%). On the contrary, variants 40+0 m^3/ha, 80+0 m^3/ha and 40+40 m^3/ha showed the least negative effect on pH (-3%, -5%, -5%, respectively).

Variant 80+0 m^3/ha was found to have the most positive effect on basal respiration (+14%) and on following soil enzymes activities: dehydrogenase (+72%), urease (+28%), phosphatase (+100%), N-acetyl-β-D-glucosaminidase (+186%) and β-glucosidase (+114%). On the other hand, variant 40+0 m^3/ha showed the most negative effect on basal respiration (-38%), β-glucosidase (-16%) and the least positive effect on phosphatase (+3%), N-acetyl-β-D-glucosaminidase (+48%).

Variant 80+0 m^3/ha also showed the highest content of nutrients in soil as total carbon, total nitrogen and available phosphorus (+71%, +91%, +355%, respectively). On the contrary, application on soil surface led to the lowest content of these nutrients (C -2%, N +8%, P -66%).

In this study, the repeated application of digestate below the soil surface at a higher dose after first mowing (80+0 m^3/ha) proved to be the most suitable for maintaining soil health and quality, which are represented by soil respiration, enzymes activities and nutrients content. On the other hand, application of digestate on soil surface in dose 20+20 m^3/ha showed the worse results. This variant led to the most considerable decrease in soil pH, to the lowest content of total carbon, total nitrogen and available phosphorus in soil and to the lowest plant biomass yield. In conclusion, the digestate application below the soil surface is more efficient than the conventional approach, both in terms of hay yield and the soil health and quality.

Acknowledgement

The work was supported by Technology Agency of the Czech Republic, grant number TH04030132 and by the Ministry of Education, Youth and Sports of the Czech Republic, grant number FCH-S-22-8001.

Evaluation of winter wheat nitrogen status by multispectral unmanned aerial survey

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Keywords: plant diagnosis, precision agriculture, remote sensing, vegetation indices

The monitoring of winter wheat plant vigour during vegetation period is crucial in site specific crop management, mainly for correct topdressing of nitrogen. The aim of this study is to describe the evaluation of unmanned multispectral imaging for the diagnosis of the nutritional status of winter wheat in precision agriculture. This study was made in the form of a field experiment in the years 2018, 2019 and 2020 on the plots of ZD Kojčice (Pelhřimov, Czech Republic) with a total areas of 36 ha, 41.38 ha and 28 ha. In important vegetation phases for the application of nitrogen fertilizers (stem elongation - BBCH 31 and heading - BBCH 51), plant samples were taken to determine the nitrogen content and the total amount of above-ground biomass. Simultaneously, UAV imaging was performed using a drone-mounted multispectral camera to capture plant reflectance in the blue, green, red, red edge, and near-infrared spectral bands. The images prepared in this way were processed in photogrammetric software to create a complete orthomosaic. A set of vegetation indices (NDVI, NDRE, etc.) was calculated from these data and from the average value estimated by zonal statistics from a 2 m buffer zone around each sampling point. Statistical evaluation by correlation and regression analysis showed a significant relationship between crop parameters and vegetation indices from the UAV survey. For the estimation of nitrogen uptake, the most sensitive correlations were achieved with the red-edge vegetation indices (NDRE, NRERI). On the other hand, the highest sensitivity with the amount of above-ground biomass was achieved by the NDVI and SRI indices. It could be therefore concluded that UAV multispectral survey may alternate traditional field monitoring even with a smaller number of calibration points and with the high spatial resolution of provided data.

Acknowledgement

This study was supported by Internal Grant Agency of Faculty of Agriscience at Mendel University in Brno as the research project AF-IGA2021-IP088.

The effect of growth regulators application on the yield and economy of poppy cultivation

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Keywords: growth regulators, seed poppy, seed yield, economics of cultivation, gross margin

From 2016 to 2020, a field trial with growth regulators application in poppy was established and conducted at the Field Experimental Station of the Mendel University in Žabčice in the maize production area. The aim of investigation was to determine the effect of the use of growth regulators on the yield of poppy seed and the economy of poppy cultivation expressed by the gross margin (GM) determined as the difference between sales and direct costs in CZK/ha. The Retacel Extra R68 (chlormequat chloride 720 g/l), Cerone 480 SL (ethephone 480 g/l), Tilmor (prothioconazole 80 g/l + tebuconazole 160 g/l), Caramba (metconazole 60 g/l) and Caryx (metconazole 60 g/l + mepiquat chloride 210 g/l) were used in the experiment. In the individual variants, different doses of growth regulators, as well as their combinations were applied to poppy stand at the development phase BBCH 39. The average yield of individual variants in 2016-2020 ranged between 0.75-0.92 t/ha. The highest yield was recorded by the Tilmor variant at a dose of 1 l/ha (0.92 t/ha). In the years with higher precipitation (2016, 2019 and 2020), the increase in yield was higher after the application of growth regulators than in the drier years 2017 and 2018.The highest GM (CZK 33,093/ha) was achieved in the variant where Tilmor was applied at a dose of 1 l/ha. For most variants, the negative effect of growth regulator applications on the yield and economy of poppy cultivation was not found.

Acknowledgement

The contribution was made with the support of the MendelFarm project – Integrated plant protection in a company farming in dry conditions, which is financed from the subsidy program 9.f.m. Ministry of Agriculture "Demonstration Farms".

Impact of different land-use on aggregate stability of soils in the viticulture region in The Little Carpathians Mountains

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Keywords: soil aggregate stability, vineyard, rain simulator, wet sieving

Soil structure is one of the key factors in the proper functioning of soil, its ability to support the existence of flora and fauna, and to affect the quality of the environment. Degradation of the soil structure due to unsustainable management leads to the formation of soils that are more susceptible to erosion, surface runoff and other undesirable phenomena. The aim of this paper was to evaluate the impact of long-term viticulture in The Little Carpathians Mountains region on soils with different management types. Particular emphasis was placed on determining selected chemical and physical properties and their influence on the stability of aggregates. For the purposes of this research, 4 areas with different soil management were selected – intensively cultivated vineyard, old plowed vineyard, abandoned vineyard and grassed site of the former vineyard. Abandoning the vineyard was proved to be beneficial due to the higher stability of soil aggregates, higher content of soil organic carbon and clay fraction, which were measured on the grassed site of the former vineyard. The lowest value of aggregate stability - 13%, was measured in the cultivated vineyard by using the rain simulator method. On the other hand, the stability of the aggregates determined by wet sieving method was lowest in the old plowed vineyard and the cultivated vineyard, 41.6% and 44.4% respectively. Using the rain simulator appears to be a more appropriate method for determining the stability of soil aggregates, as it is a natural process occurring in the environment. From all the soil properties studied, it was proved the soil organic matter content is the main factor influencing the stability of soil aggregates.

Acknowledgement

This research was supported by the project UK/367/2022 and UK/395/2022.

The effect of plasma activated water application on physical chemical soil properties

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Keywords: plasma activated water, agriculture, physical chemical soil properties

Plasma activated water (PAW) applications in agriculture deals into two mail directions. The first one is application on seeds with aim to improve their germination and early phase of groove. Less investigated is PAW application on plants as leave fertilizer and antibacterial/antifungal agent. PAW is applied by spraying on leaves and some part also terminates on soil. However, effects on plants are generally positive, there is leak of knowledge what will happen with soil affected by PAW application. Soil itself is very complex system combining inorganic and organic compounds with huge number of living organisms and all of these components can be affected by PAW. Unfortunately, it is not known yet, if this effect is positive, neutral or negative. The aim of this work is extension of our recent study on different soils.

13 different soils were selected for this comparative study. PAW was prepared from distilled water using DBD system with liquid electrode. Water was applied on the soil samples surface twice per week (10 ml per dose to 90 g of the soil samples pressed by 5 atmospheres in Kopecky cylinders), whole experiment was designed for 8 weeks. Samples were kept in dark closed room without with no air flow. All was carried out in twelve replication divided in two groups; 6 for PAW and 6 for distilled water as reference.

Tap water absorption of three samples from each group was tested by saturation on the glass covered by a filter paper with continuous tap water delivery The absorption was measured at selected times by sample weighing. In next step, the fully water saturated soil samples were put on the dry filter paper (4 layers) to monitor water holding capability, this was measured at selected times by sample weighing.

Soil from the second group of samples was removed from the rolls individually, dried and stored at ambient laboratory conditions up to their processing. An amount of 10 g of the soil was shaken with 25 ml of boiled distilled water or with 25 ml of 1 M solution of potassium chloride for 1 minute. The colloid solution was kept in a closed vessel for 24 hours at laboratory temperature. After that, the solution was shaken again for 1 minute and solution pH was measured. The pH values measured using distilled water reflect free proton concentrations in the soil, while pH values measured using the KCl solution also reflect bounded protons in the sorption system of the soil.

The final part of experiments was focused on the long term PAW influence on the soil biological activity. Measurements were carried out in the special soil incubator for 6 weeks that relates to two years under the outdoor conditions. 50 g of dried soil ware saturated to 60% of their retention capability before incubation start.

The obtained results show that PAW application is strongly soil dependent and thus further experiments will be needed to be able generalize results about PAW application.

Acknowledgement

This work was carried out under the COST Action CA19110 frame.

Effects of conservation tillage on maize yield

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Keywords: soil degradation, conservation tillage, grain yield, straw yields, harvest index

Conservation tillage is prescribed to prevent and protect soil from degradation processes. Conservation tillage ensures more moisture storage, reduces erosion, benefits the crop in arid and semiarid areas by reducing drought risk and increasing grain yield. The aim of the research was to determine the changes in the grain and straw yield as a harvest index with regard to the tillage systems, fertilization treatment and liming. This research was conducted in 2020/2021 on two experimental fields in two different agricultural subregions of Croatia (Krizevci and Cacinci site). Cultivated crop was maize and the treatments were: ST-standard tillage (deep mouldboard ploughing), CTD-Conservation System Deep (chiseling with minimum 30% of surface covered with plant residues), CTS-Conservation System Shallow (tillage up to 10 cm and minimum 50% of surface covered with plant or plant residues). Liming was applied with two different variants: CY-treatment with liming (according to recommendation for neutralization soil pH) and CN-treatment without liming. Fertilization treatments include: FR-according recommendation (NPK), FD-fertilization decreased by 50% compared to recommendation, GFR-fertilization according recommendation + 300 kg/ha Geo2 (biophysiological soil activator), GFD-fertilization decreased by 50% + 300 kg/ha Geo2. After maize harvest the grain and straw yield was measured and the harvest index was calculated. All collected data was statistically processed by the statistical package TIBCO Soft-ware Inc. The means were compared by LSD tests upon significant results of F-test at $P < 0.05$ for observed factors. Grain and straw yields were significantly influenced by the tillage, lime and fertilization treatments in Krizevci site. The highest grain (15.67 t/ha) and straw (15.28 t/ha) yield were achieved on ST /CY/ GFR treatment at Krizevci site. Grain and straw yields, as harvest index were significantly influenced by the tillage, lime and fertilization treatments in Cacinci site. The highest grain yield (9.76 t/ha) and harvest index (0.66) were achieved on CTD/CY/ GFR treatment; the highest straw yield (10.60 t/ha) was recorded on CTS/CY/GFR. The obtained results indicate the importance liming (on acid soils), applying optimal doses of fertilizer with the use of biophysiological soil activators and the possibility of implementation conservation tillage for maize production in different agroecological conditions.

Acknowledgement

This work has been fully supported by Croatian Science Foundation under the project "Assessment of conservation soil tillage as advanced methods for crop production and prevention of soil degradation" (IP-2020-02-2647).

The effect of pyrolysis temperature and the origin of source biomass on the properties of biochar produced for the application in agriculture as a soil conditioner

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Keywords: biochar, biomass, pyrolysis, temperature, soil conditioner

Biochar represents a stable form of carbon-rich organic material produced by pyrolysis of various biomass residues. It has the potential to stabilize organic carbon in the soil and improve soil fertility, water retention, and enhance plant growth. This ubiquitous natural resources-based material is the main object of present research mainly connected with its possible utilization as a soil conditioner in agriculture. For these reasons the knowledge of the mutual interconnection of biochar physical-chemical properties with the production conditions of pyrolysis (pressure, temperature, residence time) and the effect of used source biomass seems to be crucial for further utilization of biochar in its potential applications. For these reasons, the research of the present work was focused on a comparison of the properties of biochar samples produced at temperatures between 400 and 700 °C and 2 different residence times (10 and 60 minutes). Under these conditions, biochar samples from 4 different biomass residues were studied (oat brans, mixed woodcut, corn residues, and commercial compost). The results of our research showed that the obtained biochar samples showed several similar features, nevertheless, the original biomass samples showed significant differences in physico-chemical properties. The obtained biochar yields varied according to the original biomass source. The minimal yield was 24 wt. %. Analysis of the content of organic matter (TGA analysis) revealed, that oat brans, mixed woodcut and corn residue contain a lot of organic matter, relatively, and contains a lot of organic carbon. Results of structural analysis confirmed individual structural properties, porosity and content of functional groups in particular. The influence of higher pyrolysis temperature resulted in slightly lower yields, however, it provided products with higher content of organic carbon and higher surface area, in the majority of cases. Based on the obtained experimental data, the preparation or production of biochar can be optimized with respect to the used biomass source and the need for a potential application. The lignin-based biomass residues showed to be interesting source material for the production of biochar with potential applications in agriculture as the soil conditioner.

Acknowledgement

This research was funded by Czech Science Foundation of Czech Republic by grant number GJ20-28208Y.

Possible use of mixed cropping system composed of *Zea mays* and *Phaseolus vulgaris* for phytoremediation and theoretical methane yield

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Keywords: biogas plant; mixed cropping; methane yield; legumes

Recently, agriculture faces many challenges, which are connected with the climate changes but also with the intensive form of agriculture. Soil erosion, loss of biodiversity, excessive fertilization, droughts, heavy rains, degradation of soil, heavy metal pollution and spreading of diseases are only a few of the problems. The use of mixed cropping systems can be an efficient tool to reduce some of these negative aspects. In this study, a possible use of the mixed cropping system including maize (*Zea mays*) and common bean (*Phaseolus vulgaris*) for phytoremediation processes and methane production was assessed in a two-year experiment. The crops were grown on fields with the natural abundance of heavy metals. The heavy metals were accumulated more in legumes than in maize variants. There were no significant differences between heavy metal concentrations in the maize grown alone and the maize grown in the mixed cropping system. The highest BAC (indicator of the efficiency of heavy metal accumulation in the plant body) was observed in Cd (1.06) in the maize monoculture in 2020. However, it was not observed in 2021. The calculated TMY values indicate that using the mixed cropping system composed of maize and bean leads to a higher methane yield (by 19.95% and 18.14% in 2020 and 2021, respectively) than in the crops grown alone.

Acknowledgement

This work was supported by the National Agency for Agricultural Research (NAZV), Project: Innovation of maize cropping systems using intercrops to reduce soil degradation and improve water management in changing climate, registration no. QK1910334.

Differences in the ripening of two clover species and the effect of pre-harvest treatment

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Keywords: *Trifolium incarnatum*, *Trifolium pratense*, ripening, harvest, desiccations

In 2019, 2020, and 2021, experiments (field trials) were carried out on crimson clover (*Trifolium incarnatum* L.) and red clover (*Trifolium pratense* L.) to evaluate differences in the maturation and the effect of pre-harvest treatment with desiccants on seed stands drying. The drying of leaves, stems, and flower heads during ripening was compared in both species. The evaluation of dried tissue percentage was carried out visually. In addition, the cover of regrown plants per plot was monitored during maturation. Six treatment options of the pre-harvest treatment were compared: 1. untreated control, 2. diquat (700 g/ha), 3. pyraflufen-ethyl (21.5 g/ha), 4. carfentrazone-ethyl (60 g/ha), 5. pelargonic acid (10 880 g/ha) and 6. high dose of DAM fertilizer (200 l/ha) in a ratio of 1:1 with water. The amount of the application liquid solution was 400 l/ha. The active ingredients pyraflufen-ethyl, carfentrazone-ethyl, and pelargonic acid were combined with DAM fertilizer at 10 l/ha and a surfactant to increase efficacy. Variant 7 (diquat in combination with DAM fertilizer and surfactant) was also tested on crimson clover. We studied the effect of the tested variants on regrowing, the acceleration of drying of clover stands, and the drying of most of the common weeds. The effect on yield parameters (yield, weight of 1000 seeds, and germination percentage) was evaluated too.

Differences were found in the drying of leaves, stems, and flower heads in both clover species during ripening. Crimson clover had faster drying of leaves, stems, and flower heads than red clover. For crimson clover, natural drying before the harvest was from 80 to 100 % for leaves, from 50 to 95 % for stems, and 100 % for flower heads. In red clover natural drying before harvest ranged from 25 to 84 % for leaves, from 20 to 72 % for stems, and from 45 to 99 % for flower heads, depending on the year and the weather. The best tissue drying for both species was in 2019, which was a warm and dry year. In other years, which were wetter, tissue drying was slower. The drying of the tissues was strongly influenced by temperature and especially by the amount of rainfall during ripening. Precipitation also influenced regrowing. There were large differences in regrowing between crimson clover and red clover. In crimson clover, the regrowing ranged from 0 to 15% of leaf cover of regrown plants per plot just before harvest. In red clover, there was a large variability and the regrowing ranged from 7 to 99 % depending on the amount of rainfall. There were also differences in the head breakdown in both species. In crimson clover, the number of shattered seeds was very high during the drying process and the pre-harvest losses ranged from 15 to 45 %. In the case of red clover, there was no shattering of seeds during ripening.

Since the natural drying of the maturing plants is not sufficient to harvest the seed, the desiccation of vegetation is necessary before harvesting for both clover species. Until now, the active substance diquat has been used for desiccation in the Czech Republic, which was removed from the list of applicable substances by the Commission Regulation (EU) 2018/1532 of 12 October, 2018. Unfortunately, there is no suitable alternative for this active substance, which brings several problems in practice, not only when harvesting clover seed stands. For this reason, alternative pre-harvest treatments for crimson clover and red clover were tested. The efficacy of three herbicides was evaluated as well as the efficacy of a high dose of DAM fertilizer in combination with water and wetting agent. The tested variants were compared with both the untreated control and the diquat-treated variant. It was found that the addition of DAM fertilizer and wetting agent to the active ingredient increased its effectiveness and accelerated crop drying after treatment. There was an acceleration of drying after treatment compared to the untreated control. Compared to diquat, drying was slower for the other active ingredients. In crimson clover, the fastest plant drying occurred in the diquat (2) and pelargonic acid (5) treated variants. In red clover, the best pre-harvest drying of clover plants was after diquat (2) treatment and then after carfentrazone-ethyl treatment (4). Pyraflufen-ethyl had the best efficacy on weeds (3). There was no conclusive effect of the tested active ingredients on yield, the weight of 1000 seeds, and germination percentage.

Acknowledgement

The paper was prepared with the support of the Ministry of Agriculture of the Czech Republic, institutional support MZE-RO1722.

Cultivar difference in the nitrate uptake ability of wheat at different temperature conditions

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Keywords: nitrogen, nutrient uptake, Vmax, nitrate assimilation

The temperature is a key parameter of the rate of nitrate uptake and utilization. The effect of suboptimal (5 °C), optimal (15 °C), and supraoptimal (30 °C) temperature on nitrate uptake and metabolism was monitored in six varieties of bread wheat (*Triticum aestivum* L.) and two varieties of emmer wheat (*Triticum dicoccum*). Plants were grown in hydroponic solution under controlled conditions with a photoperiod of 16 h. The temperature acclimation started one week before the experiment was performed. The rates of nitrate uptake were determined from the concentration changes of the nutrient solution, during the experiment. The rate of uptake was expressed as a micromole of NO_3^- absorbed per g of root fresh weight per hour. At higher temperatures, a higher rate of uptake and assimilation of nitrate anion was observed. At lower temperatures, the metabolism was slower. At both high and low temperatures, the maximum uptake rate (Vmax) was higher in the observed emmer wheat (*T. dicoccum*) varieties than in the bread wheat (*T. aestivum* L.) ones. Interspecies and varietal differences in nitrate assimilation are discussed.

Acknowledgement

Supported by the Ministry of Agriculture of the Czech Republic, projects No. QK1910041 and Research Plan CRI RO0418

Optimization of crop management practices by smart farming technologies for small and medium-sized farms

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Keywords: precision agriculture, digital soil mapping, crop sensing, variable rate application

Farmers currently have a wide range of precision agriculture technologies for the optimization of crop management practices. The main principle is to respect the spatial variability of soil, thus leading to more efficient plant production and at the same time reducing the burden of agriculture on the environment. Regarding the size structure of farms in the Czech Republic and the agricultural land management, these technologies are mainly adapted by large farm enterprises managing thousands of hectares of land with high capital for investments in modern mechanization.

As part of the research project TACR TH04010494, Mendel University in Brno and the Czech University of Life Sciences cooperate with P&L, an agricultural technology company, on the development of smart farming approaches for small and medium-sized farms. The solution of the project is mainly devoted to the mapping of the variability of soil and vegetation conditions and the subsequent recommendation of crop management practices in the form of variable rate application of fertilizers or variable seeding.

The research activities of Mendel University have been realized since 2020 on the family farm of Pavel Obdrzalek (Rasovice, Slavkov u Brna, Czech Republic), which manages more than 900 ha of agricultural land. The first part of the research was the evaluation of methods for effective mapping the heterogeneity of soil conditions using digital soil mapping techniques, including measurements of geophysical soil properties by sensors in combination with traditional soil sampling. The sensor measurement of the electrical conductivity of soil was carried out by electromagnetic induction (EMI) devices CMD–MiniExplorer 6L and CMD-1 (both GF Instruments, Czech Republic). EMI enables a fast and relatively accurate non-invasive assessment of differences in the soil condition according to its conductivity. Simultaneously soil samples were taken in April 2019 from the depth of 0 – 30 cm in an irregular grid on selected plots to identify individual soil agrochemical properties by laboratory analysis. The method of directed/zone sampling was chosen, which optimizes the number of samples based on the preliminary analysis of soil heterogeneity within the field – in homogeneous areas the number of samples will be lower than in areas with higher variability. Based on the results of the analysed samples, the spatial variability of the agrochemical properties (pH value, the content of available nutrients – P, K, Mg, Ca). The variability of the results estimated by coefficient of variability (CV) ranged from CV = 14.65% (pH) to CV = 59.10% (content of Ca). Results of soil sampling were input information for the preparation of variable rate application maps for liming and fertilizing.

The second part of the research was the verification of diagnostic methods for assessing the nutritional status of crop stands based on spectral measurements by proximal and remote sensing. For this purpose, the AgLeader OptRx sensor device mounted on the tractor, and Sentinel-2 satellite imagery was compared. Data from the satellite system were continuously provided from the publicly available Copernicus ESA Open Hub data repository and the Google Earth Engine (GEE) computing platform and processed in the form of vegetation indices. Spectral measurement can detect the differences in plant status (insufficient nutrition, water stress, plant infestation), but is usually unable to determine the exact cause of the identified stress. Comparisons with the results of plant sampling (N content, amount of biomass, N uptake, NNI) showed a close relationship with vegetation indices from Sentinel-2 ($r = >0.8$), especially calculated from reflectance in the red-edge band (e.g. NDRE). The high value of correlation coefficient between the NDRE values from the proximal (OptRx) and remote sensing ($r = 0.942$) indicates the mutual comparability of both methods and their applicability for crop sensing for the variable top-dressing of nitrogen fertilizers. The last year of the research project (2022) is focused on the overall evaluation of the economic benefits of the variable application of fertilizers and their implementation into agronomic decision-making procedures.

Acknowledgement

The study is supported by the national research project TH04010494 “Research and development of smart farming technologies for small and medium-sized farms”.

The effect of soil-climate conditions and fertilizer treatment on maize yield and quality

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Keywords: *Zea mays* L., dry matter yield, starch content, neutral detergent fiber, organic matter digestion

Maize is a warm-requiring C4 plant suitable for planting in warm regions, such as the South Moravian Region in the Czech Republic. With the development of new, early maturing hybrids, the area of maize cultivation greatly expanded to localities, such as uplands, where the previous planting was connected with low yields. Another factor influencing crop productivity is climate change, causing a higher occurrence of extraordinary weather conditions. These conditions were recorded in Lukavec in 2020. In this paper, we evaluated how long-term and regular application of four different fertilizer treatments (Control, farmyard manure – FYM, FYM+mineral N – FYM+N, FYM+mineral NPK – FYM+NPK) and three different localities (Ivanovice – excellent conditions for maize cultivation, Caslav – similar weather conditions to Ivanovice but different soil type, and Lukavec – upland area suitable mainly for root crops) affected biomass yield and quality of silage maize and basic soil properties.

The locality was the dominant factor affecting biomass yield. The highest mean biomass yields were harvested in Ivanovice (24.4 t/ha), where even unfertilized Control provided higher mean yields than highly fertilized treatments in Caslav and Lukavec. Due to the extraordinarily warm weather in 2020, Lukavec (16.7 t/ha) provided comparable mean yields as Caslav (17.6 t/ha). The lowest dry matter yield was always recorded in the Control treatment (all localities). The significantly beneficial effect of the FYM was mostly visible at Lukavec (+6.8 t/ha in comparison with Control) and Caslav (+3.7 t/ha in comparison with Control), while minimal on highly fertile soil at Ivanovice (+0.2 t/ha in comparison with Control). Starch content (SC, 34.6%) and neutral detergent fibre digestibility (NDFD, 52.1%) was highest in Caslav, while lowest in Lukavec (SC – 27.7%, NDFD – 46.2%). The content of neutral detergent fibre (NDF) was lowest in Caslav (44.4%) and highest in Ivanovice (47.6%). Organic matter digestibility (OMD) ranged from 66.3% (Lukavec) to 76.3% (Caslav). Application of fertilizers resulted in higher NDF and lower OMD.

The values of soil pH were not significantly affected by fertilization, but significant differences were recorded among the localities. The lowest soil pH was in Lukavec (5.90), while the highest was in Ivanovice (6.68). In the case of soil nutrient concentrations (P, K, Ca, Mg), the results of the analyses significantly depended on locality x fertilizer treatment interaction. The soil in Caslav had the lowest content of organic carbon (1.28%) and the content increased with the application of FYM and mineral fertilizers. Higher organic carbon contents were recorded in Lukavec (1.63%) and Ivanovice (1.81%), but the differences among treatments were insignificant in both localities. In the case of soil nitrogen, the concentration varied from 0.17% (Caslav) to 0.22% (Ivanovice, Lukavec). Again, no differences among treatments were recorded in Ivanovice and Caslav, while the increasing effect of mineral fertilizers was significant in Caslav (in comparison to Control).

Acknowledgement

The following text was supported by the projects: VURV RO0418, NAZV QK22020053 – Conditions for growing maize planted on severely eroded soil, and NAZV QK1910334 – Innovating environmentally friendly maize cropping systems using intercropping to reduce soil degradation and improve water management in a changing climate.

Effect of drought and irrigation after flowering on yields of winter wheat, spelt wheat and einkorn wheat

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Keywords: water stress, grain filling, crop temperature, ^{13}C discrimination

Increased weather variability and a gradual temperature rise increase the risk of drought, with impacts on the yield stability and quality of crop production. Under the soil and climatic conditions of Central Europe, drought in wheat (and other annual crops) most often occurs after the depletion of soil winter water supply and during high water consumption in the stages of stem elongation and grain growth.

Four-year (2018–2021) field experiment with stressed and irrigated wheat was conducted at Crop Research Institute in Prague–Ruzyně to determine the impact of water shortage and optimal water supply during grain filling. In the years 2018 to 2021, two commonly grown varieties of winter bread wheat (*Triticum aestivum* L.) and one variety of other wheat species, spelt wheat (*Triticum spelta* L.) in 2018 and 2019, and einkorn wheat (*Triticum monococum* L.) in 2020 and 2021 were studied. Water shortage (S treatment) was induced from the start of anthesis (BBCH 61) by covering crop during rains with a mobile shelter. The aim was to deplete water close to the level of wilting point in the 0-90 cm soil layer, where most of the wheat roots are situated, at the start of grain development. Drip irrigation (IR) was used to keep soil moisture from flowering at the optimal level, about 70-80% of available water capacity, in the 0-90 cm soil layer. Rain-fed treatment served as control (C). Soil water content was manipulated based on water balance calculation corrected with soil moisture determination. The canopy temperature, measured with a hand-held thermal camera (FLIR), and grain ^{13}C discrimination ($\Delta^{13}C$) was determined as indicators of the effect of water availability on plants.

Drought during grain growth significantly reduced the yield of winter wheat in all years, to an average of 66.7 % (57-74%) of the rain-fed control yield and 61.8% (50-74 %) of the yield of irrigated wheat. The average yields of wheat reached 8.31 t/ha, 5.22 t/ha, and 7.71 t/ha for treatments IR, S, and C. The average yield of all variants in the years 2018 to 2021 was 6.28 t/ha, 5.52 t/ha, 8.61 t/ha, and 7.90 t/ha, respectively. For spelt and einkorn wheat, the average values of stressed plants were at the level of 78.3% and 69.8% of variants C and IR, respectively. These old species had low HI and low yields, by 34.5%, 46.2%, and 33.4% of winter wheat yields in variants IR, S, and C, respectively. A significant increase in yield by irrigation compared to rain-fed control, by 12% and 28%, was recorded for cultivars of winter wheat only in the dry years 2018 and 2019; for old wheats, the increase by 30%, 15%, and 9% was observed in 2018, 2019, and 2021.

The values of $\Delta^{13}C$ corresponded to water supply treatments and weather conditions during the experimental years. Precipitation was higher and temperature lower in 2020 and especially in 2021 in the comparison with 2018 and 2019 conditions. The average $\Delta^{13}C$ of winter wheat cultivars in years reached 20.51‰, 17.76‰, and 19.57‰, for variants IR, S, and C, respectively. The average $\Delta^{13}C$ in the successive experimental years reached 17.92‰, 18.92‰, 19.89‰, and 20.65‰, in agreement with weather conditions, precipitation, and water balance. The year weather conditions were apparent in all treatments, probably due to the utilization of carbon assimilated by plants before the grain growth period (before induction of stress and application of irrigation). Old species of wheat showed lower $\Delta^{13}C$ in comparison with two bread wheat cultivars (*T. aestivum* L.), by 1.15‰ and 1.26‰ (einkorn) and 0.04‰ and 0.48‰ (spelt), suggesting a greater impact of differentiated water supply. Higher canopy temperature well indicated a lack of water, but differences between plant temperature in the control and irrigated variants were often not significant, especially in 2021 and 2020. The relationship of temperature to the final grain yield depended on the current state of the stand at the time of measurement and did not reliably predict the yield differences in the reaction of wheat varieties and species on differentiated water supply.

Acknowledgement

Supported by the Ministry of Agriculture of the Czech Republic, projects No. QK1910041 and Research Plan CRI RO0418.

Growing of maize (yields, forage quality, erosion) using a narrow row of 37.5 cm

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Keywords: soil conservation techniques; yield; forage quality; soil erosion; multi-criteria evaluation

Maize (*Zea mays* L.) is an important feedstuff, food and industrial crop grown on arable land in the Czech Republic. Current advances in genetics, plant breeding and the technical sophistication and precision of planting machines make it possible to plant a precise number of maize plants at different row spacing (e.g. 37.5; 45; 51; 75 cm, etc.). The use of narrow planting technology has resulted in a 5-10% increase in yield worldwide compared to conventional technology (75 cm). In our study, we evaluated yield, forage quality, and soil loss, caused by erosion, when maize was planted in a narrow row (37.5 cm) under different soil-climatic conditions. The experiment was conducted at two localities between 2016 and 2018. The first locality was Jevíčko (JEV), Boskovická brázda, 360 m a.s.l., mean annual temperature: 7.4 °C, long-term annual precipitation 545 mm, soil type: Haplic Luvisol. The second locality was Skoupý (SKO), Central Bohemian Upland, 525 m a.s.l., mean annual temperature: 6.7 °C, long-term precipitation: 577 mm, soil type: Cambisol. Maize was planted in the second half of April or early May (after harvesting rye for haylage). The hybrid maize FAO 280 was used in the experiment. Sowing rate was 85 thousand germinated seeds/ha (JEV) and 110 thousand germinated seeds (SKO). For planting, we used a Kinze 350 planting machine. The row spacing was 75 and 37.5 cm. In total, three planting treatments were analysed: 1) Control - conventional method (75 cm) - ploughing in autumn + spring pre-planting preparation (CT); (2) narrow row (37.5 cm) - ploughing in autumn + spring pre-planting preparation (NR); (3) direct planting into stubble or rye crop (37.5 cm) (DSNR). Based on the results, we can say that the narrow-row technology (NR - JEV, DSNR - SKO) provides comparable or higher biomass yields while maintaining forage quality. Furthermore, it can be concluded that the method of maize planting does not affect its feeding value in both localities. A significant anti-erosion effect was demonstrated in the DSNR treatment (direct planting into stubble or rye crop), when compared to CT at both localities (JEV, SKO).

Acknowledgement

The contribution was supported by the Ministry of Agriculture of the Czech Republic (MA CR) - RO0418, RO0218 and further projects MoA CR NAZV QK1910334 and QK22020054.

Biomass production of inter-row seeding cover crops and the effect on yield of maize

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Keywords: inter-row cover crops, growth dynamic, biomass production, yield of maize

Interseeding is an approach when a cover crop is sown early in the season prior to crop canopy closure of the main crop. The benefits are of the stated as: fixation of nitrogen by leguminous cover crops that can be utilised by the main crop, improvement of nitrogen use efficiency (NUE) and reduction of nitrate contamination of surface and ground water, weed suppression and erosion control, improvement of soil health, and production of biomass for post-harvest field grazing. Successful technology must be based on selection of appropriate cover crop species, proper method of drilling together with correct timing according to the developmental stage of main crop, and selecting a compatible herbicide treatment.

The aim of our study was: a) to compare the yield of above-ground biomass by different inter-row seeding cover crop species and b) to evaluate the effect of cover crop variants on yield of maize. The field trials were carried out in two locations in 2020 and 2021: in Žabčice (ZAB) locality (South Moravian region, Czech Republic, 49°01´ N, 16°37´E, altitude 179 m, average annual temperature 10.3 °C and the long-term sum of annual precipitation 491 mm, the soil type is Gleyic Fluvisol Clayic, the soil texture is clay loam) and Jevíčko (JEV), Boskovická brázda, Czech Republic, 49.6239914N, 16.7284039E, 360 m a.s.l., average annual temperature: 7.4 °C, long-term sum of annual precipitation 545 mm, soil type: Haplic Luvisol. The maize hybrid Walterinio KWS was sown at both locations in the middle of April using KINZE 3500 seeding machine (80,000 seeds per hectare). In the growth stage of the third to fourth leaf, all variants of interseeding cover crops were sown with a multi-functional four-row experimental machine designed by P&L company. Four operations were carried out in one pass over the plot: 1) cultivation of the 32 cm wide strip in the space between the rows, 2) sowing of interseeding cover crops into the cultivated strip, 3) nitrogen fertilization (mixture of ammonium nitrate and urea in liquid form at a dose of 40 kg of nitrogen per hectare) and 4) strip application of post-emergent herbicide over the maize rows. The share of cultivated and treated area represented 42 % and 58 %. The aim of the experiment was to evaluate the dynamics of the growth of the biomass of interseeding cover crops together with the effect on yield of silage maize.

Results showed that tested cover crops varied in growth dynamics, biomass production and density of soil cover. Species as Italian ryegrass (*Lolium multiflorum ssp. italicum*), phacelia (*Phacelia tanacetifolia*), rye (*Secale cereale*) and crimson clover (*Trifolium incarnatum*) were characterised by rapid growth and produced a large amount of biomass (1-2 t/ha of dry biomass). Similar results were obtained also for the mixtures of these species. The yield of silage maize was affected by year and locality. Under favourable moisture conditions (2020 year) the yield from cover crop variants was comparable with the yield of control variant (or in some cases higher). However, a yield reduction (5-14%) was found in Žabčice in 2021, especially in variants with high production of cover crop biomass.

Acknowledgement

Acknowledgement to the Ministry of Agriculture of the Czech Republic for financial support, Project No. QK1910334 and MendelFarm project – Integrated plant protection in a company farming in dry conditions, which is financed from the subsidy programme 9.f.m. Ministry of Agriculture "Demonstration Farms".

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The effect of permanent grassland fertilization on the state of soil organic matter and nutrients in Haplic Luvisol

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Keywords: permanent grassland; fertilization; humic substances; nutrients; multi-criteria evaluation

Soil and Soil organic matter (SOM) represents one of the largest and most important reservoirs of organic carbon (SOC) in the terrestrial ecosystems. The quality of SOM (e.g. content of SOC and fractional composition of humic substances /HS/: humic acids /HA/, fulvic acids /FA/, HA/FA ratio) is the key factor of soil fertility and productivity. The loss of SOM is currently considered to be clearly a negative form of soil degradation, which disturbs the ecological stability and causes other environmental problems. The aim of the study was to evaluate the effect of long-term application of mineral (NPK), livestock (manure /FYM/, slurry /CS/) and organic (digestate) fertilizers on the state of soil organic matter (SOC content, HS content, fractional composition of humic substances /HA, FA/, degree of humification /DH/, etc.), soil reaction and content of available nutrients in the permanent grassland (PG). The type of studied PG is the oat-type grassland (*Arrhenatheretum*), with intensive 4-cutting management. The soil type is classified as Haplic Luvisol (region of Boskovice Furrow /Malá Haná/, the Czech Republic). The results showed that the lowest carbon content (SOC) was determined in the variant of control, the highest in the FYM, and lower in the CS, NPK, and Digestate variants. The highest content of HS, HA was determined in the FYM, the lowest in the control variant. The lowest HA/FA ratio was found in the control and digestate variant (0.80–0.87), higher in the NPK and CS (0.91–0.93), and the highest in the FYM (1.13). The lowest values of soil reaction (pH/KCl) were found in the NPK and control variants, the highest pH was determined in the FYM, slightly lower in the CS and digestate variants. The content of available nutrients (P, K, Ca, Mg) was the lowest in the control and NPK variants, higher contents were recorded in the CS and digestate variants, and the highest contents were determined in the FYM. The results of the multicriteria evaluation (principal component analysis, factor analysis) confirm that fertilization with manure (manure /FYM/, slurry /CS/) clearly leads to an increase in soil quality and health (higher soil fertility compared to NPK and digestate fertilization) in the current conditions of the global climate change (GCC).

Acknowledgement

The contribution was supported by the Ministry of Agriculture of the Czech Republic (MoA CR) – RO0418 (“Internal grant to support young researchers – "Influence of mineral, manure, and organic fertilizers on the stable component SOM /HA, FA/ in the soil under PG with intensive use /4 cut/year/") and further projects MoA CR NAZV QK21010124, QK21020155, and QK1810010.

Comparison of aboveground biomass production of selected varieties of forage sorghum

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Keywords: maize, sorghum, forage, dry above ground biomass, dry climate region of South Moravia

Unusually high temperatures and at the same time lower total precipitation which is irregularly distributed during the season, have occurred more and more often in recent years. The yield of silage maize decreases with climate change. Therefore, new ways are being looking for to ensure sufficient forage for cattle. One of the promising options is growing of sorghum. This contribution is focused on the evaluation of the yield level of dry aboveground biomass (AGB) of different varieties of silage sorghum grown at the two experimental localities (Nosislav and Unkovice) of the Field Experimental Station in Žabčice. Both locations are situated in the very dry and warm climate region of South Moravia.

Small-plot field trials were established in 2019 and 2020 to compare the yield of dry AGB of silage varieties of sorghum at two sites, in the locality Nosislav (with good availability of groundwater) and Unkovice (drier, with light sandy soil). The variety of maize SY Orpheus (FAO 370, row spacing 0.75 m, sowing rate 80,000 seeds/ha) was used to compare a yield of dry AGB. Sorghum was sown at a row spacing of 0.45 m, sowing rate was 245,000 seeds/ha. Varieties from the portfolio of companies KWS OSIVA Ltd. and SEED SERVICE Ltd. were used. The obtained data were statistically processed by analysis of variance.

The total amount of precipitation of the growing season was lower in 2019. The average yield of dry AGB of SY Orpheus at the locality Nosislav (with better availability of soil moisture) was 12.17 t/ha. Only one variety of sorghum achieved a lower yield of dry AGB, namely Nutrigrain (10.64 t/ha), at this locality. All other varieties achieved a higher yield. Seven varieties of sorghum achieved a significantly higher yield than maize. The highest yield had KWS Titus (21.68 t/ha). The yield of dry AGB of maize was 11.46 t/ha in the drier location of Unkovice. Three of the experimental varieties had a lower yield than maize, the lowest yield had variety KWS Titus (10.75 t/ha). Other varieties achieved the same or higher yield of dry AGB. The highest yield was achieved with the variety KWS Sammos (16.48 t/ha).

The distribution of precipitation was more suitable in 2020, which was also reflected in the higher yield of dry AGB of maize (23.80 t/ha) at the wetter locality Nosislav. Only three varieties of sorghum achieved a comparable yield of dry AGB. The highest yield achieved the variety Latte (23.72 t/ha). Maize achieved a slightly lower yield of dry AGB in the drier locality of Unkovice in 2020. The average yield at this location was 20.78 t/ha of dry AGB. A total six varieties of sorghum achieved a comparable yield. The highest yield was by variety KWS Kallisto (19.40 t/ha). The lowest yield was recorded again by variety Nutrigrain (10.89 t/ha).

The results of yield of dry aboveground biomass was showed, that the average yield of silage sorghum across varieties was 14.5–16.5 t/ha, while the influence of the year and locality was evident. It is thus possible to confirm that sorghum is a perspective crop that could suitably complement the cultivation of maize for silage in warm, dry regions of South Moravia.

Acknowledgement

The contribution was made with the support of the MendelFarm project – Integrated plant protection in a company farming in dry conditions, which is financed from the subsidy program 9.f.m. Ministry of Agriculture "Demonstration Farms".

Soil organic matter quality and microbial activity as affected by ameliorative liming

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Keywords: soil organic carbon, liming, regression models

The global carbon storage in soils is widely discussed today because of climate uncertainty and maintaining sustainable agricultural production. Human intervention for agricultural or energy production poses many changes in soil management, which highly effects soil quality/health. Permanent grasslands fulfil a wide range of ecosystem functions and have high potential for increasing arable land. Optimizing their management is important to maintain resilient and stable ecosystem. Today, grasslands are becoming more and more disturbed by intensive fertilizing and produced biomass is mainly used as a forage source or energy production. This study examined the impact of long-term grasslands liming on total content of soil organic carbon (SOC), humic substances (C_{HS}), and microbial biomass (C_{mic}). Furthermore, selected soil chemical parameters and available nutrients content were evaluated. Soil samples were collected from a split-plot field experiment of Mendel University in Brno (locality Kameničky). The soil was classified as Dystric Planosol, medium textured, strongly acidic, with high soil organic carbon content. The yearly liming rate was 1.4 t/ha CaO. The linkage between the soil pH, SOC, C_{mic}, and available nutrients content was evaluated by the multivariate exploratory techniques and regression models. Results showed that long-term liming affects both soil biota and carbon storage.

Acknowledgement

The work was supported by projects QK 21010124 „Soil organic matter – evaluation of selected indicators" (MoA, NAZV, Czechia), SSO2030018 „Centre for Landscape and Biodiversity" (MoE, TAČR, Czechia), and project RO-0418 (MoA, Czechia).

The effect of crop rotation, tillage and nitrogen fertilization on soil organic matter content and its quality

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Keywords: SOM content and quality, long-term field experiment, monoculture of spring barley, Norfolk crop rotation, soil tillage

The quantity and quality of soil organic matter (SOM) is a key factor in soil fertility and productivity and is closely related to land management and farming systems. Intensive agriculture can affect SOM content and its quality positively or negatively. One of the negative aberrations is a decline of humus and gradual soil degradation. Besides, agrotechnical measures, post-harvest crop residue management, biomass inputs, and fertilizing systems influence soil's physical, chemical, physic-chemical, and biological properties. The decline or deficiency of humic substances reduces soil sorption capacity for nutrients and water, accelerates the mineralization processes and influences the overall stability of the agroecosystem. Organic carbon losses from different farming systems are difficult to evaluate and compensate for as they are related to many other factors (e.g. type of soils, soil pH, biological activity, soil chemistry, climatic conditions and other anthropogenic influence). For this reason, the long-term field experiments are an important source which represents valuable information related to the above-mentioned consequences. The long-term field experiment was established in 1969 in Žabčice at the Experimental Stationary of Mendel University in Brno. The mean annual air temperature is 10.3 °C, and the mean annual precipitations are 491 mm. The soil was sampled after harvest from a depth of 0-0.10 m. The classification of soil type was done according to the IUSS Working Group WRB (2014) as the soil was classified as Gleyic Fluvisol Clayic. The main hypothesis was, that the content and quality of soil organic matter are affected by crop residues input and there are differences between the soil under monoculture of spring barley (*Hordeum vulgare* L.) and under spring barley in the Norfolk crop rotation. The objectives were: (i) to determine total organic carbon (TOC, %), humic substances (HS) content and quality (HA/FA, HD %) in the different crop rotations; (ii) to study the effect of different soil tillage systems; (iii) to evaluate the effect of different doses of nitrogen (30; 60; and 90 N (kg/ha). The selected soil chemical parameters were determined by standard analytical methods according to Zbíral et al. (2016). The oxidimetric titration method was used for the evaluation of total organic carbon content (TOC, %) (Nelson and Sommers, 1996). The short fractionation method was used for HS content determination (Kononova and Belchikova, 1963). UV-VIS and FTIR spectroscopy were used for HS quality assessment. The results achieved during 2017-2020 were evaluated by multifactorial analysis ANOVA (program StatisticaCZ12 software) and post-hoc Tukey test ($p \leq 0.05$). Results showed a statistically higher total organic carbon and HS content in the Norfolk crop rotation. The effect of the tillage system was significant, and the minimum tillage showed a significantly higher content of total organic carbon and HS compared to the conventional tillage system. Other parameters, like rate of acids (HA/FA) and degree of humification (HD, %) didn´t confirm the significant effect of the crop rotation and soil tillage. In summary, in the evaluated years, the following average values for the mentioned parameters were: TOC (%) 1.243; HS (%) 0.497; HA/FA 1.037; HD (%) 20.135.

Acknowledgement

The work was supported by the project TAČR SS02030018 „Centre for Landscape and Biodiversity“, and NAZV QK21010124 „Soil organic matter - evaluating of quality parameters“, and by the MoA of the Czech Republic, institutional support MZE-RO1722.

Conservation tillage systems could increase maize resilience to climate change

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Keywords: reduced tillage, direct sowing, fertilization, maize, productivity

Climate changes severely affect agricultural production, particularly dry farming. Even crops that are relatively tolerant to drought, like maize, have been recently influenced by meteorological extremes, thus significantly reducing yield potential. The adjustment of cropping technology in which soil tillage system is an essential maize growing practice is the only way for stable maize cultivation. The objective of the study was to monitor and understand how different tillage systems and fertilizer rates influence grain yield of maize grown in dry farming conditions. The study was initiated in 1978 in Zemun Polje, Belgrade, Serbia, on the chernozem soil type, while the results from 2011-2021 period are analysed. Maize hybrid ZP SC 606 has been sown at the middle of April every year. The experiment was set as a split-split-plot block design with four replications. The main treatments were three tillage systems: NT - no-till, RT – reduced, and CT - conventional tillage. In the no-tillage treatment, maize seeds were sown in the upper soil layer of 5-7 cm, directly by a special planter. In the reduced tillage treatment, soil tillage was performed in the depth of 8-10 cm, with a rotovator in autumn, while sowing is conducted in the spring after seedbed preparation (10-12 cm) with a conventional drill. The conventional tillage treatment consisted in shallow ploughing, immediately after wheat harvest in the depth of 10-15 cm, primary tillage (ploughing) in the depth of 25-30 cm in autumn and seedbed preparation (10-12 cm) in spring. The fertilizer treatments, as subplots, included control (Ø) - without fertilization, incorporation of 50 kg/ha N, 50 kg/ha P and 50 kg/ha K in the autumn and supplemental N addition up to the 180 kg/ha N (F1) and 240 kg/ha N (F2) before sowing in the spring. Variations in meteorological conditions of the season caused high variability in maize grain yield. The lowest grain yield, in average, was achieved in 2021 (3.38 t/ha) and the highest in 2014 (11.33 t/ha). Among tillage practices, higher average yield was achieved with CT (9.38 t/ha) while lower values were in NT (6.14 t/ha). In dry seasons and seasons with extreme variations (2012, 2017 and 2021), stable and even higher yields were achieved in RT and NT. Thus, in 2021 the highest yield was achieved in NT (to 2.34 t/ha concerning CT). Increased fertilizer rates resulted in yield increase, from 6.59 t/ha in Ø to 8.35 t/ha in F2. The differences in grain yield between fertilizer rates were higher in RT. Correlation analysis indicated that with tillage intensification (CT), yield potential is highly negatively dependent on temperature, particularly during grain filing (correlation coefficient 0.8) and high and positive with precipitation amount (correlation coefficient > 0.7), while this dependence was reduced, especially in NT (correlation coefficients < 0.5). Irrespective that CT contributed to the higher grain yield in average, less intensive tillage systems enabled yield stability in drier and extreme seasons. It was noticeable that increased fertilizer rates were required in reduced systems, such as NT and particularly RT.

Acknowledgement

Ministry of Education, Science and Technological Development of the Republic of Serbia, Project No.TR31037, supported the investigation.

The long-term influence of different crop rotations on soil hydrophysical properties in winter rye

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Keywords: crop rotations, water retention capacity, pore size distribution, soil bulk density, surface moisture content

The soil water capacity describes the maximum amount of water moisture that the soil can retain. Soil water retention is critical for plant growth because the amount of moisture retained can compensate for the lack of moisture in dry conditions (Zhang et al., 2021).

This investigation aimed to evaluate the long-term effect of 4 crop rotations (intensive, field rotation with row crops, for green manure, and three-course) with different pre-crops and rye monoculture on soil hydrophysical properties. The research object was winter rye 'Matador' and continuous bare fallow was used as a control. The long-term stationary field experiment was established in 1966 at Vytautas Magnus University Experimental Station in Kaunas, Lithuania (54°53′ N, 23°50′ E) and has been continued until now. The soil of the experimental site was *Endocalcari-Epihypogleyic Cambisol* (sicco) (CMg-p-w-can). Granulometric composition - dusty loam on loam and clay. During the experiment, the same tillage system was implemented, and plant protection products were used as needed.

Research methods: Water retention capacity was determined by the sorption (pF) method. Results obtained by this analysis were used to calculate soil bulk density and pore size distribution. Soil surface moisture content, temperature and soil-CO_2 emissions were determined by the IRGA method and calculated as an average of 3 measurements (at the beginning, middle and the end of winter rye vegetation) performed with an automated soil gas flux system LI-8100A with 8100-103 chamber, analyser LI-8100A (LI-COR Inc.).

Research results: The best soil water capacity properties were established in field rotation with row crops after the second year of use of perennial grasses. Investigated crop rotations had no significant effect on soil bulk density and pore size distribution. To compare with continuous bare fallow all crops increased the soil-CO_2 emission. In the winter rye crop, the most intensive soil-CO_2 emission was determined after perennial grasses of the first year of use in the intensive crop rotation, after winter oilseed rape green manure in the green manure rotation and after perennial grasses of the second year of use in the field rotation with row crops. The pre-crops with higher organic matter input including plant residues resulted in higher soil surface moisture content, lower soil temperature and higher soil-CO_2 emission. The lowest intensity of soil-CO_2 emission was found in continuous bare fallow and the three-course crop rotation with bare fallow as well.

Acknowledgement

This research was conducted under European Joint Programme (EJP) Soil and the Ministry of Agriculture of the Republic of Lithuania funded project "Soil management effects on soil organic matter properties and carbon sequestration" SOMPACS.

Sequential chemical fractionation as a tool for biochar organic matter characterization

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Keywords: biochar, fractionation of organic matter

Biochar is a promising soil conditioner that attracted attention but still has not been intensively studied yet, especially due to high complexity and heterogeneity of biochar. The application of biochar into soil improves soil quality, water retention and enhances plant growth. Also, biochar is a highly effective natural sorbent of hazardous organic and inorganic compounds. Moreover, the use of biochar could be a way how to mitigate the climate changes by sequestration of carbon in natural systems. Biochar is a carbon rich black solid product of pyrolysis. Physical and chemical properties of biochar strongly depends on the thermochemical (pyrolysis) operating conditions as well as intrinsic nature of the source biomass. Therefore, in 2012 the European Biochar Certificate (EBC) was developed to ensures that the produced biochar has sustainable properties meeting the European restrictions with a low potential hazard of its use in agriculture or other human-driven applications. In this work, various EBC certified biochars are studied by sequential chemical fractionation of organic matter. This procedure consists of the cleavage and alternation of original organic matter by the series of solvents/reagents (both aqueous and non-aqueous) and obtaining set of fractions, in other words, the fractions are separated according to the solubility and strength of binding to the biochar residual organic matter. These aqua-soluble and organic-soluble fractions are mobile, weakly and strongly ester-bound fractions and ether-bound fractions. Individual fractions have significantly lower heterogeneity and narrower molecule distributions and subsequently characterized by thermo-gravimetric (ash content, organic matter content and moisture) and elemental analysis (organic element content).

Acknowledgement

This project was supported by project GJ20-28208Y from Czech Science Foundation.

Soil organic carbon as reflected by long-term complex measures

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Keywords: conventional tillage; reduced tillage; no-till; cover crops; soil organic carbon

Improved management practices must integrate unique differences in climate and site-specific soil properties, including the use of crop residue management to improve carbon sequestration as a soil stability measure. Therefore, a study was initiated to evaluate the effects of long-term reduced tillage and no-tillage in combination with the use of plant residues and cover crops for green manure on soil organic carbon (SOC). The long-term stationary field experiment was established at Vytautas Magnus University Experimental Station at 54º52′50″ N latitude and 23º49′41″ E longitude on Gleysols in 1999. Factor A consisted of: R - straw removed (control) and S – straw chopped and spread. Factor B included: CP – disking and conventional deep ploughing (control), SP – disking and shallow ploughing, PLT – ploughless tillage, SD – single seedbed disking before sowing, CCD – cover crops followed seedbed no-tillage, NT - no-tillage. The following crop rotation sequence was employed: spring oilseed rape (*Brassica napus* L.), winter wheat (*Triticum aestivum* L.), and spring barley (*Hordeum vulgare* L.).

Soil tillage systems and other complex measures in permanent crop rotation influenced the accumulation of SOC. In plots without straw reduced tillage systems SD, CCD and NT increased SOC poll in the 0-25 cm soil layer by 22.1-28.1 % compared with that in conventional tillage. Straw retention in these treatments increased SOC poll by 18.5-30.6 %. Reduced tillage systems SD, CCD and NT intensified the accumulation of SOC and humification was observed. These practices are efficient measures of soil organic carbon resilience and recovery in a long-term period.

Acknowledgement

The authors dedicate this article to the European Joint Programme (EJP) Soil and the Ministry of Agriculture of the Republic of Lithuania-funded project SOMPACS

Row cleaner coulter disc performance effects on no-till pneumatic precision direct seeding machines

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Keywords: no-till pneumatic precise planter, pneumatic precise planter, planter, direct seeding, mulch sowing

Unnecessary and excessive tillage causes significant damage to agricultural lands. One of the most important problems in no-till planting operation, which should be applied to avoid this damage, is that the seeding coulter of the planter cannot sow at the desired planting depth by being sufficiently immersed in the soil. As the subject of this contribution, it is aimed to increase the sowing performance of the no-till planter by enabling the stubble cutter row cleaner discs, which should be located in front of the seeding coulter of the no-till planter, to be driven hydraulically and in adjustable manner, to cut the soil covered with stubble more easily and to ensure that the planter's coulter is better sunk into the soil.

Within the scoop of the study, the effects of the row cleaner discs in two different profiles, "wide profile" (8 waves) and "narrow profile" (13 waves), on the performance of the row cleaner disc's width has been investigated. In addition, with the designed rotation speed adjustable system, the effects of the speed of the cutter discs on the performance of the no-till planter were investigated by operating the disc at 65 – 130 – 180 rpm. The designed system has been applied to pneumatic no-till precise planter.

Laboratory and field tests were carried out in order to determine the working performance of the no-till planter in which the designed system was applied. On sticky band in Ege University Faculty of Agriculture, Agricultural Machinery Laboratory, the twinning, void and seed damage ratio values were investigated by operating the machines on a straight line. The field success criteria of the no-till planter, in which the designed system was applied, were determined in the plots of Ege University Faculty of Agriculture, Menemen Research Application and Production Farm, with 3 replications according to the randomized plots trial design. Within the scope of the field trial, the aboveground organic matter amount, soil particle distribution, soil moisture change, soil temperature change, soil compaction change, skidding, fuel consumption, draft force and traction force requirement values and these of the effects of the machine variations on values were investigated. Field emergence degree, plant height, seeding depth, plant root length, acceptable plant range values of the corn (Zea Mays) were investigated and analysed with the IBM SPSS program.

It was observed that the best results in terms of plant development values were obtained as a result of the field trials by operating the narrow-formed row cleaner cutter disc at a speed of 130 rpm on the no-till pneumatic precise planter. It was observed that the worst results were obtained with the wide formed row cleaner cutter disc at a speed of 65 rpm on the no-till pneumatic precise planter.

As a result, within the scope of this study, a hydraulically driven row cleaner system with adjustable working speed was designed, which could be applied to all pneumatic precise planters and could make all machines capable of no-till planting. The designed system has been successfully produced and applied and it has been seen that the applied system gives satisfactory results with a very good performance. In addition, the comprehensive comparative data obtained as a result of this study is expected to be a reference for researchers who will work on determining the performance criteria of no-till planters.

Acknowledgement

I am grateful to The Scientific and Technological Research Council of Turkey (TÜBİTAK) for the financial support of this project. I would like to express my deepest appreciation to Dr. Erdem AYKAS for guiding me during the entire study. Many thanks to the cooperative and supportive staff of Ege University Agricultural Machinery and Technologies Engineering branch for all provided help. Special thanks to Azim Ziraat Aletleri Company and the entire technical staff for cooperation and hardworking at all the stages of production and testing.

Content

Effect of grape pomace compost application on selected parameters of soil properties

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Keywords: grape pomace compost, chernozem, soil organic matter

The grape pomace compost represents a common waste material, which is generated annually in the processing of grapes. This work aims to determine the long-term effect of grape pomace compost on chemical and biological soil parameters. It was applied at a rate of 30, 50, 60, and 100 t/ha in the selected vineyards at Rakvice and Velké Bílovice (South Moravia, Czech Republic). In addition, the relationship between soil organic matter (SOM) and soil biological parameters was studied. Results showed that the effect of the grape pomace compost on SOM depends on agrotechnical measures in vineyards. A correlation between the microbial biomass (C_{mic}) and humification degree (Dh) was found. A negative significant correlation -0.72 at P <0.001 between humic and fulvic acids (HA/FA ratio) and colour quotient $Q_{4/6}$ was determined. Grape pomace compost is a suitable organic fertilizer. $Q_{4/6}$ varied within the range of 3.05–5.30. For given specific conditions in studied localities, different agricultural management practices a significant negative correlation between SOM content and $Q_{4/6}$ was determined (-0.78 at P <0.001). Nevertheless, it has been shown that C_{mic} decreases in individual localities with increasing colour quotient $Q_{4/6}$ and decreasing application rate of grape pomace compost. However, the degree of humification (Dh) was not significantly affected by the application of grape pomace compost. There was a significant positive correlation (0.58 at P <0.001) between Dh and soil pH and a negative correlation between Dh and humus content (-0.67 at P <0.001). Obtained results confirm the possibility of effective removal and effective use of grape pomace for the compost production and producing high quality organic fertilizer.

Acknowledgement

The study was supported by the Ministry of Agriculture of the Czech Republic, National Agriculture Research Agency of the Czech Republic, projects No QJ1210263, QK1810233 and within the Institutional support of the long-term conception of the DKRVO solution, reg. no. MZE-RO1722, financed by the Ministry of Agriculture of the Czech Republic.

Differences in nutrient availability and microbial activity in erosive and accumulation areas of Chernozems and Cambisols

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Keywords: nutrients, soil respiration, C/N ratio, erosion.

The paper evaluated changes in the distribution of nutrients on land affected by water erosion. These lands were selected in the project QK1810233. There were three parcels with originally Chernozems (locality Bošovice 1, Bošovice 2 and Hrušky) and one parcel with original Cambisols (locality Zástřizly). The erosion areas of Bošovice 1, Bošovice 2 and Hrušky were generally similar: the active soil reaction was weakly alkaline in the topsoil and subsoil, the exchange soil reactions were from neutral to alkaline in the same profile. Topsoil, which was formed by mixing of the original Chernic horizons with the parent material, usually contained less than 1% of Cox (oxidizable carbon). The accumulation areas of Chernozem had an active soil reaction weakly alkaline, the exchange soil reactions were from neutral to alkaline. According to the assumptions, topsoil contained a slightly higher amount of Cox (1–2%) than erosion areas. In the locality Zástřizly (originally Cambisols) the active and exchange soil reaction were weakly acidic in the topsoil and subsoil in the both variants (erosion and accumulation), while the Cox content was 1.31% (erosion part) and 2.10% (accumulation part). In terms of observed nutrients (K, Mg, Ca, K and Nt) there was detected the accumulation of nutrients K, Mg, P and total N in the locality Bošovice 1 and 2 in the horizon 0–15 cm at the accumulation part, but also a significant depletion of these elements in the horizon 15–30 cm. Higher concentrations of calcium and magnesium in the erosion variant may indicate the exposure of layers rich in these elements due to erosion. At the locality Hrušky was observed the accumulation of elements K, P and Ca (in the accumulation part) due to erosion processes. The stated disproportion of the Cox and Nt content leaded to the unbalanced C/N ratio, which was always closer to 10 on the accumulation areas than on the erosion areas, where it decreased to 4. However, the results of the soil respiratory tests showed the increase of microbial respiration on erosive areas compared to accumulation areas (probably caused by stress); and on erosion areas there were observed a great lack of physiologically utilizable nitrogen and lack of easily degradable organic substances (which were usually eroded). In addition, there were Ca/Mg and Mg/K ratios significantly affected by the mobility of these elements. The magnesium content was in all localities higher on the erosive areas compared to the accumulated areas, potassium was the opposite – it dominated on the accumulation parts of plots. All these disproportions subsequently affect the yield, fertilization plans and thus cultivation economics.

Acknowledgement

Grant No. QK1810233 “Quantification of the impact farming management on soil erosion, soil quality and yields of crops with proposals of the environmentally friendly cultivation technologies” (funded by the National Agricultural Research) is gratefully acknowledged.

Title: Trends and challenges in soil-crop management. 2nd Central European ISTRO Conference (CESTRO) and 8th International Conference of the Czech ISTRO branch. Book of Abstracts

Editors: Vladimír Smutný, Vojtěch Lukas

Publisher: Mendel University in Brno, Zemědělská 1, 613 00 Brno

Edition, Year of issue: 1st, 2022
Number of pages: 80

ISBN 978-80-7509-847-4 (pdf ; online)