ORAL SESSIONS

S1. PRODUCTION TECHNOLOGIES OF BIOCHARS, COMPOSTS AND DIGESTATES BY CONVERSION OF SOLID AND FLUID BIOWASTES/BIOSOLIDS

S1.1 RECYCLING ORGANIC WASTES BY SUSTAINABLE AND INNOVATIVE TECHNOLOGIES FOR THE PRODUCTION OF TAILORED COMPOSTS
Sponsored by ***Tersan Puglia SpA***

S2. ANALYSIS AND CHARACTERIZATION OF BIOWASTERS, BIOCHARS, COMPOSTS AND DIGESTATES

S2.1 STATUS OF THE ART IN BIOCHAR CHEMISTRY: CHEMICAL AND CHEMICAL PHYSICAL CHARACTERIZATION

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S2.3. CHEMICAL PROPERTIES OF BIOCHARS, COMPOSTS AND DIGESTATES – DESIGN FOR OPTIMUM EFFICACY

S3. SUSTAINABLE USES, APPLICATIONS AND ENVIRONMENTAL IMPACT OF BIOCHARS, COMPOSTS AND DIGESTATES

S3.1 USE OF COMPOSTS TO PROMOTE THE PHYSICAL, CHEMICAL AND BIOLOGICAL SOIL QUALITY STATUS FOR PLANT PRODUCTION

S3.2. THE COMPOST AS ORGANIC AMENDMENT: A STRATEGY TO MAINTAIN SOIL SUSTAINABILITY IN A GLOBAL CHANGE ERA

S3.3. EFFECTS OF BIOWASTE AND BIOCHAR ON ENVIRONMENTAL PROPERTIES AND SOIL FUNCTIONS - CAN LONG-TERM PROCESSES BE FORECASTED FOR A SUSTAINABLE AGRICULTURE?

S3.4. IMPACT OF BIOCHARS, COMPOSTS AND DIGESTATES ON FATE, BEHAVIOUR AND BENEFIT/RISK ASSESSMENT OF ORGANIC AND INORGANIC CONTAMINANTS IN SOIL

S3.5. MANAGEMENT STRATEGIES AND ENVIRONMENTAL RISKS OF MANURES AND BY-PRODUCTSFROM AGRO-INDUSTRIES IN SUSTAINABLE AGROECOSYSTEMS

S3.6a. SMALL SCALE TREATMENT AND USE OF ORGANIC WASTES IN RURAL AREAS OF TROPICS AND SUBTROPICS

S3.6b. SMALL SCALE TREATMENT AND USE OF ORGANIC WASTES IN RURAL AREAS OF TROPICS AND SUBTROPICS

S3.7. SOIL ORGANIC MATTER AMENDMENTS: IMPACTS, BENEFITS, AND RISKS

S3.8. LONG-TERM SURVIVABILITY OF BIOCHAR AND DIGESTATES IN SOILS AND SOIL CARBON SEQUESTRATION WITH AGRICULTURAL IMPLICATIONS - MYTH OR REALITY?

W3. END O SLUDG

S4. CERTIFICATION, REGULATION AND MARKETING OF BIOCHARS, COMPOSTS AND DIGESTATES

S4.1. QUANTITATIVE DETERMINATION, APPLICATIONS AND PLANT RESPONSE OF COMMERCIAL HUMIC MATERIALS
Sponsored by the ***International Humic Substances Society (IHSS)***

S4.2. ECONOMIC AND QUALITY DETERMINANTS TO FOSTER THE BCD INDUSTRY: MARKETS, INVESTMENTS, AND POLICY MEASURES

POSTER SESSIONS

PS1. PRODUCTION TECHNOLOGIES OF BIOCHARS, COMPOSTS AND DIGESTATES BY CONVERSION OF SOLID AND FLUID BIOWASTES/BIOSOLIDS

PS2. ANALYSIS AND CHARACTERIZATION OF BIOWASTES, BIOCHARS, COMPOSTS AND DIGESTATES

PS3a. SUSTAINABLE USES, APPLICATIONS AND ENVIRONMENTAL IMPACT OF BIOCHARS, COMPOSTS AND DIGESTATES

PS3b. SUSTAINABLE USES, APPLICATIONS AND ENVIRONMENTAL IMPACT OF BIOCHARS, COMPOSTS AND DIGESTATES

PS4. CERTIFICATION, REGULATION AND MARKETING OF BIOCHARS, COMPOSTS AND DIGESTATES

S1. PRODUCTION TECHNOLOGIES OF BIOCHARS, COMPOSTS AND DIGESTATES BY CONVERSION OF SOLID AND FLUID BIOWASTES/BIOSOLIDS

S1.1 **19 October, h. 10:30 – 12:15** *Sponsored by* ***Tersan Puglia SpA***

Title: **RECYCLING ORGANIC WASTES BY SUSTAINABLE AND INNOVATIVE TECHNOLOGIES FOR THE PRODUCTION OF TAILORED COMPOSTS**

***Chairpersons*:** Paolo Sequi, *Roma, Italy*
Giovanni Gigliotti, *University of Perugia - Perugia, Italy*

S1.1.01 **Sustainable production at the firm and region level: the case of compost production**
Vito Albino, *Politecnico di Bari - Bari, Italy*

S1.1.02 **Methodologies for odour control in composting plants**
De Gennaro Gianluigi, Brattoli Magda, *University of Bari - Bari, Italy*

S1.1.03 **Effects of different substrate mixtures on methane production**
Hartung Eberhard, Ohl Susanne, Hold Annika, Bölter Manfred, Horn Rainer, Holthusen Dörthe, Völkner Amrei - *Christian-Albrechts-University Of Kiel - Kiel, Germany*

S1.1.04 **Nitrogen and water recovery from animal slurries by a new integrated ultrafiltration, reverse osmosis and cold stripping process: a case study**
Ledda Claudio, Schievano Andrea, Salati Silvia, Terruzzi Laura, D'Imporzano Giuliana, Adani Fabrizio - *University of Milan - Milan, Italy*

S1.1.05 **Microbial community characterization of a biofertilizer from biodegradable wastes**
Vernile Pasqua, *Tersan Puglia Spa – Modugno (BA), Italy*
Pascazio Silvia, *University of Bari - Bari, Italy*
Sequi Paolo, *Cra-Qce - Bari, Italy*
Monteforte Antonio, *Tersan Puglia Spa - Bari, Italy*

S1.1.06 **Biodegradability of different biochars**
Wilske Burkhard, Bai Mo, Bach Martin, Frede Hans-Georg, Breuer Lutz - *Justus Liebig University - Giessen, Germany*

S1.1.07 **Cascaded production of biogas and HTC chars using straw as feedstock**
Mumme Jan, Srocke Franziska, Schulze Michael, Lanza Giacomo, Kern Jürgen, *Leibniz Institute For Agricultural Engineering Potsdam-Bornim - Potsdam, Germany*

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International Conference
Biochars, Composts, and Digestates.
Production, Characterization, Regulation, Marketing, Uses and Environmental Impact
October 17 to 20, 2013 - Bari (Italy)

Presenting author:

Vito Albino, Dipartimento di Meccanica, Matematica e Management - Politecnico di Bari, Italia

SUSTAINABLE PRODUCTION AT THE FIRM AND REGION LEVEL: THE CASE OF COMPOST PRODUCTION

In a world at the same time demanding better lives for the global population and requiring responses to the environmental problems, growth and development have to be sought improving human well-being, and preserving the natural capital upon which we all depend. Specifically, we must catalyse investment and innovation which will underpin sustained growth and give rise to new business opportunities.
Referring to production activities (agriculture, resource extraction, manufacturing), sustainable production means the creation of goods and services using processes and systems that are non-polluting, conserving of energy and natural resources, economically efficient, safe and healthful for workers, communities, and consumers, and socially and creatively rewarding for all working people. Six sectors mainly characterize such a green economy: renewable energy, green buildings, clean transportation, water management, waste management, and land management.
In this paper we analyze an important business area which overlaps waste and land management: the compost production. Several benefits can be obtained by composting. Among them, we mention the reduction or elimination of chemical fertilizers, pesticides and water needs, the promotion of higher yields of agricultural crops and the extension of municipal landfill life by diverting organic materials from landfills.
We consider that all these benefits could be worth at both economic and social level for a firm and region. Then, it is extremely effective in terms of business as it represents a sustainable production process at both geographical scales. However, we argue that such a business area requires a socially

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METHODOLOGIES FOR ODOUR CONTROL IN COMPOSTING PLANTS

The increasing attention for odour emissions, produced by industrial plants, reveals the need to identify methodological approaches, suitable for their monitoring and control. In particular, composting plants represent critical sites; in fact, also the international and local legislations have dedicated specific regulation for them. The odour assessment is an extremely complex topic, due to the numerous substances composing the odour mixtures, the different reactions that could occur among them and the strict association with the olfactory perception.
For these reasons, a sensorial methodology, the dynamic olfactometry, has been developed and standardized as official method for odour evaluation (European technical law EN 13725/2003). It employs the human nose as the odour detector, relating directly to the properties of odours as experienced by humans. However, dynamic olfactometry is affected by some limitations; it does not allow to perform continuous and on field measurements, and it does not discriminate among single chemical compounds. So, it is necessary to integrate information provided by different approaches. The implementation of continuous monitoring systems, constituted by electronic noses, single or multiparameter sensors, etc., represents a useful approach to achieve a rigorous control of productive processes causing odour emission. Moreover, in some cases, it is necessary to employ chemical characterization for the identification of marker compounds, typical of specific sources. The emissive data are essential for estimating the impact produced by plants to the receptors, generally carried out by using dispersion models or other methods, involving directly the population.

