ISTRO Working Group - Conservation Soil Tillage: book of abstracts

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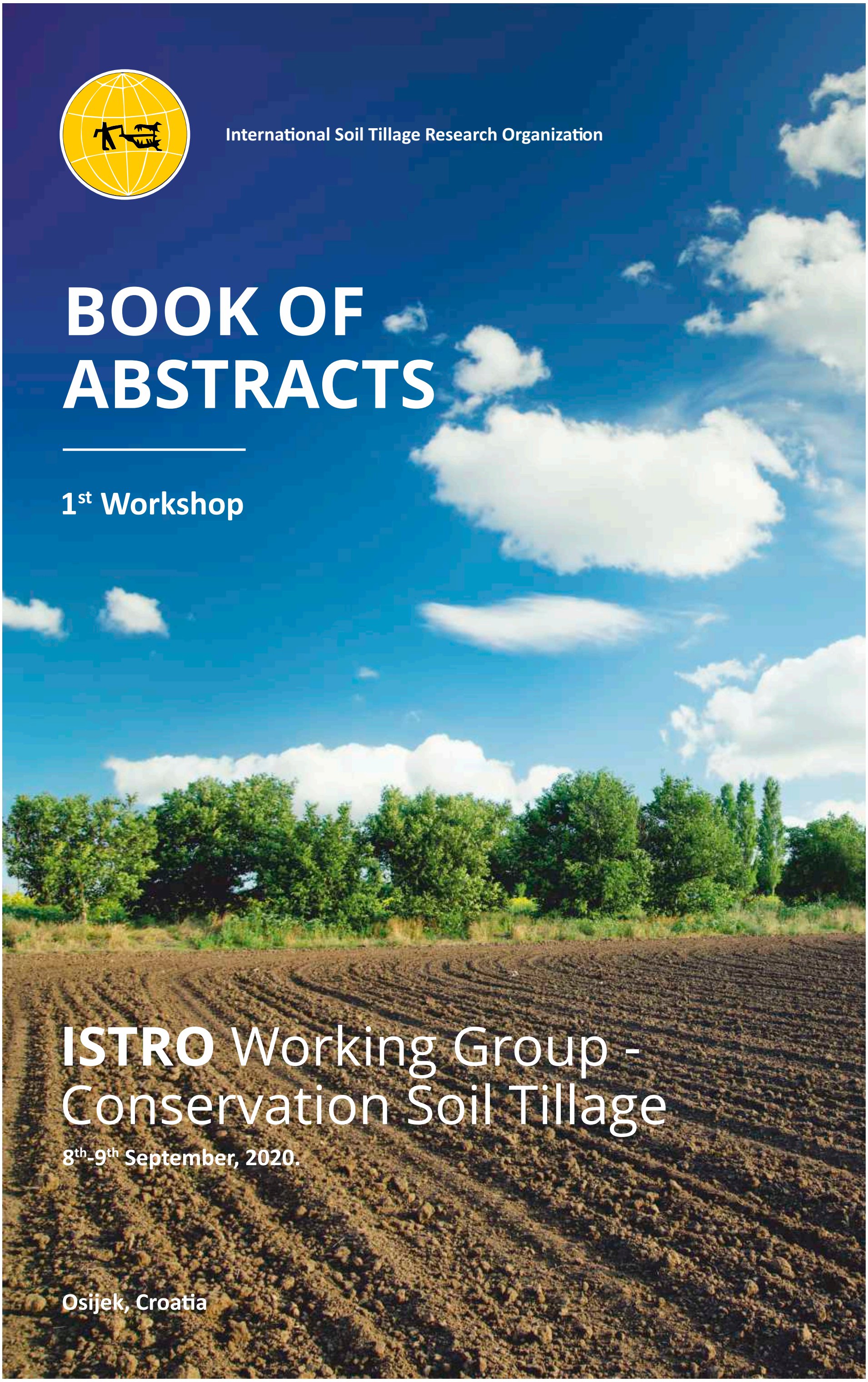

International Soil Tillage Research Organization

BOOK OF ABSTRACTS

1st Workshop

ISTRO Working Group - Conservation Soil Tillage

8th-9th September, 2020.

Osijek, Croatia

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Preface

Dear colleagues, ladies and gentlemen,

On behalf of the Working Group – Conservation Soil Tillage (WG-CST) of International Soil Tillage Research Organization (ISTRO), supportive institutions as well as sponsors, we are pleased to invite you to the WG-CST 1st Workshop which will take the place in Osijek, Republic of Croatia, 8th-9th September, 2020.

WG-CST for the first time organize workshop relating to and dealing mainly with ISTRO interest areas (e.g. Soil and Water Management, Climate Change, Plant Nutrition, Tillage tools and Implements, Crop Protection, etc.). WG-CST 1st Workshop has main intention to discuss and gathering basic knowledge about current situation in science and professional work in domain of conservation soil tillage.

WG-CST mission is based on the principles of connection, encouragement, promotion, transfer and application of knowledge about conservation soil tillage, and is realized through:

- connection of scientists and experts engaged in the research of conservation soil tillage and related scientific and research disciplines with the objective of achieving interdisciplinary,
- encouragement and promotion of the scientific research in the field of conservation soil tillage and interaction with similar disciplines,
- transfer of knowledge and scientific research results to the general scientific and professional community in order to improve the practical application of production.

Primary objective of that initiative is promotion, development and grow of interest and knowledge about conservation soil tillage science, exchange ideas and experiences and spreading modern approach of technology application in agroecosystems.

General Workshop topics will be discussed in the next sections:

- CST worldwide experiences
- Different aspects and acceptance of CST
- Research results
- Recognition and perspectives views of CST
- CST and Climate Change relation

This Workshop will cope with main goals of ISTRO respective research in soil tillage and field traffic and their relationship with the soil environment, land use and crop production. WG-CST Secretary

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Workshop program

- **Is conservation agriculture climate smart?**

  Irena Jug, Boris Đurđević, Bojana Brozović, Danijel Jug

- **Harnessing Better Productivity and Soil Health Through Climate Resilient Farming Practices**

  Sheetal Sharma, Ajay Kumar Mishra, Sabyasachi Biswal

- **Cover crops – The integrated part of conservation agriculture**

  Bojana Brozović, Danijel Jug, Irena Jug, Boris Đurđević

- **Facts and issues of soil conservation tillage in Hungary**

  Márta Birkás, Igor Đekemati, Zoltán Dezsény, Zoltán Kende, Zoltán Radics

- **Importance of tillage implmeents to promote conservation tillage**

  Parish P. Nalavade

- **Variations of some antioxidants in maize grain induced by soil tillage and nitrogen rate**

  Vesna Dragičević, Milena Simić, Jelena Vukadinović, Snežana Mladenović Drinić, Milan Brankov, Branka Kresović, Zoran Dumanović

- **Effectiveness of soil tillage systems in maize weeds control**

  Milena Simić, Vesna Dragičević, Milan Brankov, Branka Kresović, Zoran Dumanović

- **The changes of labile SOC in the long-term stationary trial on Chernozem**

  Srdjan Šeremešić

- **Biochar application or fire management – How does the input of pyrogenic residues affect C, N and P recalcitrance in soil?**

  Heike Knicker, Marina Paneque, Maria Lopez-Martin, Marta Velasco-Molina,

  Jose- Maria de la Rosa

- **Management and seasonal impacts on vineyards soil properties and hydrological response in continental Croatia**

  Paulo Pereira, Leon Josip Telak, Igor Bogunovic

- **Introducing Biochar to Conservation agriculture**

  Boris Đurđević, Irena Jug, Danijel Jug, Bojana Brozović

- **MIP technology, a tool for sustainable management of soils**

  Benoit Le Rumeur, Bruno Daridon

- **Seaweed Extracts and Traces Elements to improve plant nutrition**

  Benoit Le Rumeur, Bruno Daridon

- **Development and effectiveness of strip-till technology in Poland**

  Edward Wilczewski

- **Cover crop use for enhanced bio-energy strategy**

  Bojan Stipešević, Davor Kralik, Bojana Brozović, Danijel Jug, Irena Jug, Boris Đurđević

- **Conservation soil tillage as key approach and imperative of desertification, drought, soil degradation and climate change**

  Danijel Jug, Irena Jug, Boris Đurđević, Bojana Brozović

- **Green planting of soybean as a strategy to avoid tilled winter-bare fallows in irrigated cropping systems**

  Genís Simon-Miquel, Ramon Pujol, Daniel Plaza-Bonilla

ABSTRACTS

Is conservation agriculture climate smart?

Irena Jug, Boris Đurđević, Bojana Brozović, Danijel Jug

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One of the major challenges of the twenty-first century, in the age of global environmental problems, is sustainable food production. In order to feed the growing world population, it is necessary to change many aspects of agricultural production. Resolving these challenges will increase global pressure on natural resources, especially soil and water. To achieve food security and agricultural development goals, adaptation to climate change as one of the global environmental problem, will be necessary. Climate smart agriculture (CSA) systematically integrates climate change into the planning and development of sustainable agricultural systems. The CSA approach aims to sustainably increase agricultural productivity, increase adaptive capacity and resilience, reduce greenhouse gas emissions and increase carbon sequestration where possible. Conservation Agriculture (CA) simultaneously promotes agricultural productivity, climate resilience and other environmental goals related to sustainability. CA can better contribute to CSA goals if a comprehensive CA package is applied that includes minimal soil disturbance, crop rotation, and retention of crop residues thus improving infiltration and soil moisture retention, and reducing daily soil temperature fluctuations. The climate-smartness of CA can be enhanced of ways to reframing and adapting CA to location-specific economic and agroecological conditions, integrating CA with other CSA practices (such as agroforestry, sustainable soil management, crop management, water and energy management). The adoption of CA in different socioeconomic and agroecological conditions should contribute to the goals of CSA. CA is contributing positively to CSA productivity and adaptation/resilience objectives, although the degree of success varies considerably by agroecological characteristics of producing area.

Key words: conservation agriculture, climate smart agriculture, sustainability production, climate change

Harnessing Better Productivity and Soil Health Through Climate Resilient Farming Practices

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Increased frequency and intensity of multiple disasters triggered by climate variability possess serious threat in achieving sustainable agriculture especially in coastal regions of Odisha. Low productivity, increased cost of cultivation, lack of irrigation, grazing menace, less availability of stress-tolerant varieties compelling farmers to go for Rice-Fellow system that worsens the livelihood of small and marginal farmers. This study was an attempt to quantify the effect on productivity and greenhouse gas (GHG) reduction with conservation tillage (minimum tillage with different crop diversification options) in Eastern India. Four different cropping systems with stress-tolerant rice varieties (Rice (transplanted rice-TPR)-Fallow; rice (no-till direct seeded rice DSR)- rice (TPR)-mungbean; rice (no-till DSR)-groundnut and rice (no-till DSR)-vegetables) coupled with site-specific nutrient management were evaluated for identifying best bet management systems. Our results suggested rice (no-till DSR)-vegetables followed by rice (no-till DSR)-groundnut are not only remunerative to the farmers but also help in mitigation of GHG emissions. Rice (no-till DSR)- rice (TPR)-mungbean (incorporation after pod picking) was found to be a better option in improving soil health through organic inputs. Further observations need to be recorded to confirm long term sustainability of such systems, especially in temporal and spatial stress conditions. This study evidenced the introduction of climate-smart conservation practices offer resilience in achieving sustainable yield, improved soil health with reduced environmental footprints.

Key words: crop diversification, rice crop manager, minimum tillage, ecological engineering.

Cover crops – The integrated part of conservation agriculture

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Cover crops have been successfully involved into the conservation agriculture (CA) systems because they fit perfectly with their properties in all three main principles of CA with emphasis on soil covering. The primary function of cover crops is soil covering which is the basic principle of CA. Beside the crop residues which are left on soil surface in a minimum amount of 30%, cover crops as living mulches are often needed to replace fallow period in which they effectively protect the soil and contribute to the yield stability. This role of cover crops is particularly pronounced if the period from the harvest of one crop to the establishment of another is quite long. Cover crops will protect the soil from water and wind erosion which often occurs on bare soil. They also contribute to the conservation of nutrients and water in the soil, and have a positive effect on reducing weeds occurrence. The rapid establishment of cover crops is important for the quick achievement of effective soil cover and producing the sufficient amount of aboveground biomass which implies a better accumulation of organic matter and nutrients that will be returned to the soil by cover crops incorporation. Establishment of cover crops usually involves reduced tillage thus fitting them into the CA principle of minimal soil disturbance. Different plant species are used as cover crops, and they should be resistant to low temperatures, have a rapid and uniform emergence and ability to fix atmospheric nitrogen, which is why legumes are used as pure stands or in mixtures with grasses. The use of different cover crops species complements the crop rotation which is the third principle of CA. Cover crops are considered to be a key tool for maintaining and increasing biodiversity and thus directly improving stability and sustainability of CA system.

Key words: cover cropping, conservation agriculture, soil protection, crop rotation.

Facts and issues of soil conservation tillage in Hungary

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Five of the soil conservation tillage systems are particularly well known in Hungary, that are no-till (NT), ridge-till (RT), strip-till (ST), mulch-till-tine (mulch-till-T) and mulch-till-subsoiling (mulch-till-S). The minimum tillage principles also appeared in Hungary, but in practice only the reduction of expenditures received higher attention. Soil conservation recommendations are important because soil protection and water retention received a priority here, and other tasks may fulfill after realization of these factors. The definition of a soil protection system is known in worldwide relation that is conservation is any tillage and planting system in which at least 30% of the soil surface is covered by plant residue after planting to reduce soil erosion by water. We may complete this statement; soil conservation is realized if soil physical and biological state is improved and the soil is not damaged during the fulfilment of crop demands. Referring to the need of the plants was deficient effort in the past. We outline that assessment of soil conservation systems are indispensable and findings may help to deepen the knowledge in the practical relation.

We suggest new approaches in soil conservation and list is as follows: (1) The importance of no-till is appreciated by weather extremes in the future in regional relation). (2) Ridge-till can be significant on small farms that are farming in sloped sites and involving manual labor. (3) The significance of strip-till is expected to increase in regional relation, but the uncovered strips may be critical in some farming conditions. (4) The importance of mulch-till-T will increase, considering the importance of soil and water protection. (5) The importance of mulch-till-S will increase, due to the need of soil condition improvement in regional relation.

The aim of the paper was to assess soil conservation tillage systems that are tested and applied in the regional relation.

Key words: conservation tillage systems, soil protection system, new soil conservation approaches.

Importance of tillage implmeents to promote conservation tillage

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Soil is an important and central aspect of agriculture. However, because of the extreme tillage operations and excessive fertilizer applications especially in developing countries soil is losing structure and fertility. Consequently, soil management is becoming very important for maintaining appropriate soil structure while racing behind the higher yields. Tillage practices is one of the important factors, which has significant impact on maintaining soil management. Excess tillage generally results into soil erosion, compaction and deterioration of soil structure, consequently reduces productivity. Farmers are realizing importance of tillage and soil management and shifting from intensive to the reduced or conservational tillage practices.

On the other hand, farmers in some Asian countries are following the open field burning practice for managing crop residues as handling of these crop residues is laborious and time consuming. Only from North Indian states in 2012, more than 20 million tons of straw found to be set afire within a fortnight to prepare fields for the wheat crop, whose estimated emissions include about 12 megatons of CO2, toxic soot and smoke. This on-field crop residue burning causes loss of nitrogen content and micronutrients, in-turn soil fertility, destroys farmer-friendly insects as well as results environment pollution. However, these crop residues can be utilized for increasing soil fertility. In short, specified machinery for crop residue management and direct seeding especially in heavy crop residues can play a significant role for adoption of conservation tillage practices.

The results of preliminary studies of powered disc for understanding its various benefits for direct seeding system revealed importance and versatility of powered disc operation in terms of its ability to handle crop residues in direct seeding system and total power requirement. Hence, versatile implements such as powered disc implements can support for conservational tillage systems.

Key words: powered tillage disc, crop residue burning, conservation tillage implement.

Variations of some antioxidants in maize grain induced by soil tillage and nitrogen rate

Vesna Dragičević, Milena Simić, Jelena Vukadinović, Snežana Mladenović Drinić, Milan Brankov, Branka Kresović, Zoran Dumanović

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Soil tillage is one of the most important parts of cropping technology that affect maize growth and development. Without proper tillage, it is impossible to expect high yields. Adequate fertilization, particularly with nitrogen is also important in high yields realization. Nevertheless, the scarcity in information about the influence of tillage and nitrogen supply on kernel quality, particularly concentration of antioxidants is present. The aim of the experiment was to test the influence of different tillage practices: T1 – no-till, T2 – reduced, and T3 – conventional tillage, as well as N fertilization rate: N1 – without fertilization; N2 – 180 kg N ha^{-1}, 50 kg P ha^{-1}, 50 kg K ha^{-1}; N3–240 kg N ha^{-1}, 50 kg P ha^{-1}, 50 kg K ha^{-1}, on maize grain yield and concentration of some antioxidants: phytic acid (Phy), total glutathione (GSH), phenols, tocopherols and total carotenoids. Experiment was realized during 2016-2018 period. T3 induced increase in grain yield, in comparison to T1 (averagely for 32.7%). N3 also expressed positive impact on grain yield increase, when compared to N1, in T1, T2 and T3 treatments, averagely, up to 35.3%, 45.7% and 9.4%, respectively. The highest average concentration of Phy and carotenoids was realized by T3, while the highest concentration of GSH and phenols was achieved by T1 and the highest tocopherols concentration was reached by T2 treatment. Besides, the highest average level of Phy, carotenoids and GSH was observed in N3 and the highest average concentrations of tocopherols and phenols were in N1 treatment. The significant and positive correlation between grain yield and carotenoids, GSH and phenols in all three tillage practices, as well as negative correlation between yield and Phy in T1 and T2 treatments indicated that proper tillage could increase, not just grain yield, but also nutritional quality, by increase of some antioxidants in maize kernels.

Key words: soil tillage practices, nitrogen rate, antioxidants in maize grain.

Effectiveness of soil tillage systems in maize weeds control

Milena Simić, Vesna Dragičević, Milan Brankov, Branka Kresović, Zoran Dumanović

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Reduced soil tillage is widely adopted since the awareness of agro-ecosystem and soil preservation and protection has become more important. Besides many advantages, this system of soil cultivation usually increases amounts of herbicides and multiplies its time of application. The aim of the experiment was to evaluate the influence of different tillage practices: T1 – no-till, T2 – reduced, and T3 - conventional tillage, as well as N fertilization rate: N1 – without fertilization; N2 – 180 kg N ha^{-1}, 50 kg P ha^{-1}, 50 kg K ha^{-1}; N3–240 kg N ha^{-1}, 50 kg P ha^{-1}, 50 kg K ha^{-1}, on maize weed infestation and grain yield.

Experiment was settled down 1978 while three years overview was done during 2017-2019. Maize hybrid (FAO 600) was sown in the density of 64.935 plants ha^{-1}. The broad-spectrum systemic herbicide glyphosate (2400 g ha^{-1} a.i.) was applied as necessary to control weed vegetation, prior to planting in the no-tillage treatment. After planting, the mixture of pre-emergence herbicides S-metolachlor + terbuthylazine at recommended rates (S-metolachlor 960 g ha-1 + terbuthylazine 120 g ha^{-1} a.i.), was applied in all treatments. Six weeks after herbicide application, weed biomass was evaluated. Maize grain yield was measured at the end of growing cycle and calculated at 14% of moisture. All data were process by ANOVA and differences were analyzed by LSD-test.

Results showed that weed infestation was significantly higher in T1 than in T3. Soil tillage and level of fertilizers influenced weed fresh biomass which was significantly higher under no-tillage even with no fertilizer's application, 115.9 g m^{-2}. Maize grain yield in conventional tillage (8.27 t ha^{-1}) was noticeable higher than in reduced (5.84 t ha^{-1}) and no-tillage (3.14 t ha^{-1}) indicating that, in agroecological conditions of Zemun Polje and slightly calcareous chernozem, conventional tillage is more convenient regarding weed control and maize productivity.

Key words: soil tillage effectiveness, nitrogen fertilization rate, weeds control.

The changes of labile SOC in the long-term stationary trial on Chernozem

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Changes in cropping systems and tillage practices over time can induce problems in quantification of SOC pool due to the accumulated backgrounds and spatial variations. Therefore, the interpreting SOC based on a total carbon pool lack clarity and accuracy in explaining the dynamics and relationship between SOC content and other soil properties. This relationship was accessed on the long-term experiment "Plodoredi" at Rimski Šančevi experimental station in Novi Sad. In the soils, the input of organic matter comes in the form of crop residues or litter that is returned to the soil surface, from root turnover during crop growth and from root material left in the soil. Therefore, a tillage practice plays a crucial role in SOC accrual. The turnover of the labile SOC fraction is relatively fast, and since this fraction quickly responds to changes in land use and soil management, it can be expected as an early and sensitive indicator of the changes in total SOC. Particulate organic carbon is a readily available for microorganisms and a short-term reservoir of nutrients for plants while the hot water extricable organic carbon is sensitive indicator of soil management practices. In our study manure application within the multi-year crop rotation showed beneficial effects on SOC while control variant with omission of fertilizers resulted with negative balance of SOC. The presence of legumes in the rotation has been also associated with increased concentration of labile SOC pools. Consequently, balanced rotation, tillage and fertilization under the specific pedo-climatic condition can ensure the maintenance of soil organic carbon and affect crops productivity.

Key words: cropping systems, tillage practices, SOC, chernozem.

Biochar application or fire management – How does the input of pyrogenic residues affect C, N and P recalcitrance in soil?

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Burning of cropland has been a common agricultural practice to control pests, remove old crop residues and to fertilize the soil with nutrient-rich ash as well as to increase the pH (liming effect) and the concentration of inorganic ions. This fertilizing effect is supported by biological and non-biological processes after and during low intensity burning that transform organic N forms into more plant-available N forms and increase the amount of dissolved organic matter. However, within the last decades, burning of crop residues was heavily criticized for accelerating soil degradation, losses of SOM and nutrients, increasing C emission, causing intense air pollution, and reducing soil microbial activity. Alternatively, biochar (BC) produced by the controlled pyrolysis of organic residues has been proposed as soil ameliorants. It is suggested that BC can enhance plant growth by supplying and, more importantly, retaining nutrients and by providing other services such as improving soil physical and biological properties. In addition, the application of BC to soil has been proposed as a novel strategy to mitigate the emissions of carbon dioxide to the atmosphere. With the increasing research focus on BC, it became evident that this material can greatly vary in its chemical compositions and physical properties and that its impact on soil properties also depends on the soil itself. Thus, BC application is not a “one-size-fits-all paradigm” but instead requires careful consideration of the properties associated with each particular biochar and how those properties might remedy a specific soil/substrate deficiency or alter soil organic matter (SOM) characteristics. Therefore, the aim of my presentation lies in summarizing insights derived from our recent experiments, studying the relationship between the chemical and physical properties of pyrogenic organic matter – derived either form vegetation burning or from pyrolysis effects- and the C, N and P cycling in soils.

Key words: cropland burning, biochar, C, N and P cycling in soils.

Management and seasonal impacts on vineyards soil properties and hydrological response in continental Croatia

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Vineyards soil degradation is a global problem, especially due to the intensive practices such as frequent tillage. Several studies about the impact of vineyard management and season on soil properties and hydrological responses have been carried out in the Mediterranean region. A few studies have been carried out in other climate types. The objective of this work is to study the impacts of tilled and grass cover management on soil properties and hydrological response. The results show that Bulk density (BD), soil organic matter (SOM) and available phosphorous (P2O5) were significantly affected by treatment and time x treatment, while water holding capacity (WHC), soil water content (SWC), mean weight diameter (MWD), and water-stable aggregates (WSA) were significantly different between time, treatment, and time x treatment. BD, SOM, and P2O5 were significantly higher in grass covered plots than in the tilled ones. WHC was significantly higher in tilled plots compared to grass covered. The opposite was observed in SWC, MWD, and WSA. WHC and WSA were significantly lower in the wet period, while the contrary was identified in SWC and MWD. Time to ponding (PT), time to runoff (RT), sediment concentration (SC), sediment loss (SL), carbon loss (C loss), and P2O5 loss had significant differences in time, season, and time x season. PT and RT were higher in the tilled plot in the dry season, occurring the opposite in the wet one. SC, SL, C loss, and P2O5 loss were significantly higher in the tilled plot than in the grass covered one. Run, SC, SL, C loss, and P2O5 loss were significantly lower in the dry period. BD, MWD, WSA, SOM, and P2O5, (high in grass covered plots) were negatively associated with SC, SL, C loss, and P2O5 loss (high in tilled plots). The large amounts of sediment and nutrient transport occurred in the tilled area in the wet season. More sustainable practices are needed to decrease soil degradation and reverse this process.

Key words: Vineyards, season, soil degradation, nutrient transport, Croatia.

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Introducing Biochar to Conservation agriculture

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Climate change and soil degradation represent major threat to food production. To cope with that threat modern agricultural production must be knowledge-based and help agricultural producer to quickly adapt to this newly arisen situation. One of the latest good agricultural practice systems is Conservation agriculture (CA). The CA system follows three main principles: minimal soil disturbance, permanent soil cover and crop rotation. It is promoted as practice that is good alternative to conventional agriculture. The latest reports show that CA can cope with soil degradation, enhance soil productivity, increase yield and farmers income. But, in the view of current situation in agricultural production, especially on soils with low productivity, it is important to combine topics and to build strategy/platform through which farmers can benefit in economical way and in the same time adapt to climate change and protect the soils. The frequently mentioned measure of mitigating climate change and positively influencing soil health is the application of biochar. Biochar is the product obtained through the treatment of heating up biomass with little or no oxygen. Biochar as soil conditioner can positively affects a number of physical, chemical and biological soil properties. It is highly resistant to microbiological decomposition and mineralization, and it can be stable in the soil for few hundred years. Because of these characteristics it can sequestrate carbon in soil which directly influences the greenhouse gas emissions. To combine these two topics, we will need to overcome many gaps, especially to align biochar with the principles of CA. When we accomplish that, a base for better policy decision can be made and it can be used for creating profitable and sustainable agricultural production.

Key words: conservation agriculture, biochar, sustainable agricultural production, climate change, soil degradation.

MIP technology, a tool for sustainable management of soils

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Because soils provide 95% of food for people, it is essential to preserve and develop its ability to produce quantity and quality in a sustainable way. Soil functions are: organic matter decomposition, nutrients circulation, water retain and release and biological processes regulation. Compacted soil and lack of organic matter disturb this system. Olmix develops technology based on trace elements mixtures (Mineral Inducer Process- MIP) applied to the soil by a new generation of inputs (Geo2 and Neosol) dedicated to improve biological processes. As shown by the study led by Bioemco in France, MIP technology modifies predominant populations of microorganisms in the soil and balances soil's enzyme profile by amplifying diversity without causing a drop-in activity. The MIP ingredients act as a catalyst on plant/microflora/earthworm interaction. When MIP technology is applied to the field in a classical system with crops rotation (field crops measurements), the Agricultural Research Ltd. of Troubsko (CZ) shows that the application of this biostimulant has a positive effect on the physical and chemical properties of the soil. Improvement of soil properties is heading to better utilization of water and nutrients uptake. Yields increased by this product in comparison to control. In vineyard, the Technology Transfer Centre of San Michele all'Adige in Trento (Italy) shows that the soil receiving MIP technology exhibits a larger number of fine roots in the deeper layers in comparison to control. The effect of the treatment positively influences plant development, and significantly reflects in higher yield and better physiological and ecophysiological conditions, without modification of nutritional status, enhancing the accumulation in the plant too. The wines obtained from the treated vines appear fruitier and more floral. The results obtained using this MIP technology indicates that it seems to be interesting in root activity and soil structure, enhancing agricultural sustainability.

Key words: soil micro-organisms, rhizosphere, bio-stimulant, enzymes production, nutrient uptake.

Seaweed Extracts and Traces Elements to improve plant nutrition

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Terrestrial plant and soil micro-organisms build a strong exchange relationship in the rhizosphere. Plants give to the soil between 4 to 20 % of the carbon collected in the atmosphere. In exchange, microorganisms provide a better mineral and hydric nutrition to the plant. Moreover, they improve soil stabilization, bio-protection and improve plant yield and quality. These exchanges are essential for plant regular growth and health. One of the main actors of these exchanges are the Mycorrhiza, a symbiotic association between a fungus and a plant root. Olmix Group has developed a patented technology mixing specific trace elements (MIP Rhizo) and seaweed extract to improve the relationship between plant and soil microorganism. A study with AGRENE laboratory in France showed that MIP Rhizo increased soil organic matter mineralization and the nitrification process. BIOEMCO laboratory from Pierre and Marie Curie University (France) showed a multiplication between 3 and 10 of the Alkaline phosphatase activities (enzyme involved in phosphorus mineralization) after MIP Rhizo application. On the other side, a study set up with SAYENS AGRO-ENVIRONNEMENT showed that the use of specific seaweed extract in corn sowing line, stimulate the relative abundances of arbuscular mycorrhizal fungi Glomeromycota. The results showed a better photosynthetic activity, shoot diameter, roots growth of the corn after the seaweed application. MIP RHIZO ingredients and seaweed extract mixed together showed in a rhizotron trial a development of maize roots. It is observed as well a significant increase of mycorrhization frequency and intensity. These results on mycorrhization improvement were found again in 4 multilocation field trials on corn. The combination between MIP Rhizo and seaweed extract applied on the soil promotes interaction with plant and microorganism. That leads to a better plant nutrition and an improvement of crop yield and quality.

Key words: soil micro-organisms, rhizosphere, mycorrhiza, roots development, plant nutrition.

Development and effectiveness of strip-till technology in Poland

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Strip tillage (strip-till), enabling deep loosening (30-35cm) of narrow soil strips, was introduced in the USA in the 1980s. Initially, it was used only in the cultivation of maize, but over time it was adapted to plants grown in a row spacing of 45 cm. This mainly concerned sugar beet, and later also rapeseed. Finally, aggregates were introduced enabling cultivation and sowing in a row spacing of 30-35 cm. This enabled the use of this technology in the cultivation of most agricultural crops. In Poland, the first research works concerning strip-till were undertaken in 2006. Initially, interest in implementing of this technology was low. The growing interest has been observed since around 2010, and in the years 2015-2020 there was a dynamic development of this technology due to the appearance of aggregates from the Mzuri and Czajkowski companies. A certain obstacle in popularizing this technology was the high aggregate cost and the high demand for power of the tractor cooperating with it. However, there appeared companies providing services for farmers in this area. Currently, the share of conservation tillage in Poland is less than 10% of the cultivated area. There are no accurate data on the share of strip-till in the total area of agricultural crops. However, among conservation tillage technologies, strip-till using the mulching biomass of stubble catch crops is becoming increasingly popular. Strip-till one-pass technology is particularly interesting for farmers. It allows tillage, sowing and fertilizing, and sometimes also chemical treatment during one pass. This technology brings many economic, organizational and environmental benefits. Financial inputs and labor consumption for tillage and sowing in strip-till technology can be lower by over 50% compared to conventional technology. Moreover, it does not cause a significant reduction in yield, and some studies have even shown a positive impact of this technology on sugar beet and rapeseed yield. Research results show the numerous benefits of strip-till technology. They mainly include improving soil moisture in the vicinity of seeds sown, reducing organic matter loss and improving soil biological properties. The evaluation of the effects of strip-till is the basis for predicting its further popularization.

Key words: benefits, conservation tillage, Poland, soil properties, strip tillage.

Cover crop use for enhanced bio-energy strategy

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Cover crops, being grown on fields between main cash crops as additional bio-mass, can be utilized on several ways, such as green manure, feed or food. The upmost importance of establishing cover crop fast is more rule than exception, mostly due to local climate constrains, which provides opportunity to numerous soil tillage concepts, from no-till seeding to conservation tillage methods. At the same time, being cultivated between cash crops growth, from the standpoint of human food production, they can be assumed as non-competitive soil usage, which makes them interesting for bio-energy production. One of these options is bio-gas production, where cover crop use can be favorable for additional, food-non-competitive, bio-mass resource. Furthermore, after bio-gas production process, waste biomass, i.e. bio-digestate, can be applied directly on the field as valuable organic fertilizer, thus adding to soil fertility for following main crops. Next step is broadening of bio-digestate usage through possibility of algae production (both unicellular and multicellular) which can quickly create additional biomass, and which has the potential to convert into liquid biofuels, especially into biodiesel. Also, algae can be coupled with different bacteria, both symbiotic and non-symbiotic, which can be basis for even more productive biofuel production. Remaining material, double-used bio-digestate, cab be finally processed into convenient organic fertilizer, seedling production substrate and/or indoors plant cultivation (greenhouse production) substrate. On this way, cover crop production can enhance farm production, at the same time diversifying farm production, cutting down input costs and influencing farm sustainability and environmental functions, thus contributing toward circular economy of rural areas.

Key words: cover crops, biofuels, bio-energy strategy, algae, bio-green economy.

Conservation soil tillage as key approach and imperative of desertification, drought, soil degradation and climate change

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As an integrated and inevitable part of Conservation agriculture or Climate smart agriculture or Sustainable agriculture concepts, Conservation Soil Tillage (CST) has great potential for prevention and in some level's restoration of degraded agricultural land and soils. In the light of more frequent and severe effects and consequence of climate change, CST with different applicable techniques participate very active in mitigation and adaptation activities through crop production process. Degrading factors as desertification, drought, climate change, on global, regional or local level is recognized as one of the most important threats to land/soil/agriculture. All of these factors influenced every human and natural aspect as well as economy sectors. As results, negative effect arises and affect soil and agriculture on the most important ways. Some of most important is: soil erosion, loss of (agro)biodiversity, decreasing crop production, insufficient feed production, reduce water availability and quality, loss of soil fertility, soil salinization, loss of soil organic carbon, etc. All these phenomena lead to the degradation of the physical–chemical–biological complex of soil. All of this aforementioned factor is interconnected and they can be trigger and/or consequence of each other, but more important question is, how we can manage with it in agricultural production on sustainable way. Possible solutions can be divided to proactive and reactive approaches with different measures for prevention and restoration. Scheme for action can be simplified in pattern causes – consequences – solutions – actions. CSL, as action for solution, affects many (agro)environment aspects and as soil tillage is closer to basic conservation agriculture principles, it can be expected less soil damages and potential problems and risks to achievement of agricultural goods on sustainable way.

Key words: conservation soil tillage desertification, drought, soil degradation, climate change.

Green planting of soybean as a strategy to avoid tilled winter-bare fallows in irrigated cropping systems

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Water shortage is an important constrain for crop production in semiarid rainfed cropping systems. Water conservation through conservation soil tillage is a well-accepted strategy in areas such as the Mediterranean basin. Also, soil disturbance reduction contributes positively to soil fertility. Differently, irrigated systems in these areas are rather intensively tilled and based on maize monocropping systems, which are highly dependent on synthetic N fertilization and herbicides. Also, tilled bare fallow is the typical winter soil management. Such systems have led to soil degradation problems due to intensive winter tillage and pesticides and N dependence. In the framework of the LegumeGap EU Project (www.legumegap.eu), an on-farm irrigated cropping systems experiment was established covering 7 ha to evaluate soybean performance, among other novel aspects. Soybean establishment under a traditional winter-bare fallow was compared to green planted soybean on a living rye mulch (1000 g d.m. m-2 of biomass approximately at the termination date) using a combined equipment consisting of individual roller crimpers attached to each unit of a no-till planting machine (John Deere 1705 MaxEmerge® coupled with a ZRX Plus – With Integral row cleaner from Dawn®). Soybean emergence, biomass production, yield components, grain yield, biomass and grain nitrogen content, % of Ndfa, soil water and mineral N content and weed pressure were measured. First year's preliminary results showed that green planting does not pose a threat for soybean emergence. The percentage of emerged soybean increased slightly with the green planting system compared to the traditional management (74 and 66 %, respectively $p < 0.05$). The implementation of this system eliminates the winter-bare fallow and, therefore, the need for tillage to control weeds and prepare the soil previously to the summer crop planting. Also, it may help reduce weed pressure during soybean's development.

Key words: irrigated cropping systems; planting; roller-crimper; soybean.

Host of experiment location and field demonstration site

Family farm “PG Knežević” – Traditional Croatian breakfast

- Estate: cca 300 ha agricultural land
- Main crops: soybean, wheat, maize and silage maize
- Service / rent for cca 1500 ha
- Service for Biogas plants
- Employees: 3 family member and 2 workers

Experimental site – description and basic information

Site description

Stationary long-term field experiment was established in autumn 2017, on experimental station in Čačinci in eastern Croatia at Stagnosol soil type. Experimental site was settled in lowlands area with 1% slope (Long. 17.86336 E, Lat. 45.61316 N, Alt. 111 m) and belongs to the most crop productive region of Croatia (Appendix A.1. Experiment site location). The mean annual precipitation and temperature in 35-yr average (650 mm and 11.0 °C) is characterized by wide variation from 320 to 1240 mm and 9.4-12.9 °C. Temporal and spatial changes of main climatic element follow, in most cases, next schemes; the temperatures increase from west towards the east, and from northwest to northeast, while precipitation follow inversely sequences (source Meteorological and Hydrological Service of Croatia- DHMZ). Experimental site belongs to region which are strongly influenced by climate and weather conditions in Pannonian basin and the peri-Pannonian region.

Treatments description

(Appendix A.2. Experiment scheme)

Experimental factor A - soil tillage - as the main experimental factor:

- ST- Conventional/standard tillage – based on ploughing up to 30 cm depth,
- RT- Reduced tillage – based on chiselling up to 25 cm depth,
- CT- Conservation tillage – shallow soil surface preparation by chisel plough up to 10 cm depth.

Experimental factor B - Liming

- Wlim- With liming
- Lim- Without liming

Experimental factor C - fertilization/conditioners, as follows:

- I- Control (fertilization according to recommendation),
- II- 300 kg/ha Geo2 + fertilization (according to recommendation),
- III- 300 kg/ha Geo2 + N (according to recommendation),
- IV - 300 kg/ha Geo2 + fertilization (<50% lower dosage related to recommendation),
- V- biochar (40 t/ha), (without any additional fertilization),
- VI- biochar (40 t/ha) + N (according to recommendation).

Experimental factor D - cover crop

- a- with cover crop
- b- without cover crop

Fertilization recommendations are provided by the computer ALR expert calculator model. The experiment was set up on RCBD design with three repetitions (Appendix A.2. Experiment scheme). The size of basic experimental plot for each individual tillage treatment was 320 m2 and 80 m2 for each individual fertilization treatment. Except for the soil tillage and fertilization treatments, all the other technology sequences: sowing, P and K fertilizing, pests' control, machinery and equipment used were identical in all the treatments. Harvest was made by hand (in two days: 29-9 and 01-10) by combine harvester after sampling all plant material (grain + stalk + leaves). Combine harvester had integrated chopper/spreader system for better cutting and evenly distribution of crop residues.

Soil sampling and analysis

Soil samples for basic chemical analysis (Table 1) were collected before setting up of experiment with soil auger from 0 to 30 cm depth. Experimental site is treated as homogenous area and each composite sample were consisted of 20-25 individual soil cores.

Table 1. Soil chemical analysis (preliminary average soil sample from experimental site)

Sample	Depth	pH	pH	AL-P_2O_5	AL-K_2O	SOM	Hy
	(cm)	(KCl)	(H_2O)	(mg 100 g^{-1} soil)	(mg 100 g^{-1} soil)	(%)	($cmol^{(+)}$ kg^{-1})
Average	0-30	4.09	5.65	10.37	15.63	2.80	7.90

Soil samples for chemical properties used for soil type determination were taken from soil pit/profile (Table 2).

Table 2. Soil chemical properties of Stagnosol on experimental site

Soil depth	Soil reaction		mg 100 g^{-1} soil		SOM	Hy
cm	pH (KCl)	pH (H_2O)	AL-P_2O_5	AL-K_2O	(%)	($cmol^{(+)}$ kg^{-1})
0 - 32	3.92	5.12	4.8	11.15	2.83	7.48
32 - 65	4.23	6.16	2.0	10.69	0.83	4.07
65 - 200	4.39	5.92	1.8	11.37	0.48	3.15
200 - 240	4.72	6.11	6.1	6.50	0.31	2.67
240 - 280	4.65	6.07	8.8	7.47	0.28	2.19
280 - 305	4.73	6.17	9.1	8.89	0.34	1.79
305 - 330	5.12	6.21	11.8	9.75	0.59	1.40

Soil type was determined from soil pit (soil pit/profile (Appendix A.3.) according WRB soil determination and classification. Soil samples with undisturbed structure for analyses and determination of selected physical properties (Table 3) were taken from two different soil layer (0-32 and 32-65 cm depth) and in each layer five sample rings (metal cylinders with volume 100 cm^3).

Table 3. Soil physical properties in soil profile

Soil depth, cm	FC, %vol.	$\rho_{b,}$ g cm^{-3}	$\rho_{s,}$ g cm^{-3}	PD, g cm^{-3}	ϕ, %vol.	$\varphi_{a,}$ %vol.
10 - 15	43.04	1.50	2.65	1.76	43.50	9.07
40 - 45	42.58	1.56	2.74	1,87	42.97	9.36

FC = field capacity, %vol.; ρ_b g cm = bulk density,$^{-3}$; ρ_s = particle density, g cm^{-3}; PD = packing density, g cm^{-3}; ϕ = total porosity, %vol.; φ_a = aeration porosity, %vol.

Distribution of soil particle size (Table 4) was determined by pipette-method with wet sieving and sedimentation after dispersion with sodium pyrophosphate (ISO 11277, 2009). Soil texture determination was performed according USDA-NRCS (2016).

Determination of soil physical properties for long-term soil monitoring (Table 5), was performed according same methods.

Table 4. Soil texture and microaggregate stability

Soil depth,	Particle size mm, % fraction			Texture	Microaggregate stability	
cm	2.0-0.05	0.05-0.002	< 0.002		Ss, %	
0 - 32	9.81	60.84	29.35	silty clay loam	82.18	stability
32 - 65	8.31	57.61	34.08	silty clay loam	88.07	stability
65 - 200	10.79	58.92	30.29	silty clay loam	86.22	stability
200 - 240	30.79	55.66	13.55	silt loam	78.26	stability
240 - 280	30.46	57.14	12.40	silt loam	74.60	stability
280 - 305	26.15	59.46	14.38	silt loam	73.29	stability
305 - 330	29.24	56.14	14.61	silt loam	74.32	stability

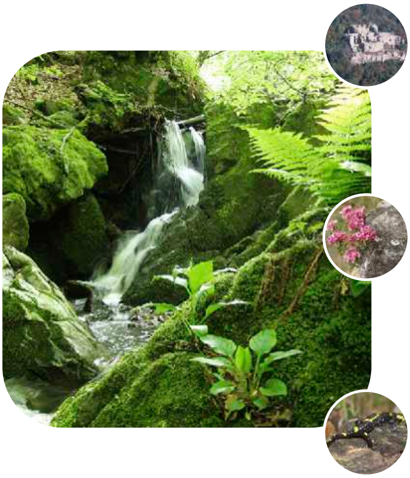
Table 5. Soil physical properties for long-term soil monitoring

Treatment	Soil depth, cm	FC, %vol.	ρ_b, g cm^{-3}	ρ_s, g cm^{-3}	PD, g cm^{-3}	ϕ, %vol.	φ_a, %vol.
ST	5	37.22	1.45	2.60	1.72	44.17	11.95
	20	35.59	1.47	2.60	1.73	43.49	13.40
	45	33.86	1.59	2.67	1.90	40.30	11.09
RT	5	38.75	1.52	2.60	1.78	41.69	5.71
	20	39.55	1.38	2.62	1.65	47.16	14.74
	45	34.35	1.59	2.60	1.89	39.05	7.57
CT	5	38.24	1.48	2.57	1.75	42.31	9.46
	20	37.30	1.49	2.60	1.75	42.86	13.87
	45	37.03	1.53	2.67	1.84	42.59	13.74
ST-	5	37.85	1.41	2.63	1.68	46.27	13.99
additional plots	20	40.24	1.40	2.62	1.66	46.71	15.58
	45	35.07	1.55	2.63	1.86	40.86	11.69
RT-	5	36.98	1.47	2.61	1.73	43.65	14.47
additional plots	20	36.80	1.50	2.62	1.76	42.88	15.48
	45	32.42	1.56	2.63	1.86	40.77	14.58
CT-		37.51	1.43	2.62	1.71	45.11	14.37
additional plots		38.12	1.44	2.62	1.77	43.71	15.50
		33.97	1.55	2.64	1.87	41.01	13.68

FC = field capacity, %vol.; ρ_b g cm = bulk density,$^{-3}$; ρ_s= particle density, g cm^{-3}; PD = packing density, g cm^{-3}; ϕ = total porosity, %vol.; φ_a = aeration porosity, %vol.

Visiting to Nature Park Papuk

Locality “Jankovac”



Proclamation of the Nature Park Papuk, on April the 23rd 1999, because of its extraordinary geological and biological variety and valuable cultural and historical inheritance.

Inside the Park are numerous areas with a higher protection level then other parts of the Park. These areas have been given the status of specially protected areas because of their unusual features, manifesting them as unique on the area, region, State or even beyond. Specially protected areas are: the geological nature monument Rupnica, the Forest Park Jankovac, the special reserve of forest vegetation Sekulinačke planine (Sekulinačke Mountains), the nature monument Dva hrasta (Two Oaks), the nature monument Stanište tise (Yew Habitat), and the special floristic reserve Pliš-Mališćak-Turjak-Lapjak.

Locality "Rupnica" (Basalt columns)

As basaltic lava cools over an extended period of time, beautiful geometric forms emerge; incredible columns of hexagonal basalt rock.

The area of the Nature Park represents geological the most various area on this part of the Republic Croatia. Following the European and World initiatives about the protection of valuable geological inheritance, associations like the European Geoparks Network (EGN) and the Global Geoparks Network (GGN) were founded. The Nature Park Papuk became member of these mentioned associations in 2007, as first geological Park from Croatia.

Soil fertility and plant biostimulation!

The French group Olmix is one of the world leaders in terms of algae valorisation.

Olmix's mission: to develop algo-based solutions for plants and animals in order to considerably reduce the use of fertilizers, pesticides and antibiotics.

With its expertise in the promotion of active ingredients from algae but also of the properties of trace elements, Olmix Group offers biosolutions dedicated to optimizing the physiology of plants and soil functioning. Soil microbial biomass activators, stimulators of the rhizosphere, organic and mineral fertilizers powered by biostimulating technologies, foliar biostimulants: so many tools available to farmers wishing to progress in agroecology. Holder of several patents and approvals, Olmix provides concrete solutions to the problems of soil degradation (capping, biodiversity loss, erosion, waterlogging, drought sensitivity, compaction) and crop stress (climatic hazards, stress linked to phytosanitary products, drought stress...).

Because the challenges of today are no longer those of yesterday, it is essential to reposition agronomy at the heart of strategic thinking. And because agronomy is not only common sense, but also good tools, Olmix's biosolutions are considerable assets in supporting and securing the evolution of performing production systems towards routes that require less fertilizer, less pesticides and energy.

Across Europe, numerous studies and scientific works demonstrate the technical and economic effectiveness of Olmix biosolutions.

As a specialist in marine biotechnology, Olmix Group brings natural sources of nutrition and health to plants, animals and people, for a complete, consistent food and health chain, thanks to algae!

Thanks to algae!

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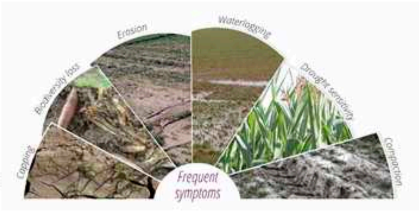
OLMIX biosolutions

Geo2 - SOIL MICROBIAL BIOMASS ACTIVATOR

RESTORED SOIL HEALTH

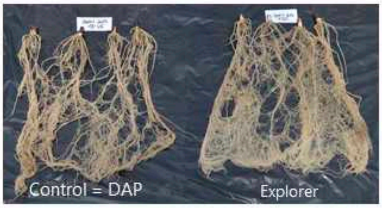


STRENGTHS

- Stimulation of soil microflora and enzymatic activity
- Better humification of organic matter
- Development of the clay-humic complex
- Improved soil structure and aeration

Explorer - ROOTING STIMULATOR

IMPROVED YIELD



STRENGTHS

- Better development of the root system
- Stimulates mycorrhizal growth
- Better resistance to drought stress
- Several formulas available (S/NS/NPS)

Agroptim SUNSET – PLANT BIOSTIMULANT

REINFORCED PLANT RESISTANCE TO STRESS

STRENGTHS

- stimulates photosynthetic activity
- Improves nutrients uptake
- Enhances root growth
- Boosts detoxification after weeding

Thanks to algae!

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savjeti * prodaja * servis
New Vario-S
TULIP Multidisc
YouTube
modular

Standard specification
- Integrated subsoiler tines with hydraulic stone protection
- 2 Rows of large discs made out of hardened steel Ø 560 mm
- Replaceable tine points, shins and wings; 3 models of wings available
- Heavy bearings with overdimensioned wheel hubs, low maintenance
- Torsion bar suspension by means of triangular rubbers for a maximum freedom of movement of every disc separately
- Stable, powder coated frame with robust headstock
- Up to 350 XL Vario: linkage cat. III
- Up from 400 XL Vario: linkage cat. III/IV
- Depth control by means of the floating system with crumbler roller Ø 520 mm
- The XXLT Vario is a rigid pulled combination: Multidisc XXL Vario with a robust transport under-carriage, hydraulically braked axle, tyres 700/50x26.5 and 2 rows of discs made out of hardened steel Ø 610 mm

Special benefits
- Tillage of the upper soil layer and deep cultivation in one pass
- Pivoting beam on which the subsoiler tines are mounted. The hydraulic retractable tine bar allows transforming the machine into a normal disc harrow in just a few seconds.
- The tines are individually adjustable in both height and width. So it's possible to position a tine right in the wheel track of the tractor and to set it a little deeper than the other tines. Or just mount 2 tines and use them only in the tram lines.
- Depth of tines: from 2 up to 24 cm under the discs. So both shallow and deep tine settings are possible.
- Hydraulic stone protection: if necessary the tines can break out upwards. The discs and roller continue to follow the ground. The sensitivity is adjustable.
- Hardened steel discs, solid side fastening with 5 bolts 10.9, simply accessible.
- The aggressive action of the serrated discs and the extra large distance between the rows of discs give an ideal mulching and mixing result of crop residue or green cover crops.
- Extra protected sealing of the bearings; lubricator chamber provided with a large quantity grease; hot forged hub.

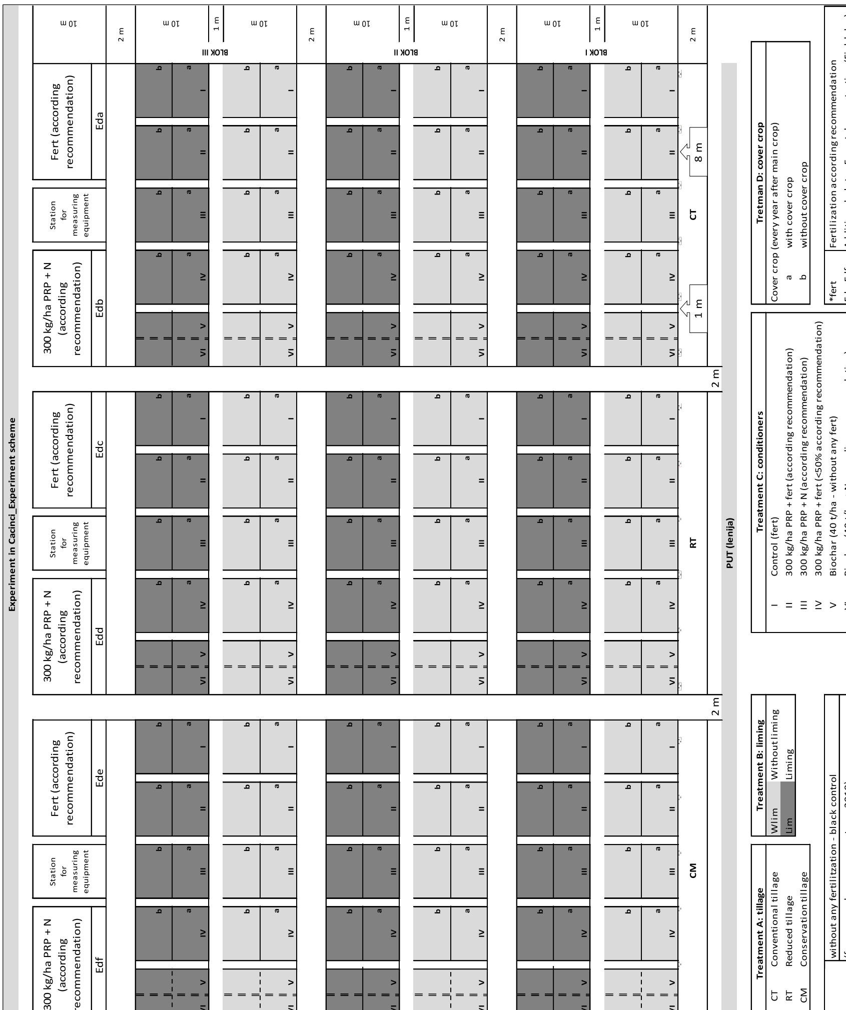
Further explanation accessories
- The packer roller Ø 500 mm is in combination with this heavy machine only suited for heavy, non sticky soil.
- Hydraulic roller adjustment: two cylinders, which make it possible to adjust the roller by using the tractor hydraulics.
- Straw harrow: is mounted behind the last row of discs and assures an improved coverage of crop residue. The height and angle are adjustable.
- Soil deflector plate right: a ground following side plate which keeps the soil stream inside the working width. Transport width increases with 7 cm.

Innovative equipment – additional material connected with Abstract "Green planting of soybean as a strategy to avoid tilled winter-bare fallows in irrigated cropping systems" (Genís Simon-Miquel, Ramon Pujol, Daniel Plaza-Bonilla

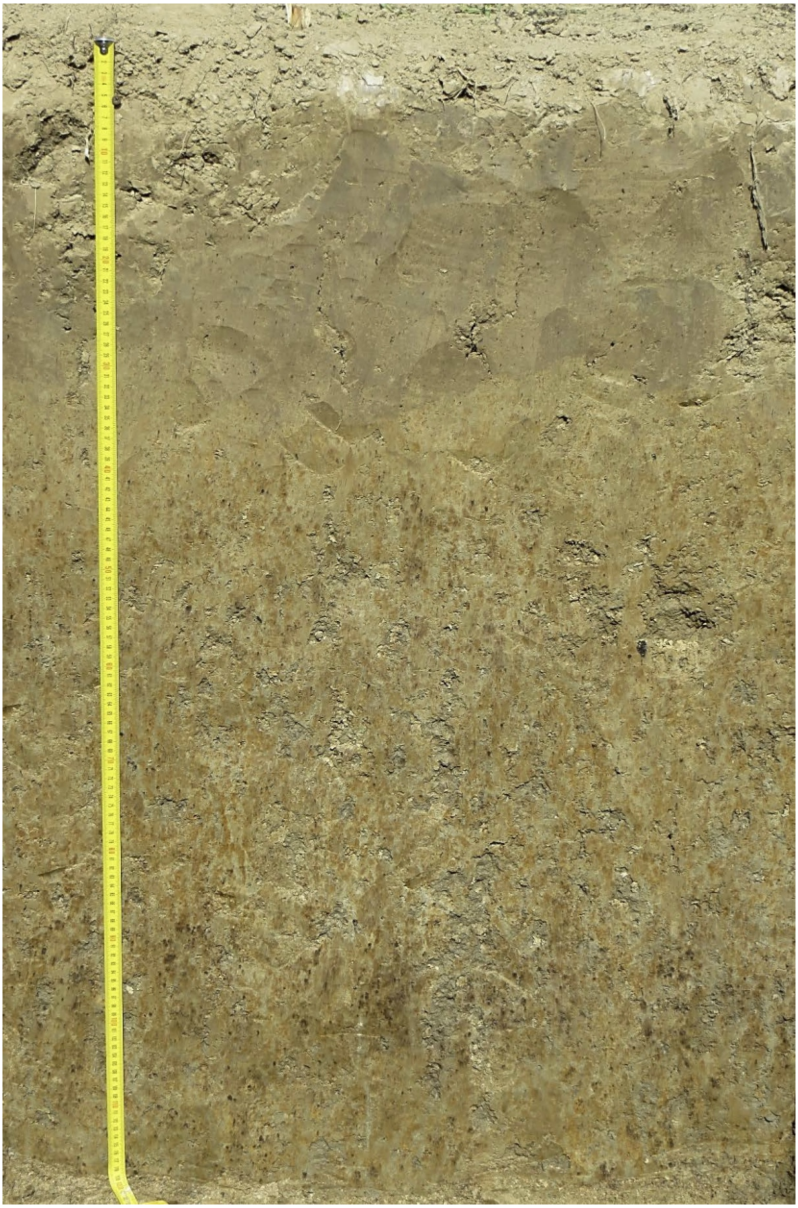
Figure 1. Soybean and maize planting green on rye cover crop in an on-farm sprinkler-irrigated cropping systems experiment located in Sucs (Lleida, Spain) in the framework of the ERA-NET project LegumeGap (www.legumegap.eu). Above: individual hydraulic roller-crimpers (ZRX Plus – With Integral row cleaner from Underground Ag Co, Dawn®, Sycamore, IL, USA) are attached to the different no-till row units. Additional weight was added by Jolbertal SL (collaborating farmers) to assure enough soil penetration under harsh conditions. Below: a proper planting depth and rye mulch management requires careful check.

Appendix A.1. Experiment site location

Appendix A.2. Experiment scheme

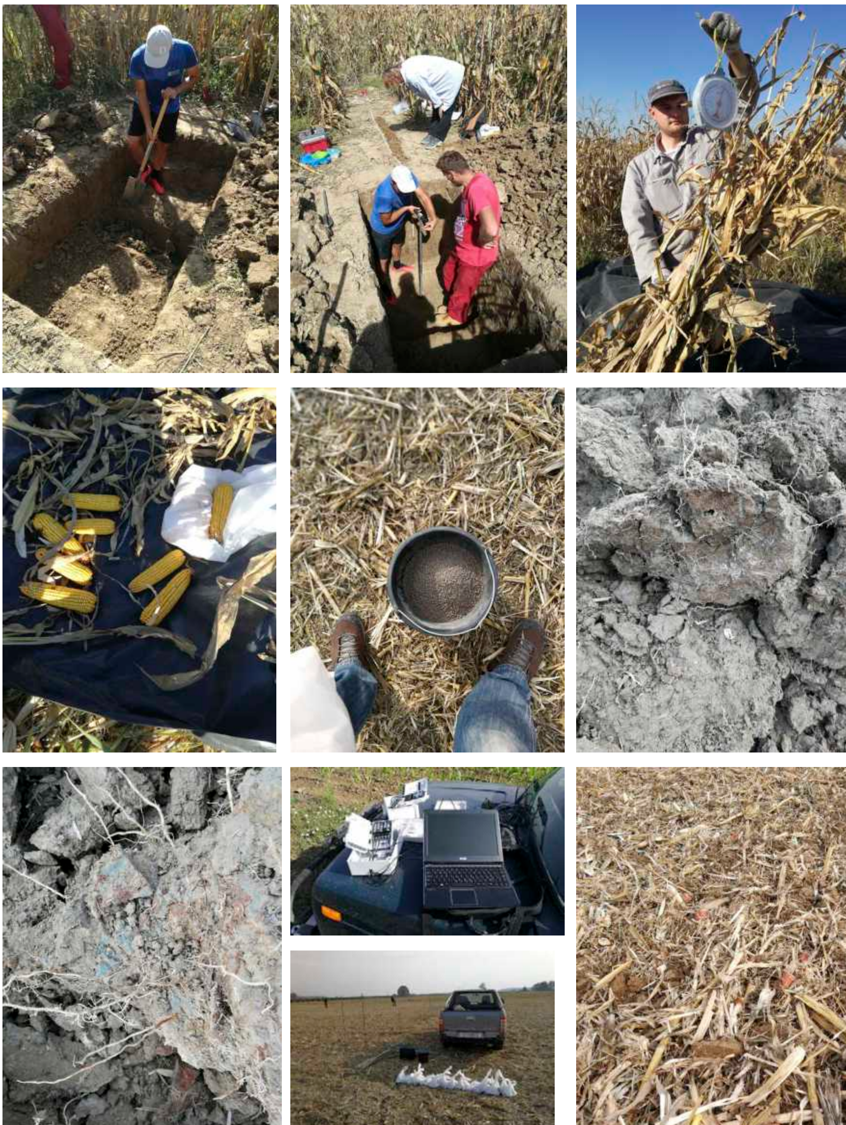


Appendix A.3. Stagnosol soil type



Profile description: P - S - II S - C

Appendix A.4a. Photo documentations from experimental site



Appendix A.4b. Photo documentations from experimental site

Appendix A.4c. Photo documentations from experimental site

Main organizer contacts:

Working Group – Conservation Soil Tillage (WG-CST): https://www.istro.org/index.php/working-groups/wg-c-conservation-soil-tillage

International Soil Tillage Research Organization (ISTRO)	Croatian Soil Tillage Research Organization (CROSTRO)
Web page: www.istro.org E-mail: ○ ISTRO Secretary General: Blair McKenzie (blair.mckenzie@hutton.ac.uk) ○ ISTRO President: Nicholas Holden (nick.holden@ucd.ie) ○ ISTRO Treasurer: Stephen A. Prior (steve.prior@ars.usda.gov) ○ Other ISTRO board members can be found on the board page	Web page: www.hdpot.hr E-mail: info@hdpot.hr Tel: +385(0)31-554-833 GSM: +385 (0)98 9318 662 Address: Croatia Soil Tillage Research Organization Faculty of Agrobitechnical Sciences Vladimira Preloga 1 31000 Osijek Croatia