The role and status of modern agriculture in climate change: innovative and sustainable approaches: 1st International Scientific Conference

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Innovative and sustainable approaches

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Plenary Abstracts

THE RELEVANCE OF SOIL STRUCTURE CONSERVATION IN GRAZING SYSTEMS ON ANDOSOLS OF SOUTHERN CHILE

José Dörner[1,2], Dorota Dec[1,2], Felipe Zúñiga[3,2], Iván Ordóñez[4], Jorge Ivelic[4,2]

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Abstract

In southern Chile, there are over 1.3 million ha of pastures on Andosols (volcanic ash soils). The climate change scenario and the need to increase yields and reduce the environmental impacts are forcing farmers to i) apply different pasture improvement managements (PIMs) and ii) increase irrigated surface areas (IMS). This implies an intensified soil use that must be analyzed to prevent soil degradation. The aim of this work is to summarize results of two research projects which highlight the relevance of soil structure conservation of volcanic ash soils under grazing systems.

The experiments were carried out at the Estación Experimental Agropecuaria Austral (EEAA-UACh) (39°46' S, 73°13' W, 12 m a.s.l.) in Valdivia, Chile. The average annual temperature is 12 °C with a yearly mean rainfall of 2440 mm between 1901 and 2005. The soil is derived from volcanic ashes, classified as a Petroduri-Silandic Andosol (WRB, 2006). The topography is normally complex, with dominant slopes from 3 to 8%. The trial "Pasture Improvement Managements (PIMs)" (Ordóñez et al., 2018) considered five types of pastures: initial situation (non-fertilized naturalized pasture without tillage treatment; NFNP); a fertilized naturalized pasture without tillage treatment (FNP); cultivated pasture with conventional tillage (CP); direct drill pasture (DP); diverse direct drill pasture (DDP). Pastures were grazed by sheep.

The trial "Irrigation Management Strategies (IMS)" (Dec et al., 2021) was conducted considering three types of pastures: (a) 100 % Lolium perenne L. (Lp), (b) 100 % Bromus valdivianus Phil. (Bv), and (c) Lp, Bv and Trifolium repens L. in equal parts (Pol), under non-irrigated conditions (control, rainfed) and 2 different irrigation strategies (100% Field Capacity and 50% FC), all treatments under grazing by cows and cutting by mower.

In both experiments undisturbed soil samples were collected at 10, 20 and 60 cm depth to measure water retention curve, air conductivity and precompression stress. At the same depths, sensors were installed to register soil water content (SWC). Soil penetration resistance and pasture yield was measured in both trials.

The PIMs trial shows that the fertilization of degraded naturalized pastures, without soil structure disturbance, improved the herbage mass production (140%), reaching values comparable to those improved with conventional systems. In the short term, the volume of macropores does not change significantly as a function PIMs. However, tilled soils presented less connected pores

compared to the non-cultivated PIMs allows roots to absorb water as evidenced by SWC. The IMS trial shows the relevance of considering the specific physical properties of Andosol so that as the water available in the soil (WAS) increased, the pasture productivity increased as well. However, it's possible to save water by restricting its application (up to 50%) without decreasing herbage mass production. This is due to the wetting–drying cycles (WD), which showed that when irrigation was applied some of the water infiltrated to deeper horizons. Irrigation reduced the mechanical strength and caused the soil to be more susceptible to animal trampling; however, when the amount of water applied to the soil was reduced, it was better able to resist the animal trampling as compared to the full irrigated treatment.

We concluded that the implementation of PIMs without alteration of structure dependent properties (FNP): i) conserves the continuity (higher values of air conductivity) of the pore system in the soil profile and throughout this, ii) improves the water accessibility by plants, and therefore, iii) encourage the multi-species contribution within the pasture, with species that differ in their traits and therefore, increasing the herbage mass production during water restriction periods, but maintaining the accumulated herbage mass during the year and as those improved pastures by conventional systems and iv) improve the resilience against mechanical and hydraulic stresses. On the other hand, the specific determination of the soil water storage capacity and the sensor calibration are essential to an effective design of irrigation schedules, allowing to save water application by irrigation as well as to prevent soil compaction by animal trampling.

Key words: Andosol, Grazing Systems, Soil Structure, Water Storage Capacity

Acknowledgement

The results presented in the paper are an output from research projects FONDECYT 1130795 and FONDECYT 1181515.

SUSTAINABLE APICULTURE AND CHALLENGES UNDER MODERN AGRICULTURE AND CLIMATE CHANGE

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Abstract

Sustainable beekeeping/ apiculture by definition is the act of bee farming using principles of ecology, in a way that bees, humans, practice and the economy of the act are bound together in a relationship where the use of the organism (bees) respect the rules of their environment. What is really happening is that: honey bee colony losses year after year are questioning our practices; The beekeepers are more and more depended on artificial feeding, veterinary medicines and even queens from breeding centers; Modern and intensive agriculture practices increase the danger and the stress to honey bee and other pollinators by reducing meliferous flora and inceasing pesticdes use; recent changes in the climate are also showing their effects on our bees and production/ profits of beekeepers; new technologies have been developed, still Varroa and other pests or pathogens do suppress the health of our bees. Is finally beekeeping a sustainabel occupation?

Good beekeeping management and proper application of the biosecurity measures are of great importance. Selected case studies from all continents have revealed successful management to overcome the risks of bee losses. Understanding and conserving the provision of bee-driven pollination services to crop and honey production needs to be adopted under the changing of climate; Better utilization of flower resources need to be implemented to decrease costs and increase benefits/ profits; Better collaboration between farmers and beekeepers is needed more than ever, as both pollination demands, and pesticide stress are increasing; Diverse food sources and agriculture degenerative initiatives might improve future conditions; Alternative methods for plant and bees' treatment need to be incorporated in to the Good Practices; Sustainable beekeeping cannot be secured without breeding towards disease resistance improving the genetic response on useful traits and preserving animal genetic resources for future generations.

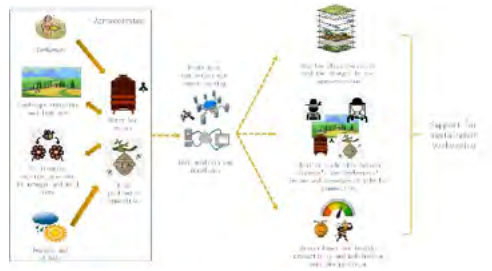

Fig. 1. The concpet of the SafeAgroBee project for sustainable beekeeping.

Key words: Apiculture, sustainability, agriculture, climate, stress

Acknowledgement

The concept and the results presented in the paper are an output from research projects PRIMA_2020- Section 2_„SafeAgroBee".

"BLACK NITROGEN" A POTENTIAL SLOW-RELEASE FERTILIZER WITH C SEQUESTRATION POTENTIAL?

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Abstract

The strong interest in the application of biochar as soil amendment is reflected in the high number of scientific publications on the subject. Most of these studies deal with the impact this practise on important soil parameters. and on soil fertility. Another part of the studies, especially those that propose the application of biochar (BC) as a carbon (C) sequestration agent, focus mainly on the half-life of the BC and its impact on soil organic matter (SOM) quantity. The obvious difference in the composition BC and natural SOM is the higher aromaticity of the first. Our studies revealed a shift of the organic nitrogen (N) from peptide-like structures in SOM towards heterocyclic N in BC, the so called "Black Nitrogen" (BN) after pyrolysis of N-rich biomass. Former studies demonstrated that, during microbial degradation of charcoal produced from grass at 350°C in the presence of oxygen, at least some of the BN were released and transformed into plant available forms (De la Rosa and Knicker, 2011). Based on those observations, it was suggested that N-rich charcoal/BC can act as a slow release fertilizer. Other studies confirmed that N of BN is also incorporated into microbial biomass although this occurs to a much lower extent than it was observed for plant-derived N or inorganic N (Lopez-Martin et al., 2017).

The success of using BC as slow release fertilizer is greatly affected by the potential of the BC to release N and by its effect on soil N dynamics (Lopez-Martin et al., 2017). Thus, the potential of BN to act as a N source for plants is highly related to the potential of the microbiome to degrade and finally mineralize BC. This, on the other hand counteracts the role of the latter as C sink in soils. Therefore, the intention of the presentation is to evaluate the price that has to be paid with respect to C sequestration if BC is used as slow release fertilizer. To achieve this, the presentation provides an overview about previous and recent studies of our group, related to the study of the fate of organic N and C of BC in soils during aging and how this aging affected SOM quality and soil fertility. This overview includes experiments both with pyrochar obtained by dry pyrolysis and with hydrochar produced during hydrothermal carbonization. Due to the fact that the latter are produced at lower temperatures, they are characterized by a lower aromaticity than pyrochars and thus are expected to be more affected by microbial degradation.

In a first study the degradability of organic C and N of hydrochars and pyrochars derived from N-rich sewage sludge (SS) and amended to soils in the presence of plants (Lolium perenne) was evaluated (Leiva-Suárez et al., 2020)respectively, which may act as slow-release fertilizers with carbon (C. The SS was enriched with 13C and 15N. For a 10-months growing period under greenhouse conditions, the partitioning of 15N and 13C among soil and plants was monitored through periodic analyses

by using an isotopic ratio mass spectrometer (IRMS). After a simulated fallow of a couple of months, a second greenhouse incubation with Lolium was conducted.

The results confirmed that hydrochar provides more plant available N than pyrochar, although the latter may release N over a longer time range than the first. Whereas clear differences with respect to plant performance were seen during the first growing period, the amendments did not promote nor decrease the number of living plants along the second incubation compared to the control. Interestingly, at the end of the second growing period, the turnover rates of both chars approached that of the natural SOM, independently of their aromatic C content. It was concluded that during the first aging stage (first growing period) the biochemical recalcitrance determines the turnover and thus the amount of C which is added to the slow turning pool. However, the turnover of the aged amendment (second growing period) were found to be determined by other mechanisms, most likely by those which are also responsible for the turnover of humified native SOM.

Also using biochar from SS, the middle-term impact on plant physiological parameters was compared with those determined with plants (maize) growing on soils amended with peat, a commercially available organic fertilizer and a mineral fertilizer (Olufemi and Knicker, in preparation). Whereas the biomass production of plants growing on biochar-amended soils was higher than of those growing on soils without amendment, the yields were considerably lower than for those cultivated with the commercially available organic fertilizer and the NPK addition. With respect to C sequestration, the biochar addition had no significant impact on C contents although the aromaticity of the SOM clearly increased. No major impact on SOM contents was also observed in a further experiment, in which hyrochar from chicken manure was added to soil before growing sunflowers. However, with respect to the control and soils treated with mineral fertilizer, addition of the amendment considerably increased the performance of the plants and their stress resistance against drought). Since in all experiments the amount of added N was the same, other factors then N availability must be responsible for the better performance of the plants grown on hydrochar treated soils. Preliminary results indicate that this is most probably related to an increase of the microbial activity in the hydrochar amended soils.

Summarizing the results obtained so far, we confirm a positive impact of N-rich biochar/hydrochar on plant growth, also it certainly can only partially replace the use of mineral fertilizer. With respect to C sequestration, the amount of added BC may not have been sufficient for a long-term impact on the C-sequestration in soils. On the other hand, increasing the doses considerably enhances the aromaticity of the SOM which may have a long-term impact not only on the quality SOM but also its hydrophobicity.

Key words: N-cycle, biochar, pot experiments, Biochar aging, Drought

Acknowledgement

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MONITORING AND MODELING OF CROP PESTS AS IMPORTANT PARTS OF AN IPM APPROACH IN A AGRICULTURAL WARNING SYSTEM IN AZORES ISLANDS, PORTUGAL

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Abstract

Monitoring and modeling of crop pests are important parts of an Integrated Pest Management (IPM) approach on agricultural production. This allows to know the current situation of crops pests in a region or for instance of Medfly (C. capitata) in some European countries in the FruitFly-Manage Project work were all the 11 partners exchange information on the situation of this pest in their countries. This information allowed the use of MaxEnt sotfware to modelling and permited to build risk maps with the occurrence probability to this pest spread and supported the control of C. capitata adults in some countries of the EPPO region.

All this information from monitoring and climatic factors allowed to create agricultural warning systems to the technicians and producers similar to the one built by the Cuarentagri project in Azores islands.

This Cuarentagri project aimed to identify pests that can affect the different crops in regions of Macaronesia and in particular the Azores islands. All the work developed prevent and/or reduce the establishment and proliferation of new harmful organisms. Also allowed a better training in pest risk analysis (PRA) for technicians and promoted the disseminating of all the results to technicians, producers and citizens in general by identifing which harmful organisms present and not yet introduced can affect the major crops of economic importance in Azores islands including those that are in the European Union priority lists like Popillia japonica, Batrocera dorsalis and Tecia solanivora, outlining and developing contingency plans in anticipation to deal with these important pests. The monitoring activities permited not only the development of early detection methods, by testing different types of traps and attractants in the field but also permitted to know the most efficient combination of trap and attractant for monitoring the population evolution and contributed to the creation of an agricultural warning system as part of a new alert system. To support this purpose, phytosanitary sheets were also issued fortnightly and disseminated to technicians and farmers with information regarding 12 of the most important azorean crops pests concerning their appearance and adult population evolution. This work was developed on three azorean islands: Terceira, São Miguel and São Jorge.

Keywords: alert network, pest priority list, phytosanitary problems, risk maps, Azores

Acknowledgement

The results presented in the paper are an output from research projects: 2017-F-236, FRUITFLY-RISKMANAGE, "Ceratitis capitata: better knowledge for better risk management" an Euphresco project; and MAC 2/1.1a/231 CUARENTAGRI, "Investigación, identificación, análisis de riesgo, formación y sensibilización sobre potenciales plagas de cuarentena y plagas reguladas no de cuarentena en los principales cultivos de las regiones de estudio"an Interreg V, MAC 2014-2020 project.

EFFECTS OF PLANT POLYPHENOL SUPPLEMENT ON PRODUCTION AND WELFARE MARKERS IN HEAT STRESSED DAIRY COWS

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Abstract

Environmental heat load has adverse effects on livestock, eliciting a reduction in feed intake and production, and increased inflammation and oxidative stress. Plant derived polyphenols are known for their anti-oxidative properties. Thus, the aim of this study was to examine the effects of a supplement comprised of plant polyphenols extracts of green tea, capsicum and fenugreek, and electrolytes [(Na+, K+), AXT; Axion ThermoPlus, CCPA, France] during summer heat load on production, welfare, and on oxidative stress proteins in adipose tissue (AT) of dairy cows. Experimental procedures: Forty-two multiparous mid-lactation cows were divided into 3 groups during summer, and were fed for 2 wks either a standard milking cows' diet (CTL, n=14), or supplemented with 100 g/d of AXT (100AXT, n=14), or 150 g/d of AXT (150AXT, n=14), while being cooled 5 times a day; then, half of the cows from each treatment were cooled (CL) or not cooled (NCL) for 2 wks, after which the CL/NCL were switched for additional 2 wks. Cows were milked 3 times a day and milk composition was analyzed at the end of each period. Vaginal temperature (VT) was measured by sensors in each period. Biopsies of subcutaneous AT were taken from 10 NCL (five CTL and five 150AXT) at the end of the period, and examined by proteomics analysis. Data were analyzed with PROC MIXED of SAS; the model included the effects of treatment, cooling, and interactions. Proteomics was analyzed by t-test. Results: Milk, 4% FCM and feed intake were higher in 100AXT than in CTL. The effect of cooling was significant for intake, 4% FCM, and milk/intake. The proportion of hours that VT was >39°C was lower in 100AXT and 150AXT than in CTL. Daily rumination time was higher in 150AXT vs. CTL, and lying time was increased in 100AXT and 150AXT vs. CTL. Proteomics demonstrated increased abundances of peroxidase, microsomal-glutathione-S-transferase-2 and heme-oxygenase-1 in 150AXT vs. CTL; the Nrf2-mediated oxidative stress response was enriched in 150AXT. In conclusion, AXT supplementation during heat load increased feed intake and production, lowered VT, improved welfare indices, and affected the Nrf2-oxidaitve stress response.

Key words: heat stress, antioxidants, Nrf-2 oxidative stress response, proteomics

Acknowledgement

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Abstracts

THE IMPACT OF CLIMATE CHANGES ON THE HEALTH AND WELFARE OF HORSES

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Abstract

Climate change has negative impacts on horse breeding and welfare. The risks of climate change to animal welfare encompass several major areas related to environment, nutrition, health, and behavior. Extreme, unexpected, and long-term weather changes have significant impacts on horse health and make them more susceptible to heat-related illnesses. During prolonged and hotter summers, horses can quickly overheat and suffer from thirst and discomfort. Reduced pasture growth and low quality forage suppress appetite weakening horse body condition and eventually leading to hunger and starvation. Conversely, severe storms bring problems of flooding and impure water. Muddy pastures cause hoof problems, the appearance of insects that in turn can be carriers of infectious diseases and metabolic problems can be the result of drinking impure water. The influence of climate change has an impact on the behavior of horses, they may show excessive fear (e.g., during storms) or become lethargic and sluggish (e.g., during high temperatures) which affects their mental health. Climate change also impact horses in sport, work and recreation. In these horses the risk of heat-related illness increases with physical activity and increased metabolic rate.

Under such conditions, it is necessary to take all necessary measures to provide the best living conditions for horses. These include good quality and quantity of feed, supply of fresh water, which must be constantly available, and provision of minerals (macro and microminerals). Adequate shaded areas and shelters will provide protection from the sun, cold winds or rain. In all respects, efforts should be made to keep horses in best body condition, which contributes to the resilience of the equine organism and reduces the incidence and development of disease. Veterinary monitoring, active cooling, ventilation, and well-organized sporting events are critical to the welfare of competition horses. In order to raise awareness of the impact of climate change on horses welfare and to take appropriate action, support from government, industry and research is of great benefit.

The aim of this abstract is to describe how climate change affects the health and welfare of horses and how horses can be helped to cope with all conditions.

Key words: horses, climate changes, health, welfare

AGROFORESTRY FOR CLIMATE RESILIENCE IN DRYLANDS? TREE-CROP INTERACTIONS MEDIATED BY MICROCLIMATE

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Abstract

As food demands are growing, environmentally related agricultural pressures are constantly increasing, the search for resilient and productive agroecological systems is inevitable. Current industrial agriculture is strictly segregated and mostly based on monocultures. This uniformity of monocultures is linked to agroecosystem vulnerability.

Our objective is to evaluate alley-cropping in Meditteranean dryland, as a novel design for climate adaptation and agroecosystem services enhancement. We hypothesize that a major mechanism for climate mitigation in dryland agroforestry is the impact of tree- and herbaceious-crop interactions on microclimatic conditions, which are formed by the system components and interactions.

We will present initial results from two experiments which began on November 2022: Citrus-Cereals (Fig. 1), Pomegranate-Cover crop-Sheep (Fig. 2).

Regarding the Citrus-Cereal experiment, we found that soil water content was affected by barley earliness. Early varieties consumed more water at the beginning of the season (winter) and less at the end of the season (spring end), as compared to the later varieties (Fig. 3). On the other hand, the early varieties yielded significantly less hay in terms of biomass (Fig. 4). These results are explained as a tradeoff between the earliness for water preservation and field crop yield which are both desirable, and need to be taken into consideration. Regarding the effect of the interactions between trees and crop, we observed tendency towards higher hay yields with the three tested barley varieties (Fig. 4). We assume this occurred due to the rain stops and high temperature at the beginning (day 30-62) and the middle of the season (day 70-112), which was conditioned by the microclimate created by the trees' shade.

Figure 1. Barley harvest in a Citrus-Cereals agroforestry system, ARO, Israel.

Figure 2. Sheep grazing in a Pomegrante – Cover crop - Sheep agroforestry system, Mishmar Hanegev, Israel.

Further data will be analyzed soon and presented at the A3C conference.

In conclusion, we will present how the components of the alley cropping design affect microclimate, field productivity, and should be designed wisely in order to contribute to agricultural resilience. Overall, we aim to suggest that dryland alley cropping may enhance sustainable intensification of food systems.

Keywords: agroforestry, microclimate, alley cropping, climate change resilience, agrobiodiversity

Acknowledgment

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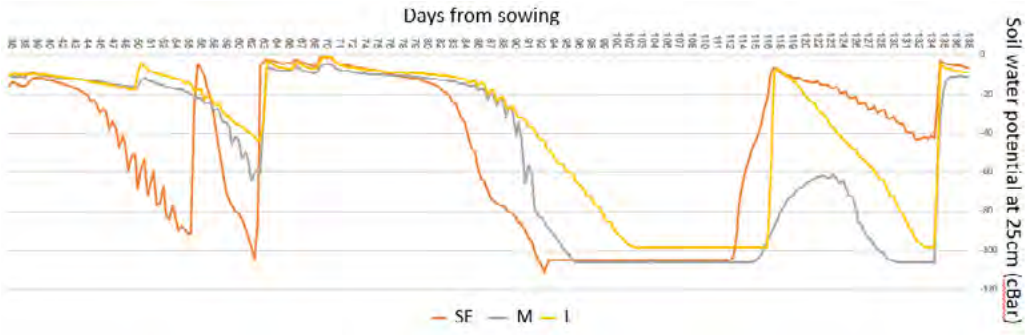

Figure 3. Soil water potential (cBar) at 25cm depth during the growing season. Different color lines represent diferent Barley vareities- SE- Super Early, M- Medium earliness, L- Late maturity. At day 55 we had technical problem with the SE sensors.

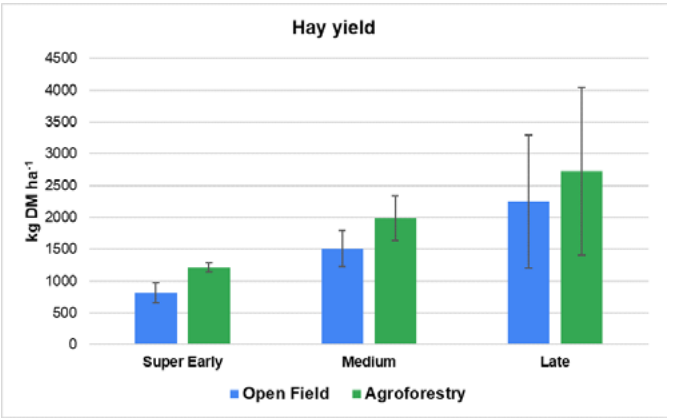

Figure 4. Barley hay yields Agroforestry (Green) and Open field (Blue), for each of the vareities (super early, Medium earliness, Late maturity).

THE INFLUENCE OF MICROCLIMATE PARAMETERS ON DAIRY COW'S BODY TEMPERATURE

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Abstract

The higher production dairy cows are more susceptible on the unfavorable microclimate conditions comparing to other livestock animals. The heat stress, which occur in the barn at high temperatures and air humidity, can have a significant impact on animal health, production and violation of welfare norms. The ability of animals to remove metabolic heat is important for maintaining a constant body temperature. In cattle, about 15% of the endogenous heat is lost through the respiratory system, while the rest of the metabolic heat is transferred to the skin, where it is removed by convection, conduction or evaporation. The aim of this paper was to show the influence of microclimate parameters on the cow's body temperature and conduction abilities of the different surfaces of the lying spots.

The study was conducted on a dairy farm with Holstein cows. Temperature and humidity in the barn were measured by the Data Logger. The temperature of the cow's body and lying place were measured with infrared thermovision camera. The body temperature of cows was significantly reacted to the changes of the temperature in the barn. The different surfaces of the lying spots had different temperature and consequently conduction values.

It is necessary to apply additional measures (fans, water sprinklers) which reduce the adverse impact of the microclimate in the environment of dairy cows. Furthermore, the negative microclimate changes can be mitigated through the management decisions, by choosing adequate surfaces on which the cows lie, so that the excess heat can be lost through conduction.

Key words: microclimate, dairy cows, body temperature, lying spots, infrared thermovision camera

Acknowledgement

The results presented in the paper are an output from two research teams: „Development of fitness potential of animals with modern technologies" and „Animal production in future society".

SOYBEAN WEEDINESS IN CONSERVATION TILLAGE SYSTEMS

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Abstract

The experiment with conservation tillage and fertilization was set up in Čačinci (17.86336 E, 45.61316 N, 111 m) on Stagnosol soil type in 2022 with the aim of determining the influence of conservation soil tillage and fertilization on the weed status of soybean. The experiment was set up as a split plot design in three replications where the main treatment was soil tillage, and the sub-treatment was fertilization. Soil tillage treatments were: conventional tillage - ST (plowing up to 30 cm depth); deep conservation tillage (loosening up to 30 cm depth) with a minimum of 30% of crop residues - CTD); shallow conservation tillage (loosening up to 10 cm depth) with a minimum of 50% of crop residues - CTS). Fertilization included treatment F - recommended (40:150:94 NPK and 40 kg N ha-1) and HF - reduced by 50%. Weed assessment was carried out by weeds sampling in V3 (three trifoliolate) and R7 (beginning maturity). The weed density, above-ground biomass, the number of weed species and weed coverage were determined at each treatment and sub-treatment. All classified weed species on the area of 0.25 m2 in four repetitions were counted and cut off on the ground level, separated by different weed types and dried at 60 °C for 48 h and weed coverage was determined visually. Tillage had a significant effect ($p<0.05$) on weed biomass, weed density and weed coverage at V3 soybean growth stage (critical weed free period). Average weediness was the highest on CTS conservation tillage system. Average weed biomass was almost three times higher (9.74 g m-2) on CTS treatment compared to ST (3.42 g m-2) while the weed coverage was more than 50 % higher (36.34 %). The highest weed density (50.33 m-2) and coverage (38.67 %) were recorded on the CTS treatment with HF. The parameters of weediness in R5 growth stage were on average the highest on CTS treatment with significant statistically difference ($p<0.05$) compared to ST which had the least average weediness. Fertilization had a significant effect on average weed density and number of weed species with the highest values on treatment HF; (25.89 m-2) and (4.22 m-2). CTS treatment with HF had the highest weed species number (6.67 m-2) and weed cover (42.33%) with statistically significant differences compared to ST/HF while the highest total weed density (32 m-2) was recorded on CTD/HF. The shallow conservation tillage system and reduced fertilization in average led to an increase in soybean weediness.

Key words: *Glycine max* (L.) Merr., weed assessment, conservation tillage

Acknowledgement

The results presented in the paper are an output from research projects (IP-2020-02-2647). "Assessment of conservation soil tillage as advanced methods for crop production and prevention of soil degradation – ACTIVEsoil

METHANE EMISSIONS REDUCTION FROM MANURE MANAGEMENT

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Abstract

Animal manure is a source of methane emissions. Methane has 28 times the global warming potential of carbon dioxide when considered on a 100-year timescale. The aim of abstract is to provide an overview of technologies currently used to reduce methane emissions during the collection, storage, and application of animal manures. Strategies to reduce methane emissions from manure management can be divided into strategies implemented during manure storage, and strategies implemented during manure land application. Manure storage strategies include the collection and capture of biogas and the utilization of anaerobic digesters to produce and collect methane for use as fuel, frequent manure removal from animal housing and storage systems, manure cooling, manure acidification, and the addition of amendments that inhibit methane production. Manure land application strategies include manure application timing, manure incorporation or injection.

Biogas collection and utilization, including the flaring, engine combustion or pipeline injection of methane is very effective as it replaces the direct release of methane into the atmosphere. To achieve methane reductions, it is important to ensure that all potential fugitive methane leaks are controlled. Frequent manure removal from storage systems will reduce methane emissions by reducing the amount of methane that can be generated during storage. For systems that do not generate the majority of methane during manure storage, this approach will have limited effectiveness. Manure cooling can significantly reduce methane emissions. Lower temperatures decrease the activity of methanogenic bacteria during manure storage and slow methane formation. Manure acidification reduces manure pH. As manure pH decreases, methanogenic bacteria are inhibited as pH decreases. Decreasing manure pH below 5.5 can reduce methane emissions by 70%. The addition of methane inhibitors, such as tannins, monensin, and narasin to manure will limit methane formation for a time specific period. The methane reduction efficacy and the time that methanogenic bacteria are inhibited are a direct function of the dose of inhibitor added.

The incorporation of manure following land application either through cultivation or direct injection of manure 15 to 20 cm below the soil surface will reduce methane emissions during application. However, soils can serve as either a source or a sink for methane, depending on if methanogenic or methanotrophic bacteria are active following the incorporation or injection of manure. Manure application timing impacts methane emissions because soil temperature and moisture content affect methanogenic bacteria activity. Application of manure, at different times of the day and seasons, used in conjunction with manure injection or incorporation can effectively limit methane emissions.

Key words: Manure, methane, greenhouse, gas emissions

CLIMATE CHANGE AND WILDFIRE RISK IN THE EASTERN CROATIA

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Abstract

Since 1982, a forest fire protection program using the Canadian Forest Fire Weather Index System (CFFWIS) has been run by the Croatian Meteorological and Hydrological Service as part of the Government Program of Open-Air Fire Prevention. The Canadian model is applied to the fire weather indices once a day, based on real-time meteorological data: daily amount of precipitation and air temperature, relative humidity and wind speed in the warmest part of a day, at 12 UTC. The predicted indices for the following two days are based on the products of the ALADIN/HR limited area numerical weather prediction model.

It is well known that the highest wildfire risk in Croatia is along the mid-Adriatic coast and its islands. However, the main goal in this study is to examine if there is a regional impact of climate change on the potentially higher wildfire risk in the eastern part of Croatia (Slavonia), which is the most important region in food production in the country.

Monthly and seasonal severity ratings (MSR and SSR), which are the products of the CFFWIS, have been estimated for two meteorological stations: Osijek in the periods 1900–2022 and 1963–2022, and Slavonski Brod in the period 1963–2022. The SSR refers to the assessment of potential wildfire risk during the fire season, from June to September, while the MSR refers to a particular month. A very high wildfire risk is when SSR equals or exceeds 7 because then it is considered that there are favorable weather conditions for the occurrence of large fires.

The SSR analysis for Osijek indicates 12 fire seasons with a very high risk in the first half of the 20th century with the absolute maximum SSR value of 11.7 in 1927. In the 21 century the highest fire risk was in 2012, 2017, 2021 and 2022. These results indicate a slight negative secular linear trend in SSR (-0.03/decade) in Osijek. However, the increase in SSR in Osijek and Slavonski Brod is evident for the last 60 years (0.61/decade and 0.37/decade, respectively). August poses the greatest potential wildfire risk, followed by July. MSR linear trends in Osijek are positive in all months in the period 1963–2022, and the highest trend is in July (0.89/decade). The impact of climate change on wildfire risk is also reflected in the tendency of the fire season to start earlier in spring as well as the possibility for it to extend in autumn.

Since 1963, the spatial distribution of SSR on the territory of Slavonia shows that SSR was higher than 8 in only three years in the 20th century and seven years in the 21st century. The fire regime in Slavonia fits into the bigger picture, which indicates higher potential wildfire risk in the eastern Europe during the summer months.

Key words: meteorological data, fire weather indices, monthly and seasonal severity rating (MSR and SSR), linear trend, Slavonia

EUROPEAN LIVESTOCK PRODUCTION IN THE ERA OF CLIMATE CHANGE - WHAT CAN WE EXPECT?

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Abstract

In 2023 the human population reached 8 billion and global livestock production has in the last 50 years increased sevenfold, reaching a total production of 350 million tons of meat. In recent decades livestock production has become more efficient thanks to significant developments in breeding, nutrition and animal health. Today, however, it faces a major challenge arising from competition for food and feed on one hand, animal welfare and environmental legislation on the other, and the overall general need to operate in a low-carbon economy. It should be emphasized that, according to European Environment Agency (2020), agriculture along with livestock production ranks fifth in terms of gas emissions. The main gas produced by livestock (mainly cattle) is methane, which is in fact a short-lived gas and therefore cannot be measured with GWP100 (Global Warming Potential of the greenhouse gases over 100 years) value but with the GWP* method, which takes into account also the removal of the gas from the atmosphere (Rocha, 2022). Using this method, researchers predict that if livestock numbers remain constant (without growth or losses), methane emissions will also remain constant, and thus there will be no additional warming of the atmosphere caused by livestock farming. Furthermore, the reduction in emissions through anaerobic digestors and feed additives, which are already used in livestock industry, could even have a cooling effect on the atmosphere. However, the goals of the EU's Green Deal, especially the Farm to Fork Strategy, as well as the growing number of citizen initiatives for plant-based and laboratory-produced meat and milk alternatives, are forcing the livestock industry to reduce herd sizes and their overall production. It is foreseeable that this forced reduction in livestock production will have a serious impact on the European supply of high-quality nutrients. This will lead to an increase in meat and milk imports from other countries where the efficiency of livestock production is lower than in Europe, resulting in an even greater impact of livestock production on climate change. With the reduction of herds, we can also expect the abandonment of pastures as important CO2 binders and the reduction of organic matter for soil fertilization.

Key words: GWP*, livestock production, climate change

FAIRNESS CA20108 – THE FRAMEWORK FOR FAIR MICROMETEOROLOGICAL MEASUREMENTS

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Abstract

With rapid advancements in centralizing ground-based and satellite measurements, weather and climate simulations have become more accessible to the public through platforms such as COPERNICUS, ECMWF, e-OBS, etc. However, amidst this progress, one aspect has remained overlooked: the meteorological conditions of micro-environments.

Recognizing this gap, a group of scientists with shared vision addressed this issue through COST Action CA20108, „FAIR Network of Micrometeorological Measurements (FAIRNESS)", which emphasized the open science concept as a fundamental element of its scientific strategy for the future.

The FAIRNESS primary targets are networks of Automated Weather Stations installed in rural, suburban, and urban areas which are in charge of research projects, specialized agencies, government offices for specific applications in the sectors of agrometeorology (e.g., pest and disease warning systems), forest-, urban- and environmental meteorology. The databases linked to these networks have a strong advantage in high spatial density, allowing for the representation of small-scale environmental conditions and processes. However, a significant drawback of existing data is their lack of compliance with the FAIR Guide Principles (findability, accessibility, interoperability, and reusability). The FAIRNESS network has grown from initial 65 proposers for 29 countries (6 international partners) to 122 researchers from 31 countries.

In the FAIRNESS's core lies the expert scientific community and the Micrometeorological Knowledge Share Platform (Micromet_KSP). This platform serves as a repository for micrometeorological metadata, enabling the transformation of large volumes of available data into FAIR-compliant formats. The data itself are stored in the Zenodo repository, further facilitating accessibility and collaboration within the scientific community.

Keywords: micrometeorological measurements, FAIR data, metadata, Knowledge Share Platform

Acknowledgement

This work is supported by the Minister of Science, Technological Development and Innovation of the Republic of Serbia (Grant No. 451-03-47/2023-01/200117) and COST Action CA20108 „FAIR NEtwork of micrometeorological measurements" (FAIRNESS).

SEASONAL VARIABILITY OF SOIL RESPIRATION UNDER DIFFERENT MAIZE HYBRIDS

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Abstract

Carbon dioxide (CO2) is released from the soil into the atmosphere through the processes of soil respiration. It is the main pathway of organic carbon from the soil carbon pool and the major source of atmospheric CO2. Soil respiration contributes about 10% of total atmospheric CO2, which is the second largest carbon cycle flux in terrestrial ecosystems. The extent of soil respiration depends on numerous biotic and abiotic factors including agro-ecological conditions and vegetation type. Soil respiration can be reduced by selecting appropriate cultivars/hybrids. Therefore, the aim of this work is to determine the degree of soil respiration and its seasonal variability, as well as microclimate conditions under different maize hybrids during one growing season. The research was conducted near the city of Osijek, by the closed static chambers method. The experimental field consists five treatments (two new maize hybrids, two old maize hybrids and a control treatment with black fallow). Statistical data analyses determined the seasonal variability in soil respiration and soil microclimate conditions for all hybrids studied, as well as the month – to – month differences. The range of monthly soil respiration during the growing season was 3.3 – 20.2 kg C-CO2 ha-1 day-1 depending on the treatment. Average monthly soil respiration was the highest in June (12.8 kg C-CO2 ha–1 day–1) and the lowest in October (7.1 kg C-CO2 ha–1 day–1). Average annual soil respiration values did not differ significantly among the studied maize hybrids (9.75 – 11.76 kg C-CO2 ha–1 day–1), but a significantly lower level of average annual soil respiration was observed on bare soil (4.48 kg C-CO2 ha–1 day–1). Soil respiration was weakly negatively correlated with soil moisture (r=-0.28) and not correlated with soil temperature (r=0.09). However, determining the total carbon budget within maize agroecosystem is necessary to determine the most appropriate hybrid in terms of climate change mitigation.

Key words: C-CO2 flux, old and new maize hybrids, soil temperature, soil moisture, Croatia

Acknowledgement

The results presented in the paper are an output from research project KK.05.1.1.02.0016 funded by European Regional Development Fund via project "Production of food, biocomposites and biofuels from cereals in the circular bioeconomy" (https://projekt-klima.eu/).

CLIMATE CHANGE IN THE PERSPECTIVE OF MEDITERRANEAN AND CROATIAN AGRICULTURE - PERSONAL OVERVIEWS

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Abstract

Here is a summary for agrometeorologists/climatologists about parts of the recent climate changes over the world and toward certain areas of the Mediterranean and Croatia. This is a snapshot of recent climate changes effects for the areas considered; it is by no means a comprehensive overview, which would be an overwhelmingly demanding task at this moment for the timely subject. The presentation is intended for agronomists in the broadest sense, yet from another view, from a perspective of atmospheric physicists, or theoretical meteorologists. Some of the current important climate issues are shown in Fig. 1: global aerosols from a finest modeling perspective (snapshot from GEOS-5 model for airborne particles).

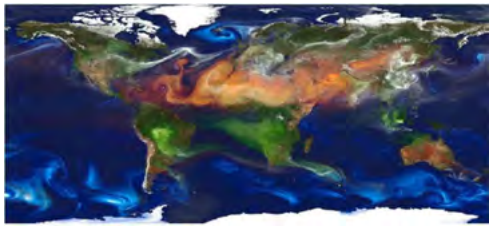

Figure 1. Dust, red, lifted from arid land areas; sea salt, blue, transported by wind over oceans and seas; smoke, due to fires; sulfate particles, white, due to fossil fuel combustion and oxidation of SO2 due to volcanoes. Credit: William Putman & Arlindo da Silva, NASA/Goddard (taken via Ralph Kahn, EOS/AGU, 13/6/2023).

Other data, not displayed here for brevity, will show in the presentation significant warming trends over the Mediterranean area for the last 60 years and longer. Moreover, related trends in vine-grapes growing and picking in Croatia shall be discussed in terms of Growing Degree Days, GDD; Fig. 2 displays typical examples of GDD positive trends.

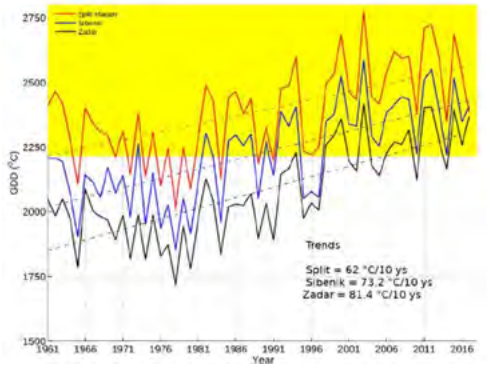

Figure 2. GDD trends for three microclimates, northern-to-central Dalmatia, Croatia.

We conclude that the speed and acceleration of the recent global and regional climate changes must be accounted for in most of human activities and especially so in agriculture.

Key words: aerosols, positive climatic trends, viticulture

AGRICULTURE CHALLENGES TO CLIMATIC CHANGES: HARNESSING SCIENCE AND TECHNOLOGY IN ISRAEL

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Abstract

Israel, like most countries in the world, is facing major changes in climate patterns which severely impact the agriculture production and food supply. This small country is characterized with diver's climate zones (arid, semi-arid, subtropical and temperate) which enable to follow the changes in many crops and environments. The R&D sector of the Israel Agriculture industry consist of academic and research institution as well as small and mid-size companies, all geared up to address the problems rising from the situation. The R&D activities are in the main directions: Increasing the resilience and tolerance of various crops; optimization of water recycling and use; Reducing losses along the supply chain of the agriculture produce; Development sustainable cultivation practices including Precision and Regenerative Agriculture. The outcome of this effort will contribute to the Israeli Agriculture as well as other countries where farmers are straggling against these challenges. Approaches, direction and examples will be presented.

Key words: climate changes, Israel agriculture, harnessing science and technology

LONG TERM APPLICATION OF SOIL BIOSTIMULANT POSITIVELY CONTRIBUTES TO THE SOIL HEALTH AND CROP PRODUCTION

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Abstract

Soil is the most important resource for crop production systems and to fulfil human demands for food. Soil health refers to the biological, chemical and physical characteristics of the soil which is crucial for sustainable agriculture. Soil management is very important for plant growth and quality. However, various environmental factors and agricultural practices can lead to the degradation of soil health and eventually impact on crop production capacity. For instance, the poor management of the soil leads to the loss of humus which create several issues like soil compaction, losses in soil fertility, and increased erosion. Several agricultural practices were shown to positively conserve the soil and thus, there is an urgent matter to protect the soil via environmentally friendly techniques. Biostimulant also could play a major role in improving the soil health and keep the soil fertile by triggering numerous physiological processes.

In this regard and in collaboration with The Croatian Soil Tillage Research Organisation, an attempt was undertaken to test the effectiveness of one of the commercialised soils biostimulant on soil health and plant productivity. In brief, a long-term research experiment (6 years) was designed in the South Eastern Croatia (Cacinci), where we investigated the cross talk between 3 different soil tillage practices (standard, reduced and conservation tillage) with a soil bio- stimulation benefiting from Mineral Inducer Technology (MIP).

The results showed that the type of tillage has an influence on soil characteristics like the humification process. In addition, we observed that the application of MIP technology increased the soil microbial activity and increased rooting depth and density. This could force faster organic matter production which eventually boosts the capacity of the soil to provide more nutrients for the plants.

Altogether, our results demonstrated a positive effect of the soil biostimulant on the health of the soil and this could encourage the farmers to seriously consider the use of biostimulants to avoid soil degradation.

Key words: Soil tillage, plant nutrition, humification, and soil microbiota

THE POSITIVE CONTRIBUTION OF SILICON AND ALGAE-BASED BIOSTIMULANTS TO SUSTAINABLE AGRICULTURE IN THE CURRENT CLIMATE CHANGES

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Abstract

Climate change is one of the major challenges to agriculture and is considered a global threat to food and nutritional security by hampering agricultural growth.

According to the Intergovernmental Panel on Climate Change, (IPCC) climate change affects crop production in several regions in the world.

Carbon footprints (CF) are considered as an important indicator of greenhouse gas (GHG) emissions. Agriculture releases large quantities of CO2 largely from microbial decay or burning of plant residues and soil organic matter. Fertilizers have become an essential part of our global food supply chain to satisfy the demand from growing populations. However, fertilizers can also contribute to significant GHG emissions along with other potential nutrient losses in the environment. Novel technologies from the fertilizer industry offer the opportunity to develop new types of fertilizers which could potentially increase nutrient use efficiency in agriculture whilst simultaneously reducing the negative impacts of nutrient applications to the environment.

In this regard, seaweed aquaculture offers a slate of opportunities to mitigate and adapt to climate change and help reduce agricultural emissions. An ever-expanding body of research in the literature shows the great potential of algae-based biostimulants to contribute to sustainable agriculture in the face of the threat from current and future changes to our climate, particularly with their ability to mitigate abiotic stresses and in removing CO2 from the atmosphere.

During the 1st International Scientific Conference - Agricultural Challenges to Climate Change – we will present a series of promising results obtained from the application of patented silicon and algae-based biostimulants. The focus will be on different ongoing applied scientific research projects by OLMIX and the data which shows how the application of algae-based biostimulants can positively contribute to sustainable agriculture.

Key words: Abiotic stresses, crop production system, and global warming

IS IT POSSIBLE TO PROTECT THE NATURAL RESOURCES WITHIN THE ECOSYSTEMS ASSOCIATED WITH LIVESTOCK FARMING IN MAGALLANES? A THEORICAL APPROACH.

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Abstract

Livestock production in Magallanes, focusing on extensive and non-set stocking livestock production, has contributed to the degradation of the Patagonian ecosystem. The absence of grazing targets that consider forage species phenology and edapho-climatic constraints has resulted in a decrease in livestock numbers, increased soil erosion, and loss of biodiversity. To reverse this situation, we propose shifting away from extensive production towards ecological intensification. The objective of this work is to present a feasible method for ecological intensification in the Magallanes region. The first step is to specialize production by considering the humid zone of the region for lamb production and the arid zones for fine wool. This will avoid overestimating the stocking rate in the region. The next step is to utilize Vegas (wetland meadows) - concave areas protected from winds - for more intensive agricultural management during late spring and summer months. Depending on the soil type of the Vega (mineral versus organic), it can be used for establishing fodder crops or for intensive rotational grazing. This grazing should be designed to stimulate the Vega's growth and survival during abiotic and biotic stresses. Ecological intensification would allow the movement of large numbers of animals from the surrounding degraded ecosystem (Pampa), giving it a rest and promoting recovery of its soil functions. Higher animal density would increase the concentration of feces and urine, promoting nutrient recycling and improving soil fertility and physical quality organically. The scale of decision-making must be taken into consideration, such as regional, ranch, or paddock level (Figure 1). Intensification, to be ecological, must be developed taking into consideration the ecosystemic functions. Clear utilization targets for the ecosystems should be studied within the region, including 1) organizing productive sectors for circular economy, 2) evaluating ecosystem functions to determine the effect of ecological intensification, and 3) considering forage defoliation criteria that encourage regrowth and survival during environmental constraints, animal welfare, and soil quality index.

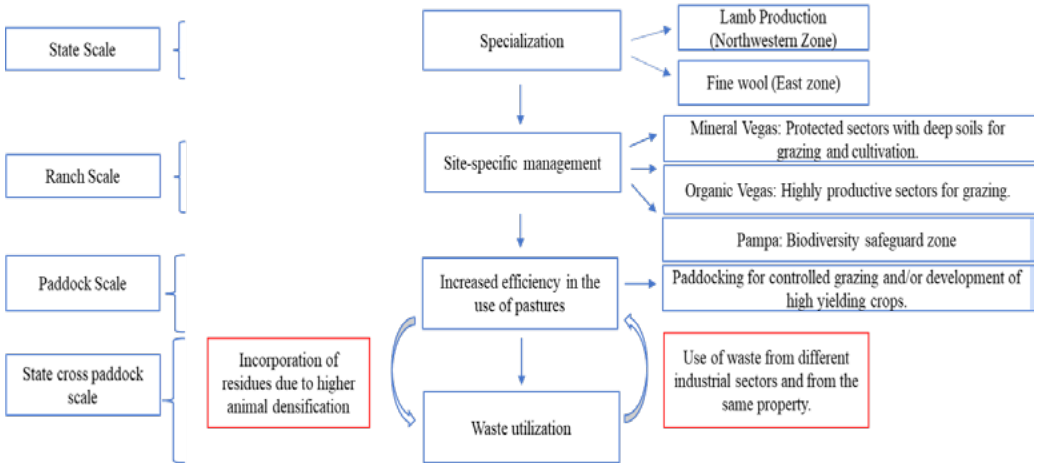

Figure 1. Ecological intensification system for Magallanes.

AGROFORESTRY PRACTICES IN EASTERN CROATIA

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Abstract

Agroforestry is a combination of forestry and agriculture. It implies combining permanent plantations of woody crops with arable crops or domestic animals on the same production area. By introducing woody species to agricultural fields, we directly affect the temperature, humidity, insolation and wind flow inside the field (microclimate), which results in a greater resistance of crops to stressful conditions such as climatic extremes (drought, flood).

Agroforestry systems most often refer to keeping livestock in the forested pastures (silvopastoral agroforestry), intercropping of arable crops in between tree lines (alley cropping), tree belts protecting agricultural fields or water bodies near agricultural fields (windbreaks, riparian buffer stripes) or establishing fast growing tree species on degraded agricultural soil with the aim of soil improvement (improved fallow). Such agroforestry systems have shown to be more resilient to the negative effects of climate extremes than conventional agricultural systems.

These advantages of agroforestry have been recognized in Europe as well as in Croatia. So today, in the eastern part of Croatia, Osijek-Baranja County, several examples of agroforestry systems can be found. Mainly these are silvopastoral systems where Black Slavonian Pig is kept in pastures with oak and ash trees. Four such locations have been reported so far (Eblin, Borovik, Slatnik Drenjski and Majar). One example of alley cropping can be found near the Osijek airport where crops are sown in 24-meter-wide alleys of short rotation coppice (SRC) – black locust, willow, and poplar. Furthermore, there are several examples of establishing SRC stands on small parcels of agricultural fields (around 0.5ha parcels). As demand for woody biomass increases, we can expect the increase of such stands on degraded soils more and more.

In conclusion, the negative effects of climate change can be reduced by establishing agroforestry systems and therefore we can expect an increase of such systems in the near future.

Key words: alley cropping, short rotation coppice, silvopastoral agroforestry

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CROP RESIDUES MANAGEMENT AS ONE OF THE MAIN FACTORS OF CONSERVATION AGRICULTURE

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Abstract

Crop remains represent not only valuable resource of many organic compounds in soil, but also represent medium for different and very complex aspects of soil/crop/environment relations. Today exists different approach to crop residue management: Historical (traditional) aspect which presume that crop residues represent all useless agricultural plant waste that disturbs agricultural areas and prevents the smooth implementation of agricultural field works and Contemporary (modern) aspect with definition that crop residues represent all agricultural high-value plant material, with potential economic and agroecological value.

Nowadays, crop residues are one of the most important factors of Conservation Agriculture (CA) as measure of adaptation to Climate change, with many benefits for the both, soil and environment. CA is based on three basic principles: a) minimal soil disturbance, b) permanent soil surface cover (with crop residues) and c) crop diversification (crop rotation). All three basic principles are interconnected by crop residues on different ways and levels, as it: way and intensity of soil tillage, mass and type of crop residue, type of crops, biological yields, harvesting quality, activity of soil biology, soil chemical and physical quality, agroecological conditions, etc. The field experiment with different conservation tillage systems, different fertilization and soil conditioners, and different crops in rotation was conducted in 2021 in Čačinci and Križevci. Tillage treatments were: ST (plowing), CTD (conservation deep, loosening up to 30 cm with a minimum of 30% of crop residues on the surface) and CTS (conservation shallow, tillage up to 10 cm with a minimum 50% of crop residues on the surface). Method for estimation of residue cover (in %) was line-transect method, and it was performed after all soil tillage operations and after sowing next crop. After first three years of research (maize was grown in first, soybean in second and winter wheat in third year) percentage of crop residue was higher than is expected, but in expected distribution. Higher soil covering was in Križevci than in Čačinci and according treatments as follows: CTS>CTD>ST. Basic paradigm in CA, related to crop residues, are in facts that CA is more efficient as higher amount (percentage) of soil surface is covered by crop residues.

Key words: crop residue management, conservation agriculture, climate change, residues estimation

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POTENTIAL OF CONSERVATION AGRICULTURE PRINCIPLES AS RESPOND ON CLIMATE CHANGES IN CROP PRODUCTION

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Abstract

Questions about soil degradation and how can we prevent its degradation, today is one of the most important aspects of human existence on global, regional and especially on local levels. Soil is most vulnerable natural resources and its quality status directly and indirectly influence human possibilities in food production.

Climate change (CC) has usually negative impact on quality of soil and agricultural land and on its productivity potential on different way, level and intensity. Basically, soil degradation processes are the most visible as direct impact on its physical, chemical and biological properties, but also as indirect impacts with consequences mainly in social and economic aspects. "Usual" degradation processes such as: erosion, drought, decrease water holding capacity, loss of soil organic matter (SOM), decrease of biodiversity are additional aggravates by CC and leads to desertification. Unfortunately, each degradation process is closely connected with many others and usually influence them on many different ways.

Conservation agriculture (CA) is one of the most effective, the most useful and the most promising global platform (but also on regional and local scale) as answer on CC in crop production. But really question is how does CA actually work?

CA is generally based on three interconnected and undivided pillars: a) soil mechanical disturbance in minimum, b) permanent soil surface cover with crop residues, c) crop rotation (species diversification + intercropping). With correct approach in application, (which means application of all these elements on proper / optimal way depending on agroecological conditions) it is possible to achieve and ensure the optimal conditions in crop production. This method can also ensure minimal soil degradation.

Application of Conservation Soil Tillage (CST) ensure minimal 30% (up to 100%) soil surface covering by crop remains and they have a few basic functions: prevent soil erosion (by wind and water), preserve soil moisture, increase soil biogenicity and biodiversity, decrease soil temperature aberration, preserve or increase soil organic matter.

Key words: conservation agriculture, climate change adaptation, crop production

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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 POTENTIAL OF TRICHODERMA SP. IN BIOCONTROL OF FUNGAL PLANT PATHOGENS

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Abstract

Biological control of diseases and pests in agriculture production involves the use of microorganisms, insects, plants, or their metabolites. Biopesticides in crop protection represent an alternative to chemical pesticides, which are toxic and slowly degradable, contaminate the soil, water, and air, and act on non-target organisms. Microbial pesticides contain highly effective strains, and their application is environmentally acceptable, the crop quality is improved, with minimal impact to human and animal health. One of the United Nations Sustainable Development Goals is dedicated to sustainable agriculture, also European Green Deal strategies involve the reduction of chemical pesticides and biopesticides are keys for sustainable soil management. Numerous scientific studies have confirmed the antifungal properties of the soilborne fungi Trichoderma spp. The antagonistic potential of genus Trichoderma can be used in the control of Fusarium pathogens of different crops in Croatia and worldwide. Fusarium spp. are also producers of mycotoxins of different spectrums of toxicity. The aim of this study was to determine the antagonistic activity of Trichoderma sp. and efficiency in the growth control of two strains of Fusarium verticillioides and Fusarium graminearum, in vitro. The results of the research determined a statistically significant inhibition of F. verticillioides ranging from 55 to 62%, while the inhibition of F. graminearum ranged from 26 to 38%, however, no statistically justified significance was determined. Considering the great potential of the Trichoderma genus, further research is needed to find, reisolate and identify strains with strong antifungal activity.

Key words: biological control, microbial pesticides, Fusarium verticillioides, Fusarium graminearum, Trichoderma sp.

EFFECTS OF LEGUMES AND FALLOW ON SOIL AND YIELD SPRING CROPS

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Abstract

Several European Union policies (e.g., Green Deal, Climate law, Biodiversity Strategy 2030, Farm to Fork) have a goal to transform the agricultural systems and one of the goals is fertilizers reduction. Nature based solutions (e.g., green manure) can help in restoring soil quality for enhanced agricultural productivity and sustainability. Three-year research (on the Dalibor Jurina family farm in Veliki Zdenci, Bjelovar-Bilogora County) was conducted to test real fallow and green fallow on the improvement of the soil quality. Experiment is conducted in random block layout with four treatments (I. black fallow; II. Black fallow + green manure; III. Crops (2021-corn; 2022-soybean and 2023-potato) + green manure; IV. same crops without green manure on plots of 10 x 35 m in four repetitions on Pseudogley on the plain in semi-humid conditions. Results confirmed that green manure affects changes in the soil reaction, the stability of structural aggregates, and C/N ratio. Soil compaction is reduced in green manure plots over a period of two years (autumn 2020 - autumn 2023). The correlation between green manure and the soil physical properties has not been confirmed. Moreover, there is no correlation between green manure and maize yield in the first year of the study. Results reveal that the maize yield was lower in the treatment where green manure was applied. In the second year of the study, the yield of soybean was higher in the treatment with green manure. It is necessary to continue research in order to determine changes in physical and chemical properties and to observe the influence of green manure on them, as well as on the yield of cultivated crops.

Key words: green manure, fallow, soil, yield

THE ROLE AND IMPORTANCE OF THE AGMEMOD MODEL IN MONITORING AND EVALUATION OF THE CAP IN THE REPUBLIC OF CROATIA

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Abstract

The AGMEMOD (AGricultural MEmber State MODelling) model is a dynamic, multiproduct, and multi-country partial equilibrium model with an econometric foundation. Its primary objective is to generate medium-term simulations or market outlooks for key agricultural products up to the year 2030. As an integral component of the iMAP (Integrated Modelling platform for Agro-economic and resource Policy analysis) platform, the AGMEMOD model plays an important role in facilitating the implementation, monitoring, and evaluation of the Common Agricultural Policy (CAP), considering its economic, environmental, and climate change objectives.

The objective of this paper is to provide medium-term scenario simulations of the anticipated changes in key cereal market indicators in the Republic of Croatia, resulting from the new policy reform within the Common Agricultural Policy (Strategic plan). Simulations will examine the effects of political changes on the soft wheat, barley, and corn markets in the Republic of Croatia. The results will showcase variations in yield, production, and net trade resulting from modifications in measures, instruments, and budget implemented as part of the CAP Strategic Plan for Croatia until 2030.

Based on the model's findings, the future scenario simulation under new CAP reform for key cereal markets in Croatia remains favorable, with positive trends expected in terms of yields, production, and net trade.

AGMEMOD, along with other advanced tools available in the iMAP platform, serves as a highly valuable foundation for evaluating the effects of policy reforms on key agricultural product markets. These results also indicate that Croatia's cereal sector is resilient and competitive.

Key words: AGMEMOD, iMAP, medium term simulation, cereals market, Republic of Croatia

VALUE CREATION AND ECOSYSTEM SERVICES OF EUROPEAN SEAWEED INDUSTRY BY REDUCING AND HANDLING POTENTIALLY TOXIC ELEMENTS (PTE) FROM BREEDING TO SOIL

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Abstract

The new BlueBio project – SeaSoil will deal with pressing issues regarding utilization of the blue biomass, seaweed, to promote a sustainable and competitive blue bioeconomy in Europe. The low trophic seaweed may significantly contribute to the food system as well as the carbon sequestration and storage (CSS) in agricultural soil when potentially toxic elements (PTE) of e.g., inorganic arsenic (As), cadmium (Cd) and iodine (I) can be managed safely in the food supply system.

The project is a consortium of ten European partners from Norway, Ireland, Denmark, Estonia, and Croatia. The project goals will be reached through six work packages. The project goals are: a) to estimate heritability's and genetic correlations in contents of Cd, As and I in sugar kelp, b) to study the impact of seaweed application rate and water saturation on the As dynamics in the soil to determine chemical reactivity and potential bioavailability of labile As, c) to estimate the potential of seaweed amendments for CSS in agricultural soils, d) to study the impact of seaweed production on the environment using LCA, and conducting a cost-benefit analysis of the seaweed industry, e) to study the economic feasibility, and regulatory incentives, for production and use of (residual) biomass from farmed seaweed and f) to ensure the multi-actor approach and integrated cooperation, communication and human capacity building in line within Responsible Research and Innovation (RRI).

The overall goal is to investigate the potential of using seaweed in agriculture where the Faculty of Agrobiotehnical Sciences has the task of studying soil respiration of soil amended with seaweed as well chemical and physical soil properties of such amended soil.

Key words: BlueBio, seaweed, agriculture, carbon sequestration, PTE

SHOULD THE USE OF FERTILIZERS WITH 60 MG CD PER KG PHOSPHORUS PENTOXIDE BE ALLOWED IN CROATIA?

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Abstract

Cadmium (Cd) is a toxic element that accumulates in soils and living organisms, and its presence in the soil is largely a consequence of the use of phosphate fertilizers. Cd content in organo-mineral fertilizer having total P content of 5% (in P2O5 equivalent) was limited at 60 mg kg–1 P2O5 by the EU Regulation 2019/1009, but 12 EU countries have a Cd threshold between 20 and 50 mg kg–1 P2O5. Should such a high concentration of Cd in fertilizers be allowed in Croatia, especially considering soil health protection and safe food production?

Data on soils and production in Croatia indicate that high Cd concentrations should not be allowed for at least 4 reasons: 1. arable soils in Croatia contain very low conc. of Cd as a comparative advantage; 2. about 50% of the soil were poor in P or has increased acidity, and an increase in Cd content would particularly burden such soils; 3. crop products in Croatia contain low Cd and it is not acceptable to increase the Cd in the agroecosystems; 4. increased input of Cd in soils will increase the Cd in the edible part of plants, possibly even up to critical values.

The total conc. of Cd in arable soils in eastern Croatia were 0.09-0.97 mg kg-1 (avg 0.34), whereas on highly acidic soils (pH KCl <5) 0.13-0.49 (avg 0.27), on acidic soils (pH 5-6) 0.11-0.59 (avg 0.34), and on neutral and alkaline soils 0.09-0.97 (avg 0.39). With such low Cd, there is apparently no need to worry about the Cd in fertilizers, because it would take > 1,500 years to increase Cd from an avg 0.34 to 1 mg kg-1 with an annual rate of 75 kg ha-1 P2O5 with 20 mg Cd kg-1 P2O5. But, if the fertilizer contains 60 mg Cd kg-1 P2O5, 590 years will be enough with the application of 75 kg ha-1 P2O5, and "only" 295 years with the application of 150 kg ha-1 P2O5.

However, are we allowed to compare only the concentration of Cd in soil and the maximum conc. allowed? Namely, some models imply that for safe food production, the total Cd in the soil should be significantly lower, like around 0.5 mg Cd kg-1 or even lower for growing on very acidic soils. If so, 104 years would be enough for 150 kg ha-1 P2O5 annually (60 mg Cd kg-1 P2O5) to increase the Cd level from avg of 0.27 to 0.5 mg Cd kg-1.

Also, a very significant risks could be the accumulation of Cd in the grain, for example the wheat grain (eg. 0.02-0.04 mg Cd kg-1 was determined in Croatia). If grain additionally accumulates only 1% of added Cd (60 mg Cd kg-1 P2O5) at 150 kg ha-1 P2O5, this could result in an additional 0.015 mg Cd kg-1 in wheat or barley grain, and 0.030 in sunflower or soybeans. Five-year fertilization could seriously jeopardize the quality of the grain. The soil tests in Croatia emphasize these risks since about 50% of the soils were poor in P or has increased acidity.

On the other hand, there is no single reason that would justify the need to use fertilizers with 60 mg Cd kg-1 P2O5 if we can require 20 mg Cd kg-1 P2O5. After all, why wouldn't fertilizer producers use decadmiation of P raw materials?

Key words: acid soils, Cd accumulation, healthy food, low Cd, soil health

MAPPING OF SOIL SPATIAL VARIABILITY BY SOIL SAMPLING IN OPTIMIZED SAMPLING GRID

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Abstract

Describing the heterogeneity of soil properties is crucial for precision agriculture, but achieving this goal is very time-consuming and costly. Traditional methods are insufficient for land with high spatial variability, thus digital soil mapping methods by implementation of sensor measurement are used. The combination of traditional and sensor methods aims to optimize the sampling network and to guarantee a sufficiently accurate mapping of soil conditions, such as soil nutrient content maps. The number of sampling points depends on the preliminary analyzed soil heterogeneity. The aim of this study is to evaluate the spatial variability of the agrochemical properties of arable soils in a selected area and to assess the application of site-specific crop management.

The study is realized within the research projects NAZV QK21010247 and AF-IGA2023-IP-038. The soil sampling was carried out in 2022 on the arable land of the farm company Rostěnice a.s. in the locality of South Moravia (Czech Republic, EU). This is a warm, moderately wet to dry region, the soil type is most commonly chernozem modal, followed by haplic Luvisol and rendzina. The total number of 1018 soil samples were collected in an irregular grid from an area of 1838 ha; the average density of the sampling network was about 1 sample per 1.8 ha. The sampling grid was created by cluster analysis of production zones, which represents relative yield potential of the soil, and bare soil mosaic. Both input layers are computed from satellite data (Sentinel-2). The sampling was carried out using an automatic sampling machine (Nietfeld N2006) from a depth of 0-30 cm after harvesting the crops (winter barley, winter rape, spring barley, winter wheat and soybean). A single composite sample was composed of 10-15 subsamples collected in a circle up to 15 m in diameter. A Trimble CFX 750 GPS with RTK was used to accurately locate the sampling points. Soil samples were analyzed in laboratory according to the Mehlich III methodology valid in the Czech Republic to determine the content of available nutrients P, K, Mg, Ca, B, Mn, Zn, Cu and also pH value. As the next step, a continuous map of the soil properties with the spatial resolution 5m per pixel were computed in ESRI ArcGIS by using spatial interpolation techniques Empirical Bayesian Kriging.

Preliminary analysis of the results showed significant differences in available nutrient content and pH values between the monitored plots and sampling sites. In the case of soil exchange reaction values, the range of pH values was from 4.5 to 7.9 with an average pH value of 7.3, indicating an alkaline soil reaction. The summary results for each nutrient showed that the phosphorus content of the soil is at a lower level as the average content is 58 mg.kg-1. Attention should be paid most to the areas with extremely low contents and significant het-

erogeneity, which indicates the importance of variable rate application of phosphorus fertilizer. After mapping the soil phosphorus supply using interpolation methods, it was found that 39% of the study area had a low phosphorus content and 53% had a satisfactory content. In the remaining 7% of the area the content was good and only 1% had a high content. When looking at the plot level in detail, some of the plots are homogeneous as they show the same class of supply over the whole area. However, the majority of the parcel shows high heterogeneity as at least three of the five classes are present. The content of other macro-elements (K, Mg, Ca) is at a very good level with less variability. Potassium has a good supply (260 mg.kg-1), magnesium a high supply (343 mg.kg-1) and calcium a very high supply (7812 mg.kg-1).

The results show the need for variable rate application of fertilizers, which will be adapted to the high spatial variability of soil conditions and, at the same time, the differences in yield levels within individual plots. This approach is gradually being introduced into the crop management technologies of the farm company Rostěnice a.s.

Key words: precision agriculture, digital soil mapping, soil sampling, variable rate application

Acknowledgement

The results presented in the paper are an output from research projects 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 AF-IGA2023-IP-038 „Use of digital soil mapping methods for evaluation of spatial heterogeneity of soil physical and chemical properties".

FROST RISK IN CURRENT AND FUTURE CLIMATE

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Abstract

Many studies showed a great impact of frost on crop reduction. In 2016 in Croatia, according to the data from the Ministry of Finance, more than 50% of economic losses were caused by frost. Agriculturists need information about changes in the number of days with frost, as well as the last days with frost in spring, not only in the current climate but also in the future climate. For this reason, in the period from 1981 to 2020 the changes in the number of days with frost were analyzed. It is determined: (i) the last day with frost in spring, (ii) the first frost day in autumn, (iii) and duration of the vegetation season. By using regional climate models, the change in the observed occurrence of frost is compared between present and future climate until the end of the century.

Results show a decrease in the number of days with frost in the period 2001-2020 compared to the 1981-2000 period in coastal areas, as well as in the eastern part of Croatia. In these areas, it is evident that, in the recent period, we have 10-20 fewer days with frost. In the coastal area, the last spring day with frost occurs mostly by mid-March. The risk of spring frost is higher in the continental area, where, despite the reduction in the recent period 2001-2020, the last day with frost in spring most often occurs in mid-April. Further reduction of 15-40% of days with frost, in regards to the period 1971-2000, is expected in the future, and an additional shift of last spring frost day up to 20 days in certain areas. Although the reduction in the number of days with frost is good news for some farmers, these changes in the occurrence of frost do not have such an effect on reducing the risk of damage caused by frost on some fruits. Due to the earlier onset of budding and flowering, some fruit trees could have even a greater risk of a reduced yield due to frost in the future.

Key words: frost risk, spring frost, climatology, regional climate models, climate change

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EFFECTS OF CLIMATE CHANGE ON THE HABITAT DIVERSITY IN KOPAČKI RIT NATURE PARK (CROATIA)

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Abstract

Climate change and habitat loss are key threatening processes driving the global loss in biodiversity. Kopački Rit Nature Park is a fluvial-marshy floodplain situated in north-eastern Croatia around the confluence of the Danube and the Drava Rivers. Due to its biological and ecological values, this area has been protected since 1967, and proclaimed a Nature Park in 1999. It is designated as a Ramsar site, Natura 2000 ecological network site, and part of the UNESCO Five-country Biosphere Reserve Mura-Drava-Danube. The appearance of the whole area and an overall biodiversity depends on the flooding intensity of the Danube River. The spatial distribution of 89 recorded terrestrial, wetland and aquatic habitats of the natural, semi-natural and anthropogenic origin is in permanent dynamic exchange, depending on frequency, intensity and duration of floods, as well as drought periods.

Based on records collected during two decades of field surveys, from 2003 to 2022, the presence and distribution of habitats and vegetation units in Kopački Rit Nature Park had been analyzed. Prolonged drought period and low water level abruptly change composition of the vegetation and stimulate growth and dispersion of amphibious communities (alliance Nanocyperion) on muddy or sandy bottoms of dried swamps, channels and fishponds. It was highly pronounced during the extremely dry summer in 2003, when large channels Čonakut and Hulovo were dried out, and followed in 2012, 2015, 2018, and 2022.

Flood occurrence and longer duration of high-water levels in the warm summer period provide optimal conditions for growth of freely floating (order Lemnetalia) and rooted and floating-leaved aquatic vegetation (order Potamogetonetalia). This was pronounced in summer period in 2011, 2013, 2016, 2019, and 2021, when the most of the flooded area was filled with water. Since the water outflow was rather slow, high air and water temperature stimulated profuse growth of the freely floating aquatic vegetation on the water surface.

The functioning and stability of habitats in Kopački Rit Nature Park are threatened by increased fluctuations in flooding intensity of the Danube River, lack of rainfalls, increased summer air temperatures, prolongation of dry season, accumulation of bedload, the spread of invasive species, and natural succession of the wetlands.

Key words: habitat, flood, Danube, Kopački rit

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THE IMPORTANCE OF ALFALFA AS A MULCHING MATERIAL IN THE CARBON SEQUESTRATION TECHNIQUE

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Abstract

Greenhouse gases have different global warming potential, and anthropogenic activities contribute to their emission. The agricultural sector accounts for more than 10% of the total emissions of all gases, and carbon dioxide is the most common greenhouse gas. Measures to mitigate climate change in the world include carbon sequestration, which involves storing atmospheric carbon dioxide through plants (photosynthesis) in biomass and soil. The aim of this paper is to highlight the importance of alfalfa (Medicago sativa L.), a perennial legume, as a carbon sequestration factor in the agricultural production. In areas with a moderate continental climate, alfalfa is primarily grown as forage crop due to its high nutritional value, and secondarily as a sequestration technique due to the large amount of organic matter. Alfalfa has the ability of symbiotic nitrogen fixation by root nodule bacteria from the genus Rhizobium. Bacteria take the sugars produced by photosynthesis from the host plant and in the process, they provide the ammonium form of nitrogen for the plant, which contributes to the development of plant biomass. Mulching is an agrotechnical measure of covering the soil with organic or inorganic materials in order to protect the soil from the negative effects of atmospheric phenomena. If alfalfa is used as mulching material, it can provide multiple benefits to the crop, such as: weed control, soil moisture conservation, soil erosion protection, increasing soil nitrogen content, reducing the need for fertilization, preventing diseases and enriching the soil with organic matter which is very important in carbon sequestration. As a nutritionally rich legume, alfalfa used as mulch can significantly affect soil quality, so it is not unusual to use it as a carbon sequestration technique. In the Osijek - Baranja County, carbon sequestration is not a frequent practice, so it is necessary to continue research on the potential of alfalfa as an organic mulch in carbon sequestration.

Key words: greenhouse gases, organic material, perennial legume, nodular bacteria

Acknowledgement

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ANALYSIS OF THE PÁLFAI DROUGHT INDEX FOR HUNGARY FOR 1975–2100

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Abstract

The aim of the present study is to analyze the Pálfai drought index (PaDI) for Hungary, as it shows a strong connection with crop yields. For the calculations the observation-based, homogenized and interpolated dataset, the so-called HuClim is used for the historical period (1975–2022). Beside the past trends, estimations for the future are also made by using six regional climate model simulations from the EURO-CORDEX data. In order to take into account the uncertainty arising from the anthropogenic factors (e.g. greenhouse gas emissions, land use changes, population), three different RCP scenarios (i.e. RCP2.6, RCP4.5, RCP8.5) are taken into consideration. We calculated PaDI with the three correction factors, therefore, monthly temperature and precipitation data were necessary beside the elevation information. In order to eliminate the systematic errors of the regional climate models' simulations, a simple delta-correction is applied to the calculated index values. Based on PaDI, seven categories can be distinguished: from droughtless to extreme drought.

Our results show that the greatest drought occurred in 2022 in Hungary considering the past 48 years. 1992 and 2003 also showed high PaDI values based on the spatial means. The number of droughtless years will decrease by the end of the 21st century, in the case of the RCP4.5 and RCP8.5 scenario according to the investigated simulations. Medium strength drought is likely to be more frequent in 2061–2080 and 2081–2100, especially in the case of RCP8.5. Considering the spatial distribution, the plain areas are the most exposed to droughts.

It can be concluded that if the RCP8.5 scenario is followed, then drought conditions will be more severe in Hungary, especially by the end of the 21st century. In order to mitigate the potential losses in agricultural production due to drought conditions, mitigating climate change is inevitable and adaptation to the modified conditions is also necessary.

Key words: precipitation, HuClim, climate change, EURO-CORDEX, RCP scenarios

Acknowledgement

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THE ROLE OF BIOSTIMULANTS ON YIELD COMPONENTS AND QUALITY CAPACITY OF SUGAR BEET IN UNFAVORABLE CLIMATIC CONDITIONS

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Abstract

The aim of the study was to determine the influence of biostimulants on growth, yield components and quality capacity of sugar beet grown in the open field. Following parameters were monitored: leaf analyses, yield and yield components (brix), soil analyses (before and after trial). The trial was carried out in an open field in municipality Ivankovo and sugar beet variety Fred Strube was sown. In the trial, the following treatments were applied: control and biostimulant LL02 in two different doses (8.5 ml L-1, 16 ml L-1) at different stages of sugar beet development. All soil and plant analyses were done in Laboratory for soil and plant analyses at Faculty of Agrobiotehnical Sciences Osijek Croatia during the 2021.

Spring in 2021 was cold and humid and April was significantly colder than usual, and May was characterized by very changeable and relatively cold weather. The summer of 2021 was marked by five heat waves. The mentioned weather conditions strongly influenced the vegetation of sugar beet, so the sowing of sugar beet was carried out in April and the harvest even in December. The soil in trial plots in Ivankovo was slightly carbonate, moderately supplied with humus. The phosphorus content was high and the potassium content was moderate. The analysis of the yield components and sugar content in the trial with sugar beet showed that all the investigated parameters were influenced by the treatment (Figure 1).

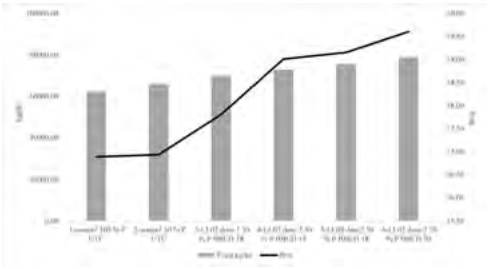

Figure 1 Sugar beet yield and content of sugar (°brix) in trial treatments

Namely, the yield and sugar content were significantly higher on treatments with biostimulants and ranged from 69 860 at control to 78 830 kg ha-1 on treatment with biostimulants. The sugar content of the same treatments ranged from 17.81 to 19.60 °brix.

The use of biostimulants had a statistically significant effect on the yield and quality of sugar beet, which indicates that the use of biostimulators has a positive effect on the increased of nutrients uptake in unfavorable climatic conditions.

Key words: biostimulants, sugarbeet yield and quality, climatic conditions

Acknowledgement

The results presented in the paper are an output from research projects EU Life 2019/2022 PFP (Plants for Plants) „LL004, LL002, LL017 application efficiency in apple, pear, wine grape, and sugar beet field production - A trial study for PUE and WUE in Croatia 2019-2022".

INFLUENCE OF GLOBAL WARMING AND HEAT STRESS ON EQUINE REPRODUCTION

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Abstract

The aim of this paper is to describe, compare and discuss recent references about global warming with its consequences and management options present in equine reproduction strategies.

Global warming is a phenomenon that is getting more and more attention every day resulting in fear and causing great level of concern of all mankind. It represents gradual warming Earth's surface and lower layers of atmosphere. Average global air temperature has rapidly increased within a last few decades leading to dire consequences for life on Earth. Climate change greatly affects the health and quality of life of both humans and animals, as well as plants, unadjusted to these changes. Horses, as a long day breeder have found themselves facing an evolutionary challenge since their reproduction depends completely on long days i.e., late spring and summer months. Since their optimal comfort zone is in between atmosphere temperature +5°C till +25°C, gradual increase for a few grades, leads to heat stress when horses are in the most vulnerable phase of their reproduction and life in general (foaling, neonatal foals, mating, early embryo development, final stage of spermatogenesis) Furthermore, higher temperature levels due to global warming act as a stressor and interfere with the normal physiological functions of the body and have also indirect negative impact on reproduction.

Negative impact on both male and female reproductive system brings into question the potential survival of the species. Temperature stressors cause early changes of reproductive system and its adjacent systems which ultimately results in irregular cycles, decay of germ cells, miscarriages or mutations. Potential solutions include management strategies for relocating reproductive season earlier in the year (i.e., early spring) or enabling horses to stay within their optimal temperature comfort zone (air-conditioned stables). However, further research is needed to discover some better and more convenient solutions for this emerging problem.

Key words: equine reproduction, global warming, climate changes, heat stress

ARE PLASTIC MULCHES A SOURCE OF MICROPLASTICS AND OTHER POLLUTANTS IN THE AGROECOSYSTEM?

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Abstract

Polymers have been produced and used in large quantities for many years. They eventually end their life cycle as waste. Only a small part is recycled. Used plastic ends up in the environment, where it gradually disintegrates under the influence of natural factors, shredding it, emitting different degradation products, as well as micro- and nano-sized particles. These nanoparticles pass through cell membranes and can be detected in unexpected places. It happened because the REACH procedure was not applied to polymers because it was considered that molecules with a mass greater than 1000 Daltons cannot be harmful because due to the size of the molecules, they do not interfere with living beings and the environment. This was the case until a few years ago, when micro and nano particles of polymers (plastic masses) were discovered in all parts of the environment, including in the cells of living organisms. Research on the impact of illegal landfills in Vojvodina on the surrounding land, conducted during 2018-2022. have winged increased concentrations of phthalate esters (PE) (Stojić et all. 2023). PEs are additives that are added to polymers to improve their physical properties. PE can be indicators of the presence of microplastics in the soil. Also, in addition to PE, monomer units from which polymers are built can be found in the soil. One of the sources of microplastics are foil mulches used in agriculture for certain well-known advantages.

Plastic residues in mulched agro-ecosystems can be transported into the air, rivers, and other freshwater bodies, by wind or surface runoff, potentially impacting upon the surrounding environment. Research (Noreen et all, 2023) confirmed that plastic mulches affect the diversity of soil fauna and lead to numerous negative phenomena. Biodegradable mulches also have a negative effect on germination and plant development (Hadalay et al. 2021). For biodegradable mulches there is an International biodegradability standard EN-17033 requires 90% degradation within 2 years. In experiments (Griffin-LaHue et all. 2022) it was found that it would take 21 to 58 months to reach 90% degradation.

A "minor" omission regarding the application of REACH for the registration of polymers, has led to the situation, that particles of polymers are found everywhere. This problem must be approached seriously because there is still not enough data on the connection between the presence of nano and microplastics and the consequences of exposure to these pollutants.

Key words: mulch, microplastic, soil, pollution

Acknowledgement

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DIGITAL SCALE AS A TOOL FOR MITIGATING NEGATIVE IMPACT OF CLIMATE CHANGE ON HONEY BEE COLONY

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Abstract

In the last 20 years, summers are getting hotter and with less precipitation, which leaves very negative consequences for the melliferous plants that bloom during the summer months, so that their honey production is more and more absent. Consequently, in such conditions, the absence of nectar intake in the hive, the honey bee queen reduces oviposition and if bad weather conditions persist, the queen stops oviposition completely. This phenomenon becomes more significant when it is taken into account that it occurs at the time when the bee colony begins to breed long-lived winter bees important for its successful overwintering. In order to prevent this phenomenon, the beekeeper can artificially create the appearance of nectar intake into the hive by stimulating feeding with sugar syrup so that the queen continues with oviposition. In order to achieve this, it is necessary to timely notice the absence of nectar intake into the hive and start feeding, which can be achieved by installing a digital scale on the apiary. The aim of our research was to examine the usability of a digital scale in the early detection of the absence of nectar flow for the timely implementation of bee colony feeding measures.

The scale measures the weight of the hive several times a day and thus provides us with information about hive weight gain (nectar intake) or hive weight loss (absence of nectar intake). Here we present 2 years of research of application of a digital scale in an apiary with the aim of mitigating the negative effect of climate conditions on the biology of bee colonies. The research was carried out in Vardarac in Baranja during year 2019. (the year when the summer was characterized by temperatures and precipitation within the multi-year average and the nectar income was not absent) and year 2021. (a particularly hot summer without precipitation and the nectar income was completely absent).

The digital beekeeping scale proved to be an excellent tool for successful and quick detection of the absence of nectar income and for ensuring the normal development of bee colonies throughout the beekeeping season. By installing a digital beekeeping scale at the apiary, we can successfully mitigate the negative effect of climate change on the bee colony.

Key words: bees, beekeeping, climate change, digital scale, overwintering

Acknowledgement

The results presented in the paper are an output from PRIMA research project „Safeguarding agroecosystem resilience under climate change through efficient pollination and sustainable beekeeping (SafeAgroBee)“

IMPROVING SOIL HEALTH AND CROP PRODUCTIVITY BY UTILIZING DIVERSE AND HIGH-RESIDUE COVER CROPS

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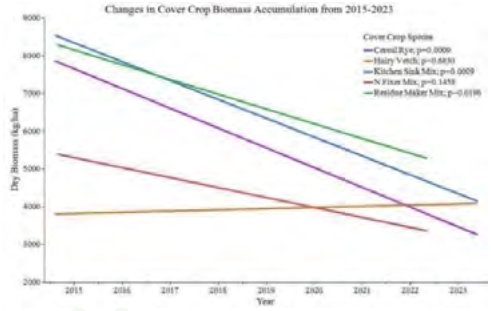
Abstract

The overall goal of this project was to document benefits of transitioning land from traditional high intensity and low biomass production to systems utilizing high-residue, diverse cover crop species. In fall 2014, we initiated a long-term study testing 12 different rotations that host a combination of cash crop sequence changes and cover crop species; which were compared to a conventionally tilled maize monoculture on a Bojac sandy loam (Coarse-loamy, mixed, semiactive, thermic Typic Hapludults).

The planting rates of the monoculture cereal rye (Secale cereale) and monoculture hairy vetch (Vicia villosa) treatments were 128.9 and 25.8 kg ha-1, respectively. The residue maker mix is comprised of 44.8 kg ha-1 of triticale (x Triticosecale), 2.2 kg ha-1 of rapeseed (Brassica napus), and 20.2 kg ha-1 of Austrian winter pea (Pisum sativum). The N fixer mix is comprised of 20.2 kg ha-1 spring oat (Avena sativa), 2.2 kg ha-1 of forage radish (Raphanus sativus var. longipinnatus), and 16.8 kg ha-1 of crimson clover (Trifolium incarnatum). Lastly, the kitchen sink mix is comprised of 9 species, which are 3.4 kg ha-1 of crimson clover, 11.2 kg ha-1 of Austrian winter pea, 4.5 kg ha-1 of hairy vetch, 11.2 kg ha-1 of spring oat, triticale, and cereal rye; and 1.1 kg ha-1 of rapeseed, forage radish, and phacelia (Phacelia).

In Spring 2015, aboveground biomass ranged from 2891 to 11729 kg biomass ha-1 in late April when desiccated, just prior to reaching physiological maturity. Mixed species cover crops and cereal rye had more biomass produced along with more N and S accumulation than other treatments. Fast forward to Spring 2023, we have noticed significant reductions in overall plant biomass produced due to a N deficiency within the overall cropping system. For instance, aboveground biomass ranged from 1324 to 6596 kg biomass ha-1 in late April 2023 when desiccated. However, unlike the mixed species cover crops and cereal rye, the monoculture hairy vetch treatments have trended upward in their biomass production over the course of this study.

We observed increases in the C:N ratios from 2015 to 2021. Monoculture cereal rye (19:1 to 42:1) and the grass dominant, residue maker mix (17:1 to 44:1) increased 119% and 157%, respectively. Whereas we saw minimal increase in the C:N ratio of monoculture hairy vetch (10:1 to 13:1).



In conclusion, when reducing N fertilizer inputs, especially when growing non-legume cover crops, system N deficiencies can severely impact your cover crop biomass production and N availability due to higher C:N ratios of the cover crops.

Key words: Cover crops, Nutrient cycling, Mixes, C:N ratio, Biomass

WEED OCCURRENCE IN SOYBEAN UNDER DIFFERENT CONSERVATION TILLAGE AND LIMING

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Abstract

Conservation tillage plays a crucial role in addressing the challenges of climate change. The field experiment was conducted in Čačinci, Croatia (17°86'36'' E, 45°61'32''N, 111 m a. s. l.) in 2022, using a split plot design with three replications. The main treatment focused on soil tillage, while liming was the sub-treatment. Plot sizes were 160 m2 for tillage and 80 m2 for liming. Three tillage treatments were applied: conventional tillage (ST - plowing up to 30 cm depth), deep conservation tillage (CTD - loosening up to 30 cm depth) with 30% minimum crop residue coverage, and shallow conservation tillage (CTS - loosening up to 10 cm depth) with 50% minimum crop residue coverage. Liming material (CaO) was manually applied in recommended amounts after winter wheat in 2020. Weed sampling occurred during critical weed free period in soybean crops (V3) and at maturity stage (R7). Weed density and above-ground biomass were determined by counting and cutting weed species in 0.25 m2 squares across four replicates. Visual assessment determined total weed coverage, and weed species were collected, dried (at 60 °C for 48 h) and weighed for biomass evaluation. Soil tillage significantly influenced weed biomass, weed species number and coverage at the V3 stage. In the R7 stage, significant differences in biomass, total number of weeds, and weed species were observed between CTS and other tillage treatments. CTS exhibited the highest weed biomass in both stages (V3: 8.54 g m-2; R7: 88.20 g m-2). CTS also had the highest weed density at the V3 stage 36.50 m-2), while CTD had the lowest 25.00 m-2). However, no significant differences were found in weed density among all tillage treatments at the V3 stage. CTS showed the highest number of weed species at the V3 stage (2.5 m-2), while ST had the lowest (1.5 m-2), with significant differences among treatments. Significant differences in weed coverage were observed among CTS and ST at the V3 stage, but not at the R7. On average, weed parameters were higher at non-limed treatments compared to limed. Liming significantly decreased weed biomass and weed density on CTS in R7 growth stage. An average decreasing in weed coverage was present in all limed tillage treatments compared to non-limed. On average, CTS with no liming led to increased weed infestation in soybean crops.

Key words: weed infestation, Glycine max (L.) Merr., conservation tillage systems, CaO

Acknowledgement

The results presented in the paper are an output from research projects (IP-2020-02-2647). "Assessment of conservation soil tillage as advanced methods for crop production and prevention of soil degradation – ACTIVEsoil.

INFLUENCE OF FLOODING ON SOIL QUALITY AND SOIL PROTECTION STRATEGY FROM HARMFUL CONSEQUENCES

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Abstract

In accordance with the role and importance given to the soil as a factor of bioproduction in the world and in our country, there is a need to examine the soil and adequately protect it from heavy metal contamination. The quality of agricultural crops that are exposed to unfavorable influences - floods - is particularly at risk. The level of contamination in the soil increases the risk of metals entering the food chain. After floods, the soil can be polluted with sediments, waste, and an increased concentration of salt and heavy metals. In addition, flooding can lead to soil erosion, which reduces fertility and promotes nutrient loss. The aim of this work is to investigate soil contamination with heavy metals caused by floods in the Unsko-sanski canton in the period March-June 2023.

In the soil samples, in addition to heavy metals, the general chemical and physical properties of the soil were analyzed. 35 soil samples were analyzed in a disturbed state, from a depth of 0-30 cm. According to the examined chemical properties, the soils are neutral to moderately alkaline, with pH values from 6.85 to 8.33. Substitution acidity ranged from 5.97 to 7.81. Humus content ranged from 0.99 to 7.25%, CaCO3 from 0.34 to 61.31%. The content of accessible P2O5 was from 2,08 to 40,93 mg/100g of soil, and K2O from 4,40 to 42,50 mg/100g of soil. According to the granulometric composition, the soils are classified into textural classes: clay loam (1 soil), loam (7 soils), loamy sand (7 soils), silt loam (3 soils), and sandy loam (17 soils).

Increased values of heavy metal content were found in 13 tested soil samples. The content of heavy metals was determined by atomic spectrometry, which was compared with the limit values from the Rulebook on determination of permitted amounts of harmful and dangerous substances in the soil and their testing methods.

Protecting the soil from the harmful effects of floods requires strategies that will reduce the risk of erosion and pollution, such as: vegetation maintenance, erosion control, regular soil analysis to monitor soil quality, soil restoration by adding organic matter, fertilizers and other nutritional elements. These strategies can help preserve soil quality and reduce the harmful effects of flooding on soil.

Key words: soil, floods, contamination, heavy metals, strategy

LUMBRICUS TERRESTRIS ENHANCEMENT CHANGES SOIL MOISTURE AND TEMPERATURE REGIME IN MAIZE CROPPING

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Abstract

Earthworms are considered as an indicator of soil health and an agronomic productivity of the soil but their number in soil is low. Lumbricus terrestris is thought to stabilize soil quality and contribute to nutrient cycling through its burrowing activity and mucus secretion. However, their activity may be dependent on tillage systems and is less understood in our temperate conditions. The aim of this study was to elucidate changes in soil temperature and moisture content in L. terrestris enriched maize plots in a long-term tillage experiment.

The trial was carried out in the long-term experiment "Plodoredi" at the Experimental Station Rimski Šančevi of the Institute of Field and Vegetable Crops, Novi Sad. For this purpose, a selected area of the field was fenced off with plastic sheets and buried in the fields, where earthworms (L. terrestris) were placed (14 individuals per m2) in May after maize sowing. Two different tillage systems were tested: mouldboard plowing (27-30 cm depth) vs. conservation tillage with a Vaderstad Tempo 6 planter after stubble mulching with a rotary tiller. The soil type was Haplic Chernozem with a clay loam texture and 2.8% organic matter, fertilised according to soil properties and crop requirements. At full maturity, maize grain yield was harvested and reported at 13% moisture. The trial was conducted in 2021 and data for soil temperature and soil moisture were obtained from the nearest meteorological station and at the experimental plot at 5 cm depth through 8 different maize growth stages.

Throughout the observation period, the average soil temperature was lowest at the meteorological station site (18.7oC) compared to the experimental plots. This indicates that tillage alters temperature regimen. Among the treatments, the lowest average temperature was observed in the conservation tillage plot with L. terrestris (19.7oC) addition and higher in the ploughed enhanced plots (20.7oC). Soil moisture (%) was higher in conservation tillage compared to plowing. Maize yield was higher in the ploughed enhanced plots (9.5 t ha-1) compared to the conservation tillage enhanced plots (8.8 t ha-1) due to better crop density. The results indicate that agricultural soil improvement with L. terrestris can alter temperature and moisture regimes by changing soil physical properties and maintaining earthworm populations can be beneficial for soil quality. With short period of study additional time would be needed to increase the effect.

Key words: soil quality, soil physics, L. terrestris, maize, tillage systems

AGRODIVERSITY FOR CLIMATE RESILIENCE? STUDYING DIMENSIONS OF DIVERSITY IN AGRICULTURE

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Abstract

Growing food demands and increasing environmental pressures necessitate the promotion of sustainable agriculture practices. Agroecosystems resilient to the projected global climate scenario holds the potential to ensure food production. Intensively grown crops are commonly farmed in uniform monoculture systems. This uniformity exposes food systems to vulnerability. Our broad objective is to introduce different dimensions of diversity and link between functions of agroecosystems.

We will present the following dimensions of diversity in agriculture: crop diversity (Fig. 1), field design (Fig. 2), agriculture-nature interface (Fig. 3), and incremental agrosystems (Fig. 4). We will present how each dimension's understanding may contribute to agro-diversification and agricultural resilience.

Overall, we aim to suggest that diversification of agriculture is key to promoting the sustainable intensification of food systems.

Key words: Agrodiversity, agriculture resilience, Intercropping, Soil biodiversity, Agroforestry

Acknowledgment

The perspectives presented are output from research projects partially funded by GFI, KKL, GIF, Israel Extension Services, and Chief Scientist of the Ministry of Agriculture and Rural Development of Israel.

Figure 1. Increasing crop diversity by studying novel crops such as wild lupins.

Figure 2. Field design, such as alley cropping, enhances agro-diversification and resilence.

Figure 3. Understanding the agriculture-nature interface to mitigate conflicts between wildlife and agriculture.

Figure 4. Urban fruit production is an intriguing concept of incremental agrosystem.

WINTER WHEAT VARIETAL TESTING FOR ORGANIC FARMING SYSTEM

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Abstract

The growing demand for organic products requires varieties adapted to low-input conditions. Current organic crop production is mostly based on varieties that were developed for the high-input production system. Although many breeding goals are identical for both conventional and organic cultivation, such as high yield potential, stable quality parameters and tolerance to biotic and abiotic stresses in general, other traits are of primary interest for organic farmers, e.g., nitrogen utilization, resistance to insects and diseases including soil-borne pathogens, and competitiveness against noxious weeds. Since 2016 the Central Institute for Supervising and Testing in Agriculture (CISTO), an authority that is responsible for testing and registration of varieties of agricultural plant species, has organized organic trials in cereals with the aim to identify the most suitable varieties. The experiments have been performed on several locations in the Czech Republic. The Field Research Station in Žabčice which belongs to Mendel University in Brno joined this testing in 2020 when a field of about 2.5 ha was split into five blocks and an organic c ropping system was established consisting of winter wheat followed by oat, spring barley and two-year alfalfa. The aim of this work is to compare results from plot experiments carried out according to the principles of the organic agriculture with the results from conventional trials performed under the same soil and weather conditions. The effect of cultivation system on grain yield, protein concentration (PC) in grain, thousand grain weight (TGW) and volume weight (VW) was documented on five and eight winter wheat varieties in 2021 and 2022 year, respectively. The yields in conventional systems were in average greater than in the organic systems by approximately 16% and 5%, respectively, whereas the differences among varieties ranged from 0 to 20%. Conventional grain had lower VW of about 2 and 4.6% in both years. Organic grain samples had significantly lower TGW in 2021 (40 g vs. 45 g). The difference in TGW in 2022 was nonsignificant (42 g vs. 41 g). Average PC in all samples was over 12.5%, in 2021 it was slightly higher in favour of organic grain and in 2022 of conventional grain. The differences among varieties were also identified.

Key words: organic and conventional trials, wheat, yield, grain quality

Acknowledgement

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EXPERIENCES WITH CULTIVATION OF MAIZE WITH UNDER-SOWING COVER CROPS IN THE CZECH REPUBLIC

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Abstract

In the current agriculture, maize is considered to be one of the major feed crops (for silage and grain) in the Czech Republic. Cultivation of maize by inappropriate agricultural practices and on unsuitable sites is connected with risks of soil degradation, mainly due to water erosion. More often, higher yield variability is due to aspects of climate change, as well. The aim of this study was to introduce innovative system of maize cultivation with under-sowing cover crops. Since 2019 we tested various species (legumes, grasses and some annual crops) which were seeded in-between the maize rows in the growth stage of the third to fourth leaf of maize. In that time there is enough light in-between the rows that the cover crop species can germinate and growth before maize canopies, and do not significantly compete with maize plants during growing season.

During the investigation we developed prototype of machine which enables four operations in one drive across the field. This involves inter-row cultivation with seeding of cover crops, application of liquid nitrogen fertilizer into the soil near the root zone and strip application of herbicide in the maize row.

Results from field experiments (three different locations in the Czech Republic) showed different growth dynamic, biomass production and soil cover in different cover crops. Species as Italian ryegrass (Lolium multiflorum ssp. italicum), phacelia (Phacelia tanacetifolia), rye (Secale cereale) and crimson clover (Trifolium incarnatum) proved a rapid growth. The production of dry matter biomass in above mentioned species was between 0.5 – 1.5 t ha-1 and soil cover were almost 100%. On the other hand, a 5-15% decrease in the yield of silage biomass and grain was found. A 40-55% reduction in surface runoff and soil loss was found compared to plowing. Variants with slower-emerging species of cover crops were often weeded with different weed species depending on the soil seedbank.

Cropping system with suitable inter-seeding cover crops in maize may be a promising technology applicable on sloping areas with potential of water erosion reduction. It can also be used in production areas as a more environmentally friendly technology due to the reduction of herbicides.

Key words: maize, cover crops, yield, water erosion, weeds

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The results presented in the paper are an output from research projects QK1910334 “Innovation of maize cropping systems using intercrops to reduce soil degradation and improve water management in changing climate”.

IMPROVING POTENTIAL NATURAL VEGETATION MODELS TO SERVE CLIMATE CHANGE ASSESSMENT

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Abstract

Potential Natural Vegetation (PNV) expresses the vegetation that could survive at a specific site without human management if restored or already there. Thus, PNV expresses the site potential for natural vegetation. Extended into multiple PNV (MPNV) it can characterize the range and chance of survival of vegetation types. Our aim was to explore how well suited the MPNV models developed for Hungary are to assess future climate change impact on vegetation. We explored this with a case study of MPNV of the Pannonian part of Serbia, Croatia and Slovenia.

The following steps constituted the study: we identified the level of climate analogy between Hungary and the surrounding areas, we applied the MPNV models to the new areas and identified the strengths and weaknesses of the resulting predictions against vegetation data collected from existing databases and our own field mapping.

Regarding climate analogy we found particularly similar areas to the future climate of Hungary in Vojvodina and in the area surrounding Varaždin. Vojvodina appeared to be relevant for Eastern Hungary, while the area near Varaždin to Western Hungary.

Evaluation of the transferability to these areas indicated necessity of extending the training area beyond Hungary. While the models performed adequately for the majority of vegetation types outside Hungary, too, we found indications that involving broader training data into climate change impact assessment will be necessary. First of all, vegetation types not present in Hungary and thus not modelled emerged even in such close vicinity of the border. Secondly, a few models, such as those of Artemisia saline steppes, did not estimate potential presence where they are extensively present today. These features show that while most of the vegetation models may be relatively well trained within Hungary, extending the training area will be necessary towards areas with climate similar to that expected in the future to arrive to reliable predictions.

Key words: climate analogy, climate change impact, transferability, Pannonian biogeographic region, potential natural vegetation

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FUNGAL ENDOPHYTES IN ROOTS OF SOYBEAN

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Abstract

Soybean is one of the most important crops from an agronomic point of view, due to its capacity to form a dual symbiosis. The plants benefit from symbiosis with bacteria, for acquiring nitrogen, and with mycorrhizal fungi. This type of symbiosis act as a root extension, with the development of an intraradical hyphal colonization, as a transfer interface between fungi and host. Outside the roots, symbiotic fungi develop an extraradical hyphal network which is responsible for the nutrient absorption, especially from areas located outside the range of host roots.

The aim of the research was to analyze the presence and of mycorrhizal structures in roots of soybean, along with the scoring of colonization parameters. A secondary aim was to analyze the presence/absence of Dark Septate Endophytes and Fine Root Endophytes in roots of soybean colonized by mycorrhizas.

Based on microscopic observations, roots of soybean present a frequency of colonization in a large interval (50-90%), which is sustained by an intensity of at least 5%. The maximum intensity recorded in colonized parts of roots was almost 50%, which indicate a proliferative colonization strategy.

Arbuscularity is present in more than 50% of analyzed roots, most arbuscules presenting the Arum type form. Vesicles have a similar share with arbuscules, with a spatial separation between the two structures. This aspect indicates a difference and an alternation of colonization strategy along the same root: from storage to transfer but located in limited areas.

Numerous root segments contain both supplementary endophytes, sustaining the perspective of soybean as a host with a high permissiveness to multiple fungal colonizers.

Soybean is a crop that accepts the development of fungal endophytes, but at different scale and intensity along the same root.

Key words: fungi, crop, endophytes, symbiosis

THE ROLE OF AGROMETEOROLOGY DEPARTMENT OF CROATIAN METEOROLOGICAL AND HYDROLOGICAL SERVICE IN SUPPORTING AGRICULTURAL SECTOR

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Abstract

The fundamental role of DHMZ is to monitor the state of the atmosphere, make risk assessments of individual weather disasters, and develop a system for forecasting and warning of storms and other extreme weather events. In this direction, within DHMZ, Agrometeorology Department has been supporting the agricultural sector with his activities for 70 years. During that period, numerous studies were conducted and forecasts for farmers were introduced as early as 1958. Constant investment in research and development in cooperation with associated partners and institutions enables continuity of progress in providing quality information to farmers.

At the end of 2021, we published the first Agroclimatic Atlas of Croatia for the period 1991-2020. and 1981-2010. which contains maps and tables with data on important agroclimatic parameters, which can be used to determine the temperature regime of air and soil, water balance, and the determination of the plant fire hazard index.

To review the situation, there is agrometeorological data that offers a monthly and weekly overview of the agrometeorological situation, as well as a weekly overview of soil and air temperature, temperature sums, forest fire danger index, either in tabular or graphical display. One can find specialized agrometeorological four-day forecasts with implications for agricultural work, as well as weather outlook.

All this information can be used collectively by the farmer in his daily decisions in the management of the agricultural economy. We will continue to introduce new products, listening to the needs of farmers, in order to provide them with valuable information and provide support in mitigating damages.

Key words: agrometeorology, DHMZ, agrometeorological forecast, agrometeorological products

ANALYSIS OF A FOREST FIRE DANGER INDEX OVER THE PANNONIAN REGION

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Abstract

Besides the historically sensitive regions of the Mediterranean, other European regions also face to an increasing forest fire risk due to climate change. Rising temperatures, more frequent heatwaves, and irregular rainfall patterns create favorable conditions for wildfires to ignite and spread rapidly. Human activities, such as deforestation and urbanization, further amplify the threat. The ecological consequences of forest fires are far-reaching, affecting carbon sequestration and biodiversity.

The forest fire danger index (FFDI) provides valuable insights for the quantification of the fire risk when the soil is dry enough. The FFDI assesses the potential risk of wildfires by considering factors such as soil dryness and fire spread influenced by daily wind speed, mean temperature and humidity levels. Higher wind speeds can accelerate fire propagation, while low humidity and high temperature increase the likelihood of ignition and facilitate the rapid spread of wildfires in dry areas. In order to calculate soil dryness specifically developed for fire controls, the widely-used Keetch-Byram drought index is analyzed in this study. For this purpose, precipitation and maximum temperature are used. These two climate variables provided on a daily basis reflect the evaporation and precipitation balance in the soil perfectly.

For the calculations, we used homogenized and interpolated observational dataset (HuClim) for 2001–2022. For the future, we used six regional climate model simulations

from the EURO-CORDEX initiative taking into account the anthropogenic activity of energy needs, land use changes, population changes through three different RCP scenarios.

The results can be concluded that extremely dry soil was infrequent over the lowlands in Hungary (a few days in a year on average), however, it is even more extremely rare (only during a few days in the entire 22-year period) when severe compound conditions (i.e., high temperature and low air humidity) occurred in order to actually ignite fire. This danger is definitely expected to change in the future, especially with following the non-mitigation scenario of RCP8.5.

Key words: aridity, climate change, HuClim, EURO-CORDEX, RCP scenarios

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THE FUTURE OF PLANT PERFORMANCE MODELING INCLUDING 5G, AI, AND DATA INTEGRATION

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Abstract

Combining 5G networks and AI-driven data integration has the potential to revolutionize agriculture by leveraging high-speed connectivity, advanced analytics, and machine learning to optimize crop yields, reduce resource consumption, and enhance overall farm efficiency. 5G provides significantly higher Internet speeds offering extremely low latency which is crucial for applications requiring immediate response times. This is particularly valuable for autonomous machinery and Internet-of-Things (IoT) devices where a larger number of connected devices per square kilometer exist. Sensors, drones, satellites, and other IoT devices can collect vast amounts of data on soil conditions, weather patterns, crop health, and more. This data needs to be aggregated and processed. AI algorithms can analyze the collected data to identify patterns, make predictions, and provide actionable insights. For example, machine learning models can anticipate plant drought stress according to (in)visible changes of the plant or to predict optimal planting times based on weather forecasts and historical data. Integrating AI into the farm's operations can provide farmers with recommendations on irrigation schedules, fertilizer application, pest control, and more. However, costs, data security, privacy, regulatory compliance and scalability seem to be challenging. Moreover, a new generation of autonomous and intelligent systems are on its way: Researchers are advocating the need for edge intelligence where AI models and systems are no longer centrally trained and periodically retrained with new huge datasets being pushed to the cloud. To achieve edge intelligence, computing resources at the edge of the network facilitated by 5G deployments are employed to create decentralized solutions which are able to collect and analyze large data sets close to data sources placed in the fields to perceive and act upon dynamic and unpredictable changes in the environments, while reducing the burden from the cloud. Such technical solutions will facilitate the creation of digital twins of arable fields to assess, analyze, predict and improve agricultural yields and help farmers increase productivity despite climate change.

Key words: AI, crop production, IoT, large data, 5G

Acknowledgement

The results presented in the paper are an output from research project "IoT-field: An Ecosystem of Networked Devices and Services for IoT Solutions Applied in Agriculture" co-financed by the European Union from the European Regional Development Fund within the Operational Programme Competitiveness and Cohesion 2014–2020 of the Republic of Croatia", KK.01.1.1.04.0108.

INTRODUCTION TO DIGITAL SOLUTIONS IN AGRICULTURE – STUDENT PERSPECTIVE

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Abstract

In this opening lecture of the student section of the conference, the idea is to give an introduction to digital solutions in agriculture, examples, and students' experiences with digital agriculture, climate change, and 5G implementations in agriculture. Agriculture is the most vulnerable sector to climate change, owing to its huge size and sensitivity to weather parameters, thereby causing huge economic impacts, especially in food-insecure regions. Various climate-driven extremes, i.e., drought, heat waves, erratic and intense rainfall patterns, storms, floods, and emerging insect pests have adversely affected the livelihood of the farmers, reducing their yields and overall quality. Climate change is a global threat to the food and nutritional security of the world. Digital technology integrates agricultural production from the field to the consumer. Provides farmers with tools and information to make more informed decisions towards improved productivity, while some of the key components are data collection, data analysis, precision farming, remote sensing, farm management software, robotics and automation, and a decision support system. Resource efficiency, improved crop yields and quality, reduced costs, and climate-resilient are some of the benefits of digital agriculture. 5G Networks play a crucial role in advancing digital agriculture by providing the high-speed, low-latency, and reliable connectivity needed for various digital technologies and applications in farming. As agriculture becomes increasingly data-driven and technologically advanced, 5G will continue to play a pivotal role in the transformation of the agricultural sector. As a part of this year's Huawei Seed for The Future Program, each student of Digital Agriculture master study created an academic paper about 5G, that revolved around different agricultural areas. Inspiration, knowledge and close-to-eye experience were gathered after the Uni visit to the 5G farm in Linz, and the Delegation trip to Huawei facilities in China. Acting as future young digital agriculture experts we've had a great opportunity to see state-of-the-art 5G technologies in person. Merlin Project and 5Genesis were mentioned as case studies examples of 5G implementation in agriculture. The final takeaway of the lecture is that climate change poses a global threat to food security, emphasizing the need for technology-driven solutions like digital agriculture and 5G connectivity.

Key words: Digital agriculture, 5G, students experience, climate change

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INCREASING KNOWLEDGE AND ADOPTION OF CLIMATE PRACTICES BY ENGAGING FARMERS IN INNOVATIVE GROUP LEARNING: A RANDOMIZED CONTROLLED TRIAL

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Abstract

Livestock management is recognized as the largest source of greenhouse gas emissions (GHG) and ammonia in agriculture, accounting for 70% of emissions from this sector. However, despite the plethora of available mitigation measures, they are often not taken up by farmers even when they would require little investment.

Effective knowledge transfer is believed to be among the critical policy instruments to change farmers' behaviour and increase the adoption of new technologies. Recently, there has been a shift in the agricultural knowledge transfer from a linear, top-down learning model, where farmers usually have a passive role as recipients of knowledge, towards more participatory approaches, such as workshops, that emphasize peer-to-peer and group learning. However, limited evaluation of their effectiveness is available.

Our study aims to analyse the effectiveness of participatory workshops on climate-friendly soil and manure management practices that can help reduce GHG emissions. A group of 438 cattle breeders from two Slovenian regions participated in the randomised controlled trial, of which 225 received training and 213 consisted the control group. A survey instrument was used to test farmers' knowledge, attitudes and beliefs about climate change, social norms, perceived behavioural control and intention to adopt proposed practices.

Our results show that the current level of knowledge and implementation of climate-friendly farming practices in Slovenia is low. After attending the participatory workshops, farmers had a statistically higher knowledge of climate change and mitigation measures and a higher intention to perform more measures in the future than the control group. The workshops also had a significant positive effect on attitudes, social norms, climate change beliefs, psychological distance and perceived behavioural control.

The results provide promising new insights into the behaviour change mechanisms, which can be facilitated with innovative knowledge transfer approaches in agriculture.

We suggest to the Author that the abstract shouldn't be too short since 2000 letters (with spaces) in abstract are allowed.

Key words: Participatory workshops, climate mitigation farming practices, randomized controlled trial (RCT), cattle breeders, Slovenia.

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THE EFFECTS OF SELECTED TECHNIQUES IN CARBON FARMING

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Abstract

The EU member states contribute to the realization of the green plan with strategic plans within the framework of the Common Agricultural Policy. Strategic Plan of the Common Agricultural Policy of the Republic of Croatia includes contribution to mitigation of climate change and adaptation to these changes, including reducing greenhouse gas emissions and improving carbon sequestration, and promoting sustainable energy. The aim of this paper is to highlight the effects and benefits of farming techniques, already practiced in Croatia, in carbon sequestration. Three principles of mitigating the effects of carbon on climate change can be applied: 1) adding of external C to the soil, 2) incorporation and bounding of atmospheric C to the soil by plants through photosynthesis, 3) avoiding loss of C/CO2 from the soil. Carbon sequestration can be achieved by incorporating organic matter into the soil. Use of organic fertilizers and relocation of harvest residues of alfalfa can be used as techniques for adding external C to the soil in the form of organic matter. Additional cultivation of cover/catch crops instead of fallow, intercropping, leaving crop residues in the field and mulching practices can be used as techniques for incorporation and bounding of atmospheric C to the soil. The soil organic carbon stock could be increased after application of any of those four techniques. Reducing tillage and liming can be used as techniques to prevent loss of C/CO2 from the soil. Former technique has great potential to increase carbon stocks in 0 - 30 cm depths, while latter could show slight increase. All aforementioned farming techniques have additional benefits. Different combinations of multiple techniques applied simultaneously could be studied to ensure years of steady and high yields for farmers in addition to environmental and climate benefits.

Key words: carbon sequestration, organic matter, harvest residues, cover crops, soil carbon stock

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