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EFFECTS OF DIFFERENT SUBSTRATE MIXTURES ON METHANE PRODUCTION

Biogas production has expanded substantially in Germany within the last years. The exact pre-estimation of the substrate specific biogas and methane yield is essential for the dimension of practical biogas plants as well as for their economic assessment. Otherwise the digestates were used as fertilizer.
The current study is part of a cooperative project of Kiel University, Northern Germany, which started in October 2012. Typical regional energy crops (maize, wheat, grass, sugar beet) are harvested, prepared and analysed in discontinuous fermentation tests, to identify their specific biogas and methane yield. The digestates are used to identify their impact on the microbiological and soil characteristics both under field and laboratory conditions. This approach enables a holistic view of the process chain from the ensiling of energy crops over the process of biogas formation to the effects of the applied digestates.
To determine the biogas and methane yield under laboratory conditions in the first step a common fermentation test with dried and milled substrates is featured. Sewage sludge is used as inoculum. Substrates are fermented separately or in different mixtures respectively for 28 days. In the next steps ensiled substrates will be investigated in the same way and in a continuous fermentation test.
Due to the compounds of substrates and mixtures different runs of the gas formation curves result as well as different level of specific methane production. For mixtures, effects will be shown, which are based on co-digestion. The presentation will highlight the first results of this study.

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Adani Fabrizio - University Of Milan - DISAA - Milan, Italy

NITROGEN AND WATER RECOVERY FROM ANIMAL SLURRIES BY A NEW INTEGRATED ULTRAFILTRATION, REVERSE OSMOSIS AND COLD STRIPPING PROCESS: A CASE STUDY.

The correct management of livestock manure represents one of the major challenge for the agricultural sector development, as it may ensure environmental and economic sustainability of livestock farming. In this work, a new treatment process called N-Free®, was monitored on two plants treating digested cattle manure (DCM) and digested swine manure (DSM). The process is characterized by sequential integration of solid/liquid separations, ultrafiltration, reverse osmosis and cold ammonia stripping. Solid and liquid streams were characterized regarding TS, TKN, N-NH4+, P and K content allowing to draw a complete mass balance. The main results were a substantial reduction of initial digestate volume (38 and 51% in DCM and DSM respectively) as clean water and a high N-NH4+ removal percentage (47 and 71% in DCM and DSM respectively), through cold ammonia stripping, allowing the production of up to 1.8 m3 concentrated ammonium sulfate, every 100 m3 of digestate treated. The concentrated streams, rich in either organic or mineral N, P and K, can be efficiently used for land application.
The N-Free® technology demonstrated to be a valuable candidate for the path towards nutrient and water recycle, in a new sustainable agriculture and farming concept.
A study has been performed, using a LCA approach, on one of the two systems (swine manure) in order to assess how environmental performances of a traditional manure management system can improve using the N-Free® technology.

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Monteforte Antonio - Tersan Puglia Spa - Direzione Agronomica - Bari, Italy

MICROBIAL COMMUNITY CHARACTERIZATION OF A BIOFERTILIZER FROM BIODEGRADABLE WASTES

In the last years the sensitiveness on environment protection has grown exponentially In particular, massive use of chemical fertilizers and pesticides has been extensively revised Soils of Mediterranean area are affected by high salt contents and/or high carbonate amounts Saline soils modify plant physiology and decrease their production; calcisols reduce trace and macro-elements availability for plants, inducing nutritional deficiencies Chemical pesticides can have mutagenic, carcinogenic and teratogenic effects on human health, therefore their replacement with organic products should be encouraged The Bacillus spp produce compatible solutes which induce plant resistance against osmotic stress in saline soils, whereas the Pseudomonas spp are plant growth promoters which produce secondary metabolites, such as antibiotics and siderophores, improving elements availability in calcisols The aim of this research is the characterization of microbial community of a biofertilizer from biodegradable wastes (food and kitchen waste, green waste) Total DNA was extracted by a direct method and PCR amplified by specific primers for the 16S rRNA gene targeting total bacteria community, Pseudomonas and Bacillus and of the 18S rRNA gene for fungal community Amplicons were separated by denaturing gradient gel electrophoresis (DGGE) and genetic fingerprints were used to produce similarity dendrograms via the unweighted pair group method with the arithmetic average (UPGMA) clustering algorithm based on the Pearson product-moment correlation coefficient by the BioNumerics software (Applied Maths) On the basis of these preliminary results, a key parameters such as pH, temperature, moisture and oxygen will be set up to promote the increase of microbial populations of interest

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BIODEGRADABILITY OF DIFFERENT BIOCHARS

Long residence times of biochar in soil are desired to achieve benefits in terms of carbon sequestration Biodegradation is a main driver restricting the carbon sequestration potential of biochar (BC) The present study aimed at BC-related parameters that inform about the biodegradability, and vice versa, about the inherent recalcitrance of BCs in soil We investigated the biodegradability of three BCs from pyrolysis (pyrBC) and six from hydrothermal carbonization (htcBC), all of which were from Miscanthus feedstock Each BC was incubated with two sandy soils representing prime candidates for agricultural BC amendment Biodegradation of BCs was determined by means of the 13CO2 efflux from sample incubations using an automatic system including wavelength scan cavity ring-down spectroscopy (Bai et al 2011) In addition, BCs were analyzed for ash content, H:C ratio and O:C ratio Only in 3 of 9 cases, biodegradation was significantly different between the two soils In agreement with an earlier study (Bai et al, 2013), the htcBCs were more readily degradable than the pyrBCs; although this time, the most recalcitrant htcBC almost matched the least recalcitrant pyrBC The 200-day biodegradation of htcBCs ranged from 4 3±0 4% to 24 0±1 5%, whereas it varied between 0 6±0 3 and 4 2±1% in pyrBC Pooled data including different BC types, BC products and soils showed clear linear correlations with O:C ratio and H:C ratio, but not with ash content or highest temperature treatment Overall, the results return importance to biochar-related parameters for the assessment of the BC-stability and potential carbon

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CASCADED PRODUCTION OF BIOGAS AND HTC CHARS USING STRAW AS FEEDSTOCK

Combining production of biogas and biochar can result in various synergies. The digestate of anaerobic digestion can serve as feedstock for biochar production while the chars can improve the biogas process by adsorbing potential inhibitors. As digestates are usually rich of water, a water-based char production process such as hydrothermal carbonization (HTC) could be more feasible than pyrolysis. The use of HTC for converting digestate into HTC char was shown by experimental means. Adding the energetic value of the digestate-based biochar to the produced biogas can increase the overall energy efficiency of biomass conversion by a large extent: Our results for the use of wheat straw show an efficiency increase from 1/3 (only biogas) to 2/3 (biogas and HTC). In respect to the soil use, incubation experiments reveal that straw-based digestates can be made seven times more stable when treated by HTC. Some process parameters, especially reaction temperature, had a significant impact on the mean residence time in the soil. Furthermore, field experiments showed that application of fresh HTC char causes negative effects on crop growth. However, fermenting the chars prior to soil application caused the negative effects to vanish. A general difficulty of the characterization of HTC char is the high variability of its composition depending on raw material and production conditions as well the complexity and dynamic of soils. Therefore, practical application of HTC chars in the soil needs more research, especially in respect to ecotoxic effects, and advanced analytical methods such as isotopic labelling.

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S2. ANALYSIS AND CHARACTERIZATION OF BIOWASTERS, BIOCHARS, COMPOSTS AND DIGESTATES

S2.1 **18 October, h. 8:30 – 10:00**

***Title*:** **STATUS OF THE ART IN BIOCHAR CHEMISTRY: CHEMICAL AND CHEMICAL-PHYSICAL CHARACTERIZATION**

***Chairpersons*:** Jose M. Garcia-Mina, *University of Navarra - Pamplona, Spain*
Bruno Glaser, *Martin-Luther-University Halle-Wittenberg, Halle, Germany*

Plenary Lecture: **Analysis and characterization of biowastes, biochars, composts and digestates**
Glaser Bruno, *Martin-Luther-University Halle-Wittenberg, Halle, Germany*

S2.1.01 **Differential and common structural domains in humic substances with diverse origins and humification degree**
Fuentes Marta, Baigorri Roberto, *G Roullier R&D - Pamplona, Spain*
Garcia-Mina Jose M., *G Roullier R&D and University of Navarra - Pamplona, Spain*

S2.1.02 **Structural differences between humic substances from natural sources and valorized organic waste (compost, biochars) – how does source material and humification conditions define their sturcture**
Knicker Heike, De La Rosa José María, López-Martín María, *IRNAS-CSIC - Sevilla, Spain*
Velasco-Molina Marta, *Universidad de Santiago de Compostela - Santiago de Compostela, Spain*
Gónzalez-Vila Francisco J., Gónzalez-Pérez José A., *IRNAS-CSIC - Sevilla, Spain*
Almendros Gonzalo - *MNCN- CSIC - Madrid, Spain*

S2.1.03 **Biochar changes the stability and fluxes of dissolved organic matter**
Smebye Andreas L., *University of Oslo - Oslo, Norway*
Alling Vanja, Hale Sarah E., *Norwegian Geotechnical Institute - Oslo, Norway*
Mulder Jan, *Norwegian University of Life Sciences - Aas, Norway*
Vogt Rolf D., *University of Oslo - Oslo, Norway*
Cornelissen Gerard, *Norwegian Geotechnical Institute, Norwegian University of Life Sciences and Stockholm University – Oslo - Norway, Aas, Norway - Stockholm, Sweden*

S2.1.04 **Biochar, can it replace soil organic matter?**
Zwart Kor, Kuikman Peter, *Alterra WageningenUR - Wageningen, Netherlands*

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Presenting author:
Glaser Bruno - Martin-Luther-University Halle-Wittenberg - Soil Biogeochemistry- Halle, Germany

ANALYSIS AND CHARACTERIZATION OF BIOWASTES, BIOCHARS, COMPOSTS AND DIGESTATES

Recycling of biowastes or creation of added value products such as biochar composts are challenges for a sustainable circular economy. To classify such materials as appropriate environmental amendments, appropriate analytical tools are necessary. For this purpose, well established classical methods such as elemental composition can be used to characterize material properties such as nutrient contents or C/N, H/C and O/C ratios. In addition, level of toxic elements such as heavy metals, polycyclic aromatic carbons or dioxins need to be analysed. Furthermore, potential environmentally toxic behaviour needs to be evaluated.

For practical purposes, the development of fast analytical tools such as non-destructive and non-invasive techniques for rapid data acquisition are required such as Fourier Transformation infrared spectroscopy or cavity ring down laser spectroscopy. Concerning identification and quantification of biowaste-related processes in the environment, also more sophisticated and resource-intensive technologies such as position-specific isotope analyses are required. This method spectrum allows us to cover research questions from the molecule up to the ecosystem or from basic research up to applied research including certification and control processes.

During the keynote lecture, these methods will be explained and available results will be summarized in a holistic context.

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Garcia-Mina Jose M - G Roullier R&D And University Of Navarra - R&D - Pamplona, Spain

DIFFERENCIAL AND COMMON STRUCTURAL DOMAINS IN HUMIC SUBSTANCES WITH DIVERSE ORIGINS AND HUMIFICATION DEGREE

The aim of this study has been to investigate those structural features that are singular of a specific type of humic substances (humic and fulvic acids with diverse origins: sedimentary, lakes, composts) as well as those that may configure the humic nature in these substances.
To this end several humic and fulvic acids extracted from diverse materials were analyzed employing complementary structural techniques such as UV-Visible, FTIR, 13C NMR, fluorescence, pyrolysis - MS and MS. The results obtained were analyzed using the Pareto and Discrminant statistical analysis.
The results showed that thiis multi-disciplinary approach is very useful in order to determine those structural domains involved in the main types of humic substances.

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STRUCTURAL DIFFERENCES BETWEEN HUMIC SUBSTANCES FROM NATURAL SOURCES AND VALORIZED ORGANIC WASTE (COMPOST, BIOCHARS) – HOW DOES SOURCE MATERIAL AND HUMIFICATION CONDITIONS DEFINE THEIR STURCTURE

Humic substances (HS) are commonly defined as natural organic matter (NOM) occurring in soil, water and geological organic deposits Although derived from detritus of decaying organisms, HS from different locations can show considerable variations with respect to their chemical composition Structural differences which were revealed by well established and advanced analytical tools indicate that the quality of HS depends not only on the source material but also on the environmental conditions governing during the humification process Whereas, for example, in anaerobic and acid environments a preferential preservation of paraffinic structures is observed, interactions of NOM with the soil mineral phase support the biochemical recalcitrance of carbohydrates Considerable chemical differences are also expected for HS derived from biosolids, composts and biochars Being suggested as a cost-effective solution to reduce organic waste by its recycling as soil amendment, the acceptance of such products on the market depends not only on their positive impact on soil fertility but also on their environmental sustainability and the capability to maintain constant quality standards Those premises require a good understanding of the chemical properties the product and their fate after their amendment to soils Therefore, the goal of the present communication is to introduce new and established analytical tools such as pyrolysis GCMS, isotopic ratio MS and advanced one and two dimensional solid-state NMR spectroscopy as means for HS characterization and to relate the determined typical patterns of the organic matter composition of various HS from different origins to their source materials and the conditions during

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BIOCHAR CHANGES THE STABILITY AND FLUXES OF DISSOLVED ORGANIC MATTER

Biochar will influence the chemical reactions taking place in the soils. Changes induced by biochar to the dissolved organic material (DOM) in soils are not well-studied, as most biochar research has focused on the much larger solid fraction of the organic material. However, even though it is minor in abundance, the dissolved fraction of organic material is of greater importance in governing soil chemistry and fluxes of elements. Biochar's great surface area is known to influence the retention of nutrients, while the sorption of the natural soil DOM has not been studied in detail. Biochar also contributes with DOM in the soil by releasing hydrophilic organic moieties. Additions of biochar to agricultural soils thus change the physiochemical characteristics of the DOM, including its stability in the soil, with implications that are not conceived.

A release and sorption experiment was conducted where temperate and tropical agricultural soils were mixed with different biochars. In addition changes induced by biochar on a DOM were studied by including thoroughly characterized reverse osmosis and freeze dried DOM material from the Nordic countries.

The physiochemical characteristics of DOM were determined spectroscopically by florescence spectrophotometry and UV-Vis absorbency, and with column fractionation by a strong non-polar adsorbent (XAD-8). These results were correlated to the DOC concentrations. This assessment gave insights on how the retention and stability of DOM in agricultural soils change with biochar additions due to release and sorption of different fractions of the DOM.

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Production, Characterization, Regulation, Marketing, Uses and Environmental Impact
October 17 to 20, 2013 - Bari (Italy)

Presenting author:

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BIOCHAR, CAN IT REPLACE SOIL ORGANIC MATTER?

When the Biobased Economy (BBE) really will break through, it may get jeopardized by its own success. The reason is that sustained soil quality is at risk in a successful BBE. In a successful BBE with an increasing need for biomass to be used, the return of crop residues to the soil may decline drastically. Crop residues are crucial to soil functioning and the soil organic matter (SOM) balance.
SOM plays an essential role in soil quality, i.e. in all processes involved in supporting crop productivity. For that reason, a declining SOM balance is a true risk for a successful BBE.

Is biochar the ideal solution to this potential problem? How do biochar properties match with SOM properties and SOM functions? And in case there is no or only a weak match, is it possible to modify biochar in such a way that its properties will improve?
These are the major questions to be answered in the INNOFER project and they will be addressed in this presentation

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S2.2 **17 October, h. 15:00 – 16:30 (Room B)**

***Title*:** **MAIN PHYSICO-CHEMICAL AND STRUCTURAL DIFFERENCES BETWEEN SEDIMENTARY AND COMPOST-RELATED HUMIC SUBSTANCES**

***Chairpersons*:** Claudio De Pasquale, *University of Palermo - Palermo, Italy*
Pellegrino Conte, *University of Palermo - Palermo, Italy*
Giuseppe Alonzo, *University of Palermo - Palermo, Italy*

S2.2.01 **Properties of biochar prepared from contaminated biomass**
Břendová Kateřina, Tlustoš Pavel, Száková Jiřina, *Czech University of Life Sciences Prague - Prague, Czech Republic*

S2.2.02 **Influence of pyrolysis conditions on composition and surface properties of corn cob and miscanthus biochars**
Budai Alic, *Norwegian Institute for Agricultural and Environmental Research – Bioforsk - Aas, Norway*
Wang Liang, *SINTEF Energy Research - Trondheim, Norway*
Grønli Morten, *Norwegian University of Science and Technology - Trondheim, Norway*
Tau Strand Line, *Norwegian University of Life Sciences - Aas, Norway*
Abiven Samuel, *University of Zurich - Zurich, Switzerland*
Dieguez-Alonso Alba, *Technical University Berlin - Berlin, Germany*
Anca-Couce Andres, *Graz University of Technology - Graz, Austria*
Rasse Daniel, *Norwegian Institute for Agricultural and Environmental Research – Bioforsk - Aas, Norway*

S2.2.03 **The characteristics of biochar derived from different feedstocks**
Dai Zhongmin, Liu Xingmei, Wang Haizhen, Xu Jianming, *College of Environmental and Natural Resource Sciences - Zhejiang University – Hangzhou, China*

S2.2.04 **Non-invasive characterization of biochar using geoelectrical measurements – a laboratory study**
Haegel Franz-Hubert, Esser Odilia, Borchard Nils, *Forschungszentrum Jülich - Institut Für Bio- Und Geowissenschaften, IBG-3 Agrosphäre -Jülich, Germany*
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Huisman Johan Alexander, Vereecken Harry, *Forschungszentrum Jülich - Institut Für Bio- Und Geowissenschaften, IBG-3 Agrosphäre -Jülich, Germany*

S2.2.05 **Green waste compost monitoring by UV-visible absorption and 3d fluorescence spectroscopy**
Mounier Stéphane, Abaker Madi, *University of Toulon - PROTEE Lab. - La Garde, France*
Rapetti Nicola, *Micro-Terra - Lunel, France*

S2.2.06 **Characterisation and potential applications of char from intermediate pyrolysis of different biomass feedstocks**
Saghir Muhammad, Hornung Andreas, *Aston University - Birmingham, United Kingdom*

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PROPERTIES OF BIOCHAR PREPARED FROM CONTAMINATED BIOMASS

The possibilities of secondary utilisation of plant biomass primarily tested in remediation technologies have been studied for energetic purposes. However there is lack information concerning the contaminated biomass transfer to biochar and its application to soil. How do risk elements influence the biochar properties? Will risk elements release again into environment from biochar? Can biochar show sorption abilities comparable to one from non - contaminated biomass?
Maize and the wood biomass of fast growing trees were harvested on contaminated site of old mining area P?íbram, Czech Republic, heavily damaged by risk elements contamination (especially Cd, Pb and Zn). This plant biomass was pyrolysed at five temperatures (400 - 600°C) and the wood of uncontaminated poplar was used for comparison.
The batch (de)sorption experiment was settled to observe either the risk element release and sorption abilities of prepared types of biochar.
The positive linear correlation for yield and final temperature and strong logarithm correlation for specific surface area of biochar and final temperature was determined. The highest specific area of poplar biochar (556 m2 g-1) wasn't resulted in highest sorption ability. However maize biochar showed with the lowest specific area (136 m2 g-1) and highest ash content greatest sorption ability. Most important was the release of Cd, Zn and Pb was negligible in comparison with sorption ability.
Our laboratory experiments showed the possibility to use the biochar from contaminated biomass origin as a soil amendment with sorption abilities with regards to control the release of risk elements during pyrolysis.

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INFLUENCE OF PYROLYSIS CONDITIONS ON COMPOSITION AND SURFACE PROPERTIES OF CORN COB AND MISCANTHUS BIOCHARS

Biochar products are increasingly considered as amendments for improving soil fertility Some key properties of potential significance for soil application include a high cation exchange capacity (CEC), high surface area, and a high pH Feedstock and pyrolysis conditions are known to strongly influence biochar properties Here we aimed at assessing key surface properties of agronomic relevance for a biochar series as a function of feedstock and pyrolysis conditions We further aimed at relating these properties to established indicators of biochar production methods, such as proximate and elemental analyses We tested a series of corncob and miscanthus biochars produced through hydrothermal carbonization (HTC) and slow pyrolysis within the temperature interval 250-800°C It was found that the ratios H/C and O/C from the elemental composition of biochars were highly correlated to the volatile matter content, i e R2 of 0 98 and 0 92, respectively Across the entire range of slow pyrolysis conditions, neither H/C nor O/C ratios were significantly modified by feedstock In addition, the H/C and O/C ratios of HTC biochars were within the 95% confidence intervals of slow pyrolysis regressions While biochar composition appeared consistent across feedstock and pyrolysis conditions, no such relationship was observed for surface properties Surface area for biochar from both feedstocks remained fairly low until 600°C, where it reached 45 and 183 m2 g-1 for corn cob and miscanthus respectively At higher temperatures, lower surface area was measured The CEC was highest for biochars produced using the HTC method, with values of 30 and 34

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THE CHARACTERISTICS OF BIOCHAR DERIVED FROM DIFFERENT FEEDSTOCKS

Biochar can be utilized as an efficient amendment for acid soils due to its high organic carbon, alkalinity, pH, CEC and adsorption capacity. In our study, biochars derived from ten types of feedstocks were pyrolysed at 300 ?C and 500 ?C for 2 h, respectively. Their physico-chemical properties were characterized to evaluate their ability for soil amendment. Both temperature and feedstock affected the characteristics of the resulting biochar. The pH, ash content (%), C (%), N (%), CEC, EC, P (%), BET, total and exchangeable base cations of biochars at 500 ?C were higher than at 300 ?C, while the yield, O (%) and H (%) of biochars were the opposite. Cluster analysis showed that biochars derived from similar feedstock types showed close physico-chemical properties. The SEM-EDS, XRD and FTIR analyses of typical biochars suggested both variations and similarities in their characteristics. In addition, nutrient concentrations such as total K, P and total base cation and pHs of swine manure, fruit peel and leaf biochars were relatively higher than in wetland plant biochars, which had the higher C concentrations. Thus, we consider that biochars derived from swine manures, fruit peels and leaves are appropriate to increase soil pH and soil nutrient availability, whereas biochars from wetland plant residues are better for soil carbon sequestration.

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NON-INVASIVE CHARACTERIZATION OF BIOCHAR USING GEOELECTRICAL MEASUREMENTS – A LABORATORY STUDY

Non-invasive methods that allow the detection and the characterization of biochar on large scales are not available. Spectral induced polarization (SIP) is a promising technology to address this need. It has been used for ore prospection since about 100 years and in more recent years, it has also been applied to soil systems. SIP yields the complex electrical conductivity in the frequency range from about 1 mHz to about 10 kHz. The complex quantity comprises a real part due to electrolytic conductivity and an imaginary part due to polarization effects in the pore space. Since the polarizability of biochar is comparatively large because of its polyaromatic structure, the addition of biochars to soil yields increased values for the imaginary part of the electrical conductivity. The signal strength depends on the type and the amount of biochar. The frequency dependence of the imaginary part of the electrical conductivity is further influenced by the particle size distribution of the biochar. Measurements on biochar in soil and systematic investigations on model systems containing series of different biochars and active carbons will be presented. The results of the measurements in the laboratory show that SIP can be used to characterize biochar in soil and to monitor changes in biochar properties with time in addition to standard SIP characterization of ion concentration and water content. Although the current results were obtained in laboratory experiments, field imaging of SIP properties of areas up to several 100 square meters is possible with multi-electrode equipment.

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GREEN WASTE COMPOST MONITORING BY UV-VISIBLE ABSORPTION AND 3D FLUORESCENCE SPECTROSCOPY

During its maturation a compost presents several phases that have to be monitoring to an optimal management of the production: good product and gain of time. The usual measurement is the monitoring of the temperature for rapid estimation of the state of the compost, and a final measurement of lignin and ISMO index. The former is not really a good indicator of the maturity of the compost as it is heterogeneous and depends on the mixing processes and the last is done at the end of a defined time which has been often subjectively determined by the producer. This work deals with the use of optical properties of the organic matter to monthly monitor the maturation of 5 composts during 6 months with a rapid extraction of the organic matter by water, and the measurement of the UV-Visible absorption and 3D fluorescence emission. The usual indexes were calculated (E4/E6, E2/E3, SUVA254, ...), but also the PARAFAC decomposition of the 3D fluorescence response, the Hx and the Milori indexes. The Non Purgeable Organic Carbon (NPOC) and the Total Dissolved Nitrogen (TDN) were also been measured. Comparisons of these results to the ISMO and the lignin compositions show that for most of the studied composts, the process of maturation occurs more rapidly than the producer had expected. Moreover, the combination the indicators gives usefull information on the different processes that occur during the compost's life: the aromatisation, the condensation and the stabilisation of the parameters.

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CHARACTERISATION AND POTENTIAL APPLICATIONS OF CHAR FROM INTERMEDIATE PYROLYSIS OF DIFFERENT BIOMASS FEEDSTOCKS

This study aims to investigate the potential combustion and agricultural application of char derived from intermediate pyrolysis of four different biomass feedstocks namely wood, miscanthus, dairy fibre and compost in pelletized form. These biomass feedstocks could be considered as the most promising sources for the sustainable production of biochar.
Intermediate Pyrolysis is an innovative thermo-chemical decomposition technique of biomass in the absence of oxygen in a specially designed industrial scale reactor known as the PyroformerTM recently developed by EBRI at Aston University which is first of its kind in the UK. The reactor is capable to process multiple waste streams with a maximum biomass feed handling capacity as 100 kg/h.

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S2.3. **18 October, h. 10:30 – 12:15**

Title: **CHEMICAL PROPERTIES OF BIOCHARS, COMPOSTS AND DIGESTATES – DESIGN FOR OPTIMUM EFFICACY**

***Chairpersons*:** Antonio Patti, *Monash University - Melbourne, Australia*
Fabrizio Adani, *University of Milan - Milan, Italy*
Teodoro Miano, *University of Bari - Bari, Italy*

S2.3.01 **Characterization of wood waste biochars for micro pollutant adsorption properties**
Favre Boivin Fabienne, *HES-SO / EIA-Fr - Fribourg, Switzerland*
Slijepcevic Ana, *University of Applied Sciences of Western Switzerland - Fribourg, Switzerland*
Guiné Véronique, Sauty Antoine, Boivin Pascal, *University of Applied Sciences of Western Switzerland - Genève, Switzerland*
Piantini Umberto, *University of Applied Sciences of Western Switzerland - Sion, Switerzland*

S2.3.02 **Sorption of N2O to biochars and other organic and inorganic materials**
Cornelissen Gerard, *Norwegian Geotechnical Institute - Oslo, Norway*
Rutherford David, *US Geological Survey - Denver, USA*
Arp Hans Peter, *Norwegian Geotechnical Institute - Oslo, Norway*
Doersch Peter, *University of Life Sciences - Aas, Norway*
Kelly Charlene, Rostad Colleen, *US Geological Survey - Denver, USA*

S2.3.03 **Characterisation and toxicant assessment of pyrolytic condensate obtained by the pyrolysis of exhausted grape marc**
Quayle Wendy, Molesworth Anika, *CSIRO - Griffith, Australia*
Zyngier Romy, *Monash University - Melbourne, Australia*
Stephen Joseph, *University NSW - Sydney, Australia*

S2.3.04 **Removal efficiency of organic matter, nutrients and faecal coliforms of wastewater large pig farms by anaerobic digester in south Mexico: on-farm study**
Trejo-Lizama Wilbert, Uicab Anilu Del Jesus, Vázquez González Liliana Betania, Belmar Casso Roberto, Caamal Maldonado Arturo, Castillo Caamal Jose, Santos Ricalde Ronald, *Autonomous University of Yucatan - Merida, Mexico*

S2.3.05 **The effect of three kinds of biochar on some chemical characteristics of clay soil in north of Iran**
Forghani Akbar, Najmi Reza, *University of Guilan - Rasht, Iran*

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CHARACTERIZATION OF WOOD WASTE BIOCHARS FOR MICRO POLLUTANT ADSORPTION PROPERTIES

Ground wood waste is a sustainable source of biochars in Switzerland. Consequently, their application to environmental technologies is expected. A full characterization of their surface properties with respect to priority micro pollutants adsorption is therefore, required. This characterization, however, must account for the variability in the biochars quality with time and char size. This analysis was conducted for the ground wood waste biochars produced by SwissBiochars® at Belmont-sur-Lausanne (Switzerland). After analysing the production process, a biochar sampling procedure allowed estimating the variability of the produced biochars with time. The surface properties of these biochars were then estimated, with special focus on the adsorption properties with respect to priority pharmaceuticals, personal care products and ETM pollutants targeted by the Swiss legislation. The results highlight a large potential of the experimented biochars for micro pollutants adsorption applications. They also highlight the need for normalised tests of organic pollutants adsorption, and the cross dependence of biochars size and biochars properties in that field.

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SORPTION OF N2O TO BIOCHARS AND OTHER ORGANIC AND INORGANIC MATERIALS

Suppression of N2O emissions from soil is commonly observed after amendment with biochar The mechanisms accounting for this suppression are not yet understood One possible contributing mechanism is N2O sorption to biochar The sorption of N2O to four biochars was measured at a range of 20 pressures in an anhydrous system with pure N2O The biochar data were compared to those for two activated carbons, uncharred pine wood and peat, and five inorganic metal oxides with variable surface areas Langmuir maximum sorption capacities (Qmax) for N2O on the six charred materials were 17-73 cm3 g-1 at 20°C (median 51 cm3 g-1), with Langmuir affinities (b) of 2-5 atm-1 (median 3 4 atm-1) Both Qmax and b of the charred materials were substantially higher than those for peat, uncharred wood and metal oxides [Qmax 1-34 cm3 g-1 (median 7 cm3 g-1); b 0 4-1 7 atm-1 (median 0 7 atm-1)] This indicates that biochar can bind N2O around one order of magnitude more strongly than both mineral and organic soil materials Qmax of N2O on biochar (50 000–130 000 µg g-1 biochar at 20°C) exceeded the N2O emission suppressions observed in the literature (range 0 5 to 960 µg g-1 biochar; median 16 µg g-1) by several orders of magnitude Thus the hypothesis could not be falsified that N2O sorption to biochar causes N2O emission suppression However, questions remain with regard to i) the effects of H2O vapor on the N2O sorption, and ii) possible desorption and the ultimate fate of

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CHARACTERISATION AND TOXICANT ASSESSMENT OF PYROLYTIC CONDENSATE OBTAINED BY THE PYROLYSIS OF EXHAUSTED GRAPE MARC.

Pyrolysis condensate (PC), also commonly known as ‘wood vinegar’, is a liquid by-product obtained from the carbonisation process The current interest in using pyrolysis of organic residues for large scale biochar production suggests that this by-product may be available in quite significant quantities in future Therefore, its assessment for the potential it may offer as a useful resource in agriculture when applied to crops and soils was considered worthwhile Pyrolysis condensates were produced during biochar manufacture from exhausted grape marc in a continuous flow process based on a narrow flighted auger system The furnace conditions involved heating to 550?C followed by sequential sampling of condensates at 500?C, 450?C, 400?C and 350?C in a descending temperature gradient To indicate the potential of the condensate to comply with regulatory requirements and measure characteristics that may affect soil functions, chemical analysis of condensates and receiving soils, an earthworm avoidance assay and a germination and seedling development trial were conducted The liquid consists of a water phase comprised mainly of water and acetic acid and an oily phase comprised of many organic components which are unstable (e g monocyclic hydrocarbons and phenolic compounds) The product has relatively high concentrations of carbon and nitrogen at up to 8 g L-1 and 2 5 g L-1 respectively that exhibit quite large differences according to pyrolysis temperature Electrical conductivity (EC) in undiluted condensates were up to 8 dS m-1 Differences in the chemical constituents of the condensates according to temperature, potential agronomic benefits and risks to soil

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REMOVAL EFFICIENCY OF ORGANIC MATTER, NUTRIENTS AND FAECAL COLIFORMS OF WASTEWATER LARGE PIG FARMS BY ANAEROBIC DIGESTER IN SOUTH MEXICO: ON-FARM STUDY

Biodigester function in intensive pig farms systems encloses risks in relation to low efficiencies of organic matter removal and other parameters. The objective of the on-farm study was to determine the removal efficiency of organic matter, nutrients and faecal coliforms of wastewater large pig farms by anaerobic digester. The study was based on the hypothesis that high diluted wastewater impose a long hydraulic retention time in biodigester before reach the optimum removal capacity of the anaerobic digestion process. 17 biodigesters in pig farms were sampled. The type of reactor was the same on all the farms of one chamber of continuous flow. The average number of animal production units (UPAS) was 4,500 .The biodigestors function was at 32oC and 7 4 pH. Three samples of each influent and effluent of the biodigester were taken. The total solids (TS) of the influent were 9768 mg/L The average reduction of TS was 68%. Total volatile solids (TVS) removal was 83%. Total fixed solids (ash) removed an average of 33%. The chemical oxygen demand (COD) was removed 82%. Unlike the COD, the biochemical oxygen demand (BOD) was 59%. Total nitrogen (TN) and phosphorous (P) reduced in 8 and 63 % respectively. Fecal coliforms (FC) were reduced 14%. Correlations between parameters were determined.
Although low concentration of TS in wastewater the COD was highly removed; remains the need to integrate following process to reduce nutrients such as TN and P in addition to pathogens.

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THE EFFECT OF THREE KINDS OF BIOCHAR ON SOME CHEMICAL CHARACTERISTICS OF CLAY SOIL IN NORTH OF IRAN

The fertility of agriculture's soil can have difference reasons, but the source of the large amounts of organic matter and high nutrient retention has been attributed to the extraordinarily high proportions of black carbon. Black carbon is the main component of biochar. We hypothesized that biochar additions to soil is causes of increase some of the important soil cation, soil PH and soil total carbon. In this study, sawmill biochar, rice straw biochar and woody wastage of paper factory biochar, produced under condition of slow pyrolysis at 500ºc. The objective of this study was to evaluate the effect of three kinds of biochars on some chemical characteristics of clay soil in north of Iran. Therefore biochars sample passes through a 2-mm sieve. Applied three different levels of biochars at a rate of 10, 20 and 30 g kg-1 soil during 1 and 3 months. After passing time, measured pH, total carbon, Ca, Mg, Na, K, P and Fe of soil biochar treatments. Also sample of biochars was analyzed for these elements. Results showed that after one month addition of biochar to soil, increased pH, total carbon, Ca, Mg, Na, K and P with increasing of biochar amount. But soil available Fe decreased with increasing of biochar percentage application. After 3 month of incubation more decreasing of available Fe and increasing of Ca, Mg, Na and K with increasing of biochar amount were obtained. It is most important that soil total carbon after 3 month had salient increased.

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S3. SUSTAINABLE USES, APPLICATIONS AND ENVIRONMENTAL IMPACT OF BIOCHARS, COMPOSTS AND DIGESTATES

S3.1 **17 October, h. 15:00 – 16:30 (Room A)**

***Title*:** **USE OF COMPOSTS TO PROMOTE THE PHYSICAL, CHEMICAL AND BIOLOGICAL SOIL QUALITY STATUS FOR PLANT PRODUCTION**

***Chairpersons*:** Donald Gabriels, *UNESCO Chair on Eremology Ghent University, Ghent, Belgium and School of Ingineers - Sfax, Tunisia*
Philip Brookes, *Zhejiang University - Hangzhou, China*

Plenary Lecture: **Use of compost, manure and organic residues as soil amendments**
Gabriels Donald, *UNESCO Chair on Eremology Ghent University, Ghent, Belgium and School of Ingineers - Sfax, Tunisia*
Lobo Deyanira, *Central University of Venezuela,*
Somers Daniel, *Terr@dialoog – Belgium*

S3.1.01 **Evaluating the effect of coconut leaf vermicompost on soil microbial biomass, microbial diversity and soil fertility**
Brookes Philip, *Zhejiang University - Hangzhou, China*
Gopal Murali, Gupta Alka, Thomas George, *Central Plantation Crops Research Institute - Kerala, India*
Dell'Abate Maria, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - Rome, Italy*
Xu Jianming, *Zhejiang University - Hangzhou, China*

S3.1.02 **Carbon and nitrogen distribution into physically separated soil organic matter in a long term experiment with compost amendment in a vegetable crop system**
Baiano Salvatore, Morra Luigi, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura (CRA) – Scafati, Italy*

S3.1.03 **Short-term changes in metabolic and genetic patterns of soil bacterial communities along a dilution gradient in response to different amendments application under organic**
Dumontet Stefano, *Università degli Studi "Parthenope", Napoli, Italy*
Cavoski Ivana, *CIHEAM – IAMB Istituto Agronomico Mediterraneo di Bari, Valenzano (BA), Italy*
Ricciuti Patrizia - Mondelli Donato, Crecchio Carmine, *Università di Bari, Bari, Italy*

S3.1.04 **Functional stoichiometry of soil microbial communities after amendment with stabilised organic matter**
Ng Ee Ling, Patti Antonio F., Rose Michael T, *Monash University - Melbourne, Australia*
Schefe Cassandra, Wilkinson Kevin, *Department of Primary Industries - Victoria, Australia*

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USE OF COMPOST, MANURE AND ORGANIC RESIDUES AS SOIL AMENDMENTS

Composts, manures and organic residues and wastes can improve the physical, chemical and biological conditions of soils. They can be applied in agriculture, horticulture, tree plantations, in parks and gardens and in sport fields, as well as for conservation of soil and water and for combating land degradation (water and wind erosion).
For the purpose of evaluating the effect on controlling runoff and erosion in the hilly region of Flanders, Belgium, composts made from the wastes of the paper mill industry, or from bark of pine trees and domestic residues were incorporated at rates of 25 to 200 tons/ha/year in the upper 10 cm layer of a sandy loam soil and subjected to natural and/or simulated rainfall tests. Positive results were obtained when the composts were incubated (incorporated) for at least 1 year at a minimum yearly rate of 50-75 ton/ha.
Field and pot experiments with cattle manure and Bokashi (compost of vegetable residues and cattle manure) mixed with a sandy soil from a dry region of Venezuela and with green pepper (Capsicum annuum L.) as indicator plant, showed an increase in nutrient uptake and in water use efficiency.
Composts from different sources were used as soil conditioners in school and community gardens of the COSWAND (Conservation of Soil and Water in Andes Countries of Latin America) programme of the UNESCO/PHI/CAZALAC project: COSWAND 2006 (Namza, Ecuador), COSWAND 2008 (Merida, Venezuela), COSWAND 2012 (AltiPlano, Bolivia).
Composts were also applied in four school gardens in the communities of the Atéda and Kara region of northern Togo (Africa) as part of one of the Terr@dialoog projects (www.terradialoog.com)
In general it can be concluded that, although the rate of yearly applications of composts (quantity) is very important, also the quality and composition of the compost, and available material, should be controlled as well. The latter depends in a large extent on the source of the available components for the production of the compost, taking into account of the different agro climatological conditions.

Key words: compost, manure, organic residues, Bokashi, Venezuela, Belgium, COSWAND, Togo, school gardens

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EVALUATING THE EFFECT OF COCONUT LEAF VERMICOMPOST ON SOIL MICROBIAL BIOMASS, MICROBIAL DIVERSITY AND SOIL FERTILITY

Evaluating the effect of coconut leaf vermicompost on soil microbial biomass, microbial diversity and soil fertility aMurali Gopal, aAlka Gupta, aGeorge Thomas, bTeresa Dell'Abate, cJianming Xu, cdPhil Brookes aCentral Plantation Crops Research Institute, Indian Council of Agricultural Research, Kasaragod – 671 124, Kerala, India bConsiglio per la Ricerca e la sperimentazione in Agricoltura, 00184 Roma, Italy cInstitute of Soil and Water Resources and Environmental Science, Zhejiang University, Hangzhou 310058, China dSustainable Systems, Rothamsted Research, Harpenden Herts AL5 2JQ Email:philip brookes@rothamsted ac uk Recycling of plant residues by composting is an important way of returning nutrients to soil With an ever increasing population and a need to conserve scant resources it is likely to become more important in the future, both as a source of nutrients and as an environmentally friendly means of residue disposal There is evidence that if the residues undergo a preliminary digestion stage with earthworms, this accelerates the overall process and enhances the fertility value of the final product We investigated the role of earthworms in composting (vermicomposting) five important Indian crop residues v z ; coconut leaf, betelnut leaf, coconut leaf + rubber, paddy straw and coconut leaf + banana pseudostem The aim was to apply standard soil microbial biomass techniques to vermicomposts to determine if they had value in differentiating and interpreting microbial and nutrient dynamics in vermicomposts We also applied thermogravimetric analysis with the same aim on both vermicompost and compost-amended soils Accordingly we used the Fumigation Extraction (FE) method to measure microbial biomass

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CARBON AND NITROGEN DISTRIBUTION INTO PHYSICALLY SEPARATED SOIL ORGANIC MATTER IN A LONG TERM EXPERIMENT WITH COMPOST AMENDMENT IN A VEGETABLE CROP SYSTEM

The application of municipal waste compost may contribute either to meet crop N requirements and to increase Soil Organic Matter (SOM) content or to solve the problem of recovery and reuse of biomasses improperly disposed in landfills.
Since 2007, a vegetables crop sequence fertilized by compost has been carrying out in the experimental station of CRA-CAT. The objectives of the research were to understand how carbon balance, nitrogen balance and crop productivity are influenced by different fertilization strategies. The soil treatments were: mineral fertilization with N-P-K doses defined according to crop requirements, compost amendment with 30 t ha-1 of dry matter (d.m.) per year in the first three years and 15 t ha-1 (d.m.) in the other three years, compost amendment with 15 t ha-1 (d.m.) per year integrated with half dose of mineral nitrogen supplied in mineral fertilization, untreated control. The compost was applied once a year in early spring.
Present challenge is about how organic C and N stocks in water resistant aggregates and in size density fractions were affected by the above mentioned fertilization strategies. Soil sampled after six years of treatments was separated into macroaggregates (>250 µm), microaggregates (53-250 µm) and microstructures (<53 µm). Then aggregates were separated into free light fraction (LF), intra-aggregate particulate organic matter (iPOM), and the mineral-associated organic fraction (MF) by size density fractionation. Whole soils, aggregates and obtained fractions were analysed for total organic C and N.

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SHORT-TERM CHANGES IN METABOLIC AND GENETIC PATTERNS OF SOIL BACTERIAL COMMUNITIES ALONG A DILUTION GRADIENT IN RESPONSE TO DIFFERENT AMENDMENTS APPLICATION UNDER ORGANIC

The diversity and functions of soil microflora have been proved to be a sensitive tool for assessing soil quality, since they respond quickly to physical and chemical changes, including nutrient availability. Among the different microbiological methods currently used to identify microbial activities, the Community Level Physiological Profile (CLPP) of soil microflora has been recently proposed. This measure is based on the score obtained by the soil microflora in the utilization of 31 sole carbon sources (Biolog EcoPlateTM). This method can be used to detect changes in microbial functional diversity.

The aim of this work was to compare the evolution of microbial diversity in a soil amended with different composted organic waste by using Biolog EcoPlateTM, in order to come to a more comprehensive understanding of the microbiological shift across parcels treated with amendments and fertilizers approved for the use in organic farming, and its impact on the overall soil quality.

Biolog EcoPlates system was applied in this work unconventionally as it was used to highlight the "conservativeness" of biochemical characteristics in different treatments, more than pointing out any "low" or "high" species richness or any community richness in biochemical activity along soil dilutions. It was matter, instead, to indentify a treatment, among those here studied, able to keep the more possible biochemical functions along soil dilutions (10-3 - 10-5), showing, that way, the resilience characteristics of the resident microbial biomass. In addition, a molecular analysis of the microbial DNA was carried out in the positive Biolog EcoPlates wells, at the dilution 10-4, in order to compare the genomic diversity of the microflora, pertaining to different treatments, by using the H' Shannon index.

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FUNCTIONAL STOICHIOMETRY OF SOIL MICROBIAL COMMUNITIES AFTER AMENDMENT WITH STABILISED ORGANIC MATTER

Organic amendment (OA) decomposition in soil depends on the chemical stability of the organic compounds and the responses of the soil microbial decomposers. As microbial nutrient acquisition from OA is largely mediated by enzymes, functional stoichiometry may reveal microbial biochemical control of OA transformation. We hypothesised that the chemical stability of an OA is inversely related to its effect on the soil microbial community and soil functions. By examining the changes in soil chemistry (total and available C, N and P), soil microbial community composition and microbial activities using fresh green waste and its compost or biochar (derived from the same green waste), we found that indeed increasing the stability of OA reduced its impact on soil microbial community and soil functions. These patterns in microbial structure and function can be partly explained by the fundamental features of life using ecological and functional stoichiometries. Such stoichiometric behaviour may be utilised to predict the effectiveness of OA for improving soil fertility and carbon sequestration.

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S3.2. **19 October, h. 17:00 – 18:45 (Room A)**

Title: **THE COMPOST AS ORGANIC AMENDMENT: A STRATEGY TO MAINTAIN SOIL SUSTAINABILITY IN A GLOBAL CHANGE ERA**

***Chairpersons*:** Gennaro Brunetti, *University of Bari, Bari, Italy*
Peter Leinweber, *University of Rostock - Rostock, Germany*

S3.2.01 **Can sewage sludge application restore paddy soil fertility? A long term case study in NW Italy**
Romani Marco, *Ente Nazionale Risi - Castello D'Agogna (PV), Italy*
Vecchio Ilaria, *Provincia di Pavia - Ambiente - Pavia, Italy*
Nègre Michele, Said-Pullicino Daniel, Martin Maria, *University of Turin - DISAFA - Turin, Italy*
Beltarre Gianluca, Miniotti Eleonora, *Ente Nazionale Risi - Castello D'Agogna (PV), Italy*
Celi Luisella, *University of Turin - DISAFA - Turin, Italy*

S3.2.02 **Influence of soil depth amended with compost or compost particle-size on the potential N and C mineralization**
Ben Chikha Leila, *National School of Ingeneers - Sfax, Tunisia*
Fangueiro David, *Superior Institute of Agronomy- Lisbon, Portugal*
Ammar Emna, Rigane Hafedh, *National School of Ingineers - Sfax, Tunisia*

S3.2.03 **Potato cultivars grown on an agricultural soil under compost amendment or mineral fertilization: productivity, quality and genetic/epigenetic variations in tubers**
Cicatelli Angela, Baldantoni Daniela, *University of Salerno – Fisciano (SA), Italy*
Iovieno Paola, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura – Pontecagnano (SA), Italy*
Alfani Anna, *University of Salerno – Fisciano (SA), Italy*
Vuylsteke Marnik, *University of Ghent - Ghent, Belgium*
Castiglione Stefano, *University of Salerno – Fisciano (SA), Italy*

S3.2.04 **From rags to riches: the story of carbon and nutrient retention with dairy compost application**
Drake Jessica, Cavagnaro Tim, Patti Tony, Johnston Priscilla, *Monash University - Melbourne, Australia*
Wilkinson Kevin, McDonald Declan, *Department of Primary Industries, Victoria - Melbourne, Australia*
Rose Mick, *Monash University - Melbourne, Australia*

S3.2.05 **The effect of straw compost and biofertilizer to improve fertilizer efficiency and soil quality with water management system**
Fitriatin Betty, Simarmata Tualar, *Padjadjaran University - Bandung, Indonesia*

S3.2.06 **Implementation and results of compost utilization in Georgia for environmental sustainability**
Matchavariani Lia, Laghidze Lamzira, Paichadze Nino, *Tbilisi State University of Iv. Javakhishvili - Tbilisi, Georgia*

S3.2.07 **Impact of compost from municipal sewage sludge and rice husk on soil fertility**
Sciubba Luigi, Cavani Luciano, Marzadori Claudio, Ciavatta Claudio, *University of Bologna - Bologna, Italy*

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CAN SEWAGE SLUDGE APPLICATION RESTORE PADDY SOIL FERTILITY? A LONG TERM CASE STUDY IN NW ITALY.

Sewage sludge is a source of organic matter and nutrients in agriculture, but at the same time may pose a potential risk for soil contamination. We evaluated the effects of sewage sludge application in single-cropped rice paddies on crop yields, grain quality and safety, as well as soil fertility and contamination by means of a long-term (12 years) experimental study. Five treatments were compared: (i) MIN: traditional mineral fertilization (urea + TSP + MOP); (ii) SS: sewage sludge + MOP; (iii) SSU: sewage sludge + urea + MOP, (iv) HH: horns and hoofs (organic N fertilizer) + urea + TSP + MOP; and (v) CT: unfertilized treatment. Every year the applied sewage sludge (3.7 t ha-1 dw) was analysed for nutrient and contaminant contents. Results from 2006-2012 showed a significant increase in grain yield with sewage sludge fertilization. The SSU treatment showed the highest grain yield. After 12 y of treatment, SS and SSU soils showed a significantly higher pH, TOC, TN, DOC, TDN, and microbial biomass C and N with respect to the other treatments. Application of sewage sludge treated soil increased the bioavailable P to values >50 mgP kg -1 with potential implications on water quality. Among the heavy metals sewage sludge applications only resulted in a significant increase in Zn and Cu soil concentrations highly related to organic matter trend. The results obtained suggest that sewage sludge may serve as an important source of organic matter suitable for enhancing the fertility of paddy soils.

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INFLUENCE OF SOIL DEPTH AMENDED WITH COMPOST OR COMPOST PARTICLE-SIZE ON THE POTENTIAL N AND C MINERALIZATION

Three soil layers ([0-10], [10-30] and [30-50] cm) were sampled and taken from southeastern of Tunisia. These soil were amended separately with compost or six compost fractions (>2000, 2000-1000, 1000-500, 500-250, 250-100, <100 µm). Compost, based on poultry manure (PM), green waste (GW) and sewage sludge (SS), was applied to soil to assess the potential Nitrogen and Carbon mineralization. Two short incubations were performed: one at 40° C to add the soil definite amount of N to analysis mineral Nitrogen and the other was conducted at 25°C to quantify C applied lost as CO_2. Results obtained show that the finest fractions (< 100 µm) have high content of total N, total K, the highest values for dry matter, total P and the minerals concentration. PNM was observed in only two amended soil layers [0-10] and [10-30] cm with all compost fractions as well as in [30-50] cm soil layer amended with the finest fractions. Soil amended with compost contributed to N immobilization excepted in one upper surface soil with 0.23% of N applied. The CO_2 produced was significantly greater ($p<0.05$) in surface soil layers amended with compost to deeper soil with rate more than 40% of total CO_2 lost as C applied. In soil surface amended with the finest fraction lead a greatest production of CO_2 lost as 23% C. The fractionation of the compost produced in PM, GW and SS seems to be suitable for degraded soils low in organic matter.

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POTATO CULTIVARS GROWN ON AN AGRICULTURAL SOIL UNDER COMPOST AMENDMENT OR MINERAL FERTILIZATION: PRODUCTIVITY, QUALITY AND GENETIC/EPIGENETIC VARIATIONS IN TUBERS.

The aim of the study was to evaluate the effects of soil amendment with compost, obtained by the organic fraction of solid urban wastes, in comparison with traditional chemical fertilization practices on potato (Solanum tuberosum L.) crop. Seven genetically biodiverse cultivars (Cvs - King Edward, Pentland Dell, Maris Piper, Wilja, Kingston, Spunta, Red Pontiac) were employed to establish an experimental field in southern Italy. The field was subdivided into two portions (about 1000 m2 each): one was amended with compost at 20 tons per hectare, while the other one was supplemented with ammonium sulphate at 200 Kg per hectare. Element concentrations, productivity and organoleptic characteristics were evaluated, at the end of the experiment, in potato tubers of all Cvs obtained from both kinds of fertilised soil. cDNA-AFLP and MSAP analyses were performed on leaves and tubers collected from Red Pontiac Cv, to estimate if any transcriptome or epigenetic modifications, due to different kinds of fertilization, were induced. Mineral fertilization and compost amendment did not cause any significant modification in transcriptome and in epigenome profiles in both analyzed organs, as well as in the productivity, organoleptic characteristics, nutrients and trace elements in tubers. Only for K, the tubers grown on compost amended soil showed, on average, a higher K concentration in respect to those grown on mineral fertilised soil. In conclusion, potato tubers, produced by means of different soil fertilizations, show similar characteristics in terms of productivity, quality and nutraceutical properties.

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FROM RAGS TO RICHES: THE STORY OF CARBON AND NUTRIENT RETENTION WITH DAIRY COMPOST APPLICATION

Around the world, dairy farmers are transforming dairy waste to compost for land application. In southeastern Australia, farmers are using composted dairy waste to increase production and reduce costs. In addition, the farmers are considering the benefits of compost for increasing sequestration of soil carbon, and on-farm nutrient retention. The “Carbon Farming Initiative” in Australia is exploring the option to allow farmers to trade Carbon Credits for carbon stored in the soil. Compost also retains vital nutrients, such as N, on farm rather than importing N in the form of mineral fertilisers. Composting also reduces greenhouse gas emissions, such as CH4 when stored in effluent ponds. This project will investigate if compost improves carbon sequestration, nutrient retention and pasture production. In this project dairy compost, made from dairy effluent, feedpad waste, spoilt sillage and wood mulch, was applied onto a 1Ha field and companion plots at a rate of 0, 3, 6 and 12 t/ha. The field plot is open to grazing and normal farm management practices. The companion plots are being subjected to simulated grazing (mowing). The trials, currently underway, will run for 18 months. Along with preliminary soil carbon results, this work will also include preliminary data for total and plant available nutrients, and farm biomass production. The outcomes of this research, and benefits it finds for “Carbon Farming” and nutrient retention has practical, policy and economic applications for world wide markets.

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THE EFFECT OF STRAW COMPOST AND BIOFERTILIZER TO IMPROVE FERTILIZER EFFICIENCY AND SOIL QUALITY WITH WATER MANAGEMENT SYSTEM

System of organic based aerobic rice intensification is a water-efficient production systems, seed and inorganic fertilizer use of force by emphasizing the biological soil (biological fertilizer, biological agents, root system), management of plants (seed selection, plant spacing, planting techniques and maintenance), fertilizers (organic fertilizers, biofertilizers, inorganic fertilizers and fertilizers techniques) and water management in an integrated and to support and maximize the growth and development of rice in optimum aerobic condition. The purpose of this study in the second year was to obtain the optimum dose of straw compost + biofertilizer that can be substituted for inorganic fertilizers, improved crop growth and yield of rice. Research at this stage using Split plot experimental design was repeated three times. As the main plot was the dose of straw compost + biofertilizer (0 t/ha to 7,5 t/ha without and plus biofertilizer 400 g/ha). As a subplot was doses of a anorganik fertilizer (nitrogen, phosphor and potasium) were 100%, 90%, 80%, 70% and 60% of recommendations doses. The results of this experiment showed that there were interaction effect between the organic fertilizer (compost straw 5 t/ha + 400 g/ha of biofertilizers) and inorganic fertilizer on content of nitrogen , phosphate and potasium soil. Giving straw compost + biofertilizer can increase significantly nutrient uptake) and content of soil nitrogen available phosphate and soil potasium. Application of straw compost + biofertilizer could substitute 20% of inorganic fertilizer and could increase the yield 13.3%.

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IMPLEMENTATION AND RESULTS OF COMPOST UTILIZATION IN GEORGIA FOR ENVIRONMENTAL SUSTAINABILITY

For sustainable development of Environment one of the key activities is composting, which is created as a result of sorting, processing and recycling of organic substances for improving of soil fertility Compost contains all necessary macro- and microelements and it's using leads to soil humus enrichment, supplies plant with nutrients and improves the soil structure Compost, which does not contain chemicals, is a cheaper and healthier alternative against expensive fertilizer The main goal of our research is improvement of ecological consciousness of rural population in Georgia In experimental region we offered to population financial and technical support for sorting of household waste and recycling in compost The selected object was a sparsely populated village ?rgokhi (?khmeta district, Kakheti, East Georgia), where each family were provided with special compost boxes, where they gather all easily accessible organic materials and natural enrichments On the base of proposed method, creating the appropriate conditions, for a short time they receive the best compost As a result, we have several benefit: formation a culture of household waste sorting in rural population; decrease the amount of waste in nature and, accordingly, diminish of costs for trash ; elaboration of ability to produce and use the cheap bio-fertilizer – compost from the household waste; improvement of soil fertility, that is the best alternative as a counterbalance to toxic chemicals; creation of preconditions for production of environmentally pure products; sensibilisation of population on this issue; implementation of results and outcomes with relevant authorities in other regions of country,

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IMPACT OF COMPOST FROM MUNICIPAL SEWAGE SLUDGE AND RICE HUSK ON SOIL FERTILITY

The use of composted sewage sludge in agriculture is an interesting way to achieve both the get back of nutrients and the supply of organic matter to soils [Laturnus et al., 2007]. Indeed, soils, especially in the Mediterranean area, are often subjected to severe degradation processes accompanied by a decline of soil organic matter content, which adversely affects soil fertility; the use of organic amendments can restore soil organic matter content and its physical, chemical and biological functions [Senesi et al., 1996]. However, the application of unstable or immature compost can cause nitrogen immobilization [Huang and Chen, 2009], while the occurrence of heavy metals in sewage sludge may cause their accumulation in soils [Baldantoni et al., 2010].
In this work we investigated the impact of two municipal sewage sludge compost on soil fertility, at different application rates. The two biosolids were obtained from the composting of municipal sewage sludge (the first from anaerobic plant, the second from aerobic ones) with rice husk and were applied, on a laboratory scale, at three different doses (8, 24 and 48 Mg/ha) on a sandy loam soil, for an incubation experiment period of 14 weeks. Particularly we studied their effect on organic nitrogen mineralization, microbial biomass carbon, soil enzyme activities, total and bioavailable heavy metals. The preliminary results showed that the application of these biosolids affected soil biochemical properties without negative effects nor heavy metal accumulation.

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S3.3. **17 October, h. 17:00 – 18:45**

Title: **EFFECTS OF BIOWASTE AND BIOCHAR ON ENVIRONMENTAL PROPERTIES AND SOIL FUNCTIONS - CAN LONG-TERM PROCESSES BE FORECASTED FOR A SUSTAINABLE AGRICULTURE?**

***Chairpersons*:** Rainer Horn, *Christian Albrechts University Kiel – Kiel, Germany*
Eberhard Hartung, *Christian Albrechts University Kiel - Kiel , Germany*
Marcello Pagliai, *CRA-ABP - Firenze, Italy*

S3.3.01 **Alteration of soil water functions due to digestate amendment**
Holthusen Dörthe, *Christian Albrechts University - Kiel , Germany*
Horn Rainer, Voelkner Amrei, Hold Annika, Ohl Susanne, Hartung Eberhard, Bölter Manfre, - *Christian Albrechts University - Kiel , Germany*

S3.3.02 **Bioash from thermal gasification of biomass as soil amendment for soil fertility and carbon sequestration**
Hansen Veronika, Hauggaard-Nielsen Henrik, *Technical University of Denmark - Copenhagen, Denmark*

S3.3.03 **The effect of biochar and other organic amendments on thermal properties of soil**
Lipiec Jerzy, Usowicz Boguslaw, Lukowski Mateusz, *Institute of Agrophysics, Polish Academy of Sciences - Lublin, Poland*

S3.3.04 **The beneficial effects of bone char on phosphorus-cadmium-interactions in the soil-plantsystem**
Leinweber Peter, Siebers Nina, *University of Rostock – Rostock, Germany*

S3.3.05 **Physical properties of digestates and consequences for the hydraulic and mechanical soil processes as a function of the biowaste fermentation**
Voelkner Amrei, Horn Rainer, Holthusen Dörthe, Bölter Manfred, Hold Annika, Hartung Eberhard, Ohl Susanne, *University of Kiel - Kiel, Germany*

S3.3.06 **The effect of biochars on the chemical properties of two different soils**
Xu Jianming, Dai Zhongmin, Philip C. Brookes, *Zhejiang University - Hangzhou, China*

S3.3.07 **Grape marc biochar – effects on soil structure, water efficiency and fertilizer productivity**
Zyngier Romy L., *Monash University – CSIRO - Melbourne, Australia*
Qualye Wendy, *CSIRO - Griffith, Australia*
Creswell Hamish, *CSIRO - Canberra, Australia*
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ALTERATION OF SOIL WATER FUNCTIONS DUE TO DIGESTATE AMENDMENT

Although there is general agreement that the character of the soil solution is defined by its chemical composition, the resulting consequences are taken into account only irregularly. Instead, soil scientists use equations for water storage and transport as if the soil solution was pure water and not a complex mixture which sometimes even does not allow for a full chemical decoding. It can be hypothesized that the sludges derived from anaerobic digestion pronouncedly influence the composition of a soil solution, especially in interaction with the amount of digestate spread, its properties, soil moisture, soil texture and local water balance. Those chemical alterations, however, directly lead to physical changes, i. e. the flow behavior of the soil solution as it can be described in terms of viscosity and surface tension.
We therefore examined the short-term impact of a digestate on the equilibrium soil solution of soils with different soil textures (sandy to loamy soil). We found noticeable deviations from standard values used for viscosity and surface tension, which justify the demand for routine analysis of soil solution rheology in order to claim correct fitting of soil water models and prediction of soil water transport processes.

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BIOASH FROM THERMAL GASIFICATION OF BIOMASS AS SOIL AMENDMENT FOR SOIL FERTILITY AND CARBON SEQUESTRATION

Thermal gasification of biomass is a source of renewable energy but also of valuable ash residual. This bioash contain carbon and nutrients and have the potential to be used as a soil fertility amendment in agriculture. The content of stabile carbon in bioashes may also contribute to carbon sequestration and thus mitigation of CO2 emissions. The main hypothesis is that carbon present in the bioash fraction is more recalcitrant than that in the original feedstock. Thus, bioash amendment might lead to higher carbon sequestration rates than those achieved with soil incorporation of the feedstock, e.g. cereal straw.
Biomass gasification for combined heat and power production is efficient and flexible way to generate energy, as a broad variety of biomass residues and other organic sources can be utilized. Two promising thermal gasification technologies are specialized to convert ash-rich residuals like cereal straw (PYONEER gasifier) and wood chips (TwoStage gasifier). Due to low temperature settings under gasification (<750oC) no contamination of agricultural soils is expected.
It will be shown how biomass ashes from thermal gasification effect soil carbon sequestration, nutrient dynamics and microbial activity focusing on recent data from short term incubations. In addition, it will be discussed how bioash can influence crop growth using previous published data together with highlights about the need to include longer term experiments to verify the real potential benefits achieved from bioash soil application.

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THE EFFECT OF BIOCHAR AND OTHER ORGANIC AMENDMENTS ON THERMAL PROPERTIES OF SOIL

The aim of this study is to assess the impacts of biochar (from tree biomass) and other organic amendments (peat, compost) on the thermal properties (thermal conductivity, heat capacity, thermal diffusivity) of soil derived from loess The measurements of the thermal properties at various water contents were performed after incubation under laboratory conditions using KD2Pro, Decagon Devices The measurement data were compared with predicted data using statistical-physical model (Usowicz et al , 2006) Additional predictions were done for terra preta soil (also known as "Amazonian dark earth"), high in charcoal due to adding a mixture of charcoal, bone, and manure for thousands of years The results showed that application of the biochar and other organic amendments into the soil resulted in a substantial reduction of the thermal conductivity and diffusivity The decline of the conductivity and diffusivity was mostly attributed to decrease in both particle density and bulk density The organic amendments caused a decrease of the heat capacity of the mixtures in dry state and considerable increase in wet state The relationship between the thermal conductivity and water content was more linear with than without organic amendments The thermal diffusivity reached a characteristic maximum for higher bulk densities and lower water contents The results showed that the statistical-physical model can be used with satisfactory accuracy for the prediction of thermal properties of the soil with organic amendments Usowicz B et al , 2006 Thermal conductivity modelling of terrestrial soil media - A comparative study Planetary and Space Science 54,

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THE BENEFICIAL EFFECTS OF BONE CHAR ON PHOSPHORUS-CADMIUM-INTERACTIONS IN THE SOIL-PLANT-SYSTEM

Bone char (BC) can be considered as a special P-, Ca- and Mg-rich biochar. To test its potential as clean and renewable P fertilizer with cadmium (Cd) immobilization capability, an incubation experiment with 11 Cd-contaminated soils was conducted. For most soils, BC increased the concentration of labile P immediately after application, reaching a maximum after 34 days. The P release was partially similar to highly soluble triple-superphosphate (TSP), and the Cd immobilization resulting from BC dissolution exceeded that of TSP by a factor of 1.4 to 2.7. Two multiple equations were established that enable the prediction of the P dissolution from BC and the subsequent Cd immobilization in acidic soils from the initial soil pH, soil P sorption capacity, and released P. Synchrotron-based P- and Cd-speciation gave evidence for the precipitation of insoluble Cd-phosphates following BD dissolution in the Cd-contaminated soil. In subsequent pot experiments, BC was less effective than the highly soluble commercial P fertilizers in enhancing the dry matter yield of plants in P a deficient soil. However, in a soil sufficiently supplied with available P the plant yields in BC treatments exceeded those in the mineral P treatments. The Cd concentration in plants was slightly reduced with fertilizer application, being more pronounced in the BC treatments compared to TSP and diammonium phosphate. Ongoing research tests effects of surface modifications on the P-Cd-interactions in order to improve P-solubility without loosing the Cd-immobilization effect.

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PHYSICAL PROPERTIES OF DIGESTATES AND CONSEQUENCES FOR THE HYDRAULIC AND MECHANICAL SOIL PROCESSES AS A FUNCTION OF THE BIOWASTE FERMENTATION

Digestates are of great importance in agricultural management due to their use as organic fertilizers It is supposed that the sludge derived from anaerobic digestion has a great influence on soil structure The consequence can be a soil degradation which results in reduced crop yield caused by acidification, dispersion and increased water-repellency In contrast, the additional supply of organic matter from the digestates contributes to a stabilization of the soil structure, although it consists mainly of lignine, or cellulose, which may certainly be seen more critically We use different digestates, deriving from maize, wheat and sugar beet, to investigate the impact of processes in soil which are implemented by the application of such slurries For this, the wetting properties of soil treated with digestate were investigated by measuring sorptivity and contact angle Further surveys were carried out to estimate the flow behavior of digestates and the deformation properties of soil by microscaled shearing Additionally, the percentage of dispersed clay was ascertained to account for the dispersive impact of digestates As a result, the digestates clearly influence the water repellency of the soil On the short run, the sludge does not have an acidifying impact on the investigated soil Instead, the pH remains on a high level due to the alkaline digestate However, soil structure was reduced as was shown by the increasing amount of dispersed clay As a conclusion, we recommend to additionally taking into account the impact, which digestates might have on soil structure besides their fertilizing effect

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THE EFFECT OF BIOCHARS ON THE CHEMICAL PROPERTIES OF TWO DIFFERENT SOILS

In China, soil acidification has become the major problem of intensive Chinese agricultural systems. Thus, it is critical to develop new effective acid soil amendments to increase soil pH and soil fertility. In our study, soil incubation experiments were conducted to investigate the effect of two biochars (swine manure biochar and rape straw biochar) on the chemical properties of two different soils (Psammaquent soil and Plinthudult soil). Biochars were added separately at 10g kg-1 (1%) and at 30g kg-1 (3%) to the soils respectively and incubated in darkness at 25?C at 70% water holding capacity. After 180d incubation, the pH, total C, total N, CEC, DOC, DON and exchangeable base cations (K, Na, Ca, Mg) in soils increased, while the exchangeable Al decreased compared to the controls. The effect of biochar on soil chemical properties depended on the soil type, biochar type and biochar incorporation rate. The Plinthudult soil was more easily influenced in chemical properties by biochar addition than the Psammaquent soil. Biochar appeared appropriate to correct the acidity in Psammaquent soil whereas it improved the fertility in Plinthudult soil. The incorporation rate of 3% induced larger changes in soil chemical parameters than 1%. Moreover, biochar derived from swine manure had a better effect on soil chemical properties than that from rape straw. The next study will investigate the effect of biochars on plant growth in pot experiments and field trials.

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GRAPE MARC BIOCHAR – EFFECTS ON SOIL STRUCTURE, WATER EFFICIENCY AND FERTILIZER PRODUCTIVITY.

Understanding changes to soil physical characteristics when amended with biochar (BC) is vital for assessing the potential of BC to reduce water and fertilizer crop requirements To address this a field trial was undertaken to assess the potential for grape marc BC to increase soil water retention, improve hydraulic conductivity, reduce bulk density and increase nutrient availability, with the goal of improving crop performance and yield Biochar was applied to a clay-loam soil (Chromosol) planted with rockmelons in NSW, SE Australia, classified as a semi-arid climate The soil has low carbon content and presents dispersive tendencies and surface crusting under irrigation Grape marc BC was produced via continuous-flow pyrolysis A composite BC was made using equal proportions of four final temperature pyrolysis conditions: 350°C; 400°C; 450°C; and 500°C (in brief: C 49 6%; N 2 23%; pH 8 8 and CEC 96 cmol+/kg) Biochar was applied at four rates (0, 0 25, 1, 20 t ha-1) with two rates of irrigation (~4 ML ha-1; half rate ~2 ML ha-1) in a split plot design Initially soils were fertilized with 48kg ha-1 of N and 20 8 kg ha -1 of P, followed by 30 kg ha-1 of N according to “farmers practice”; a half rate was applied to all BC treatments Results from the assessment of crop yield, plant water use, hydraulic conductivity, water and fertilizer productivity, soil water retention and bulk density changes will be presented The potential of biochar incorporation into irrigation farming systems for increasing water and

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S3.4. **18 October, h. 15:00 – 16:30 (Room A)**

Title: **IMPACT OF BIOCHARS, COMPOSTS AND DIGESTATES ON FATE, BEHAVIOUR AND BENEFIT/RISK ASSESSMENT OF ORGANIC AND INORGANIC CONTAMINANTS IN SOIL**

***Chairpersons*:** Melanie Kah, *University of Vienna - Vienna, Austria*
Elisabetta Loffredo, *University of Bari - Bari, Italy*

S3.4.01 **Use of biochar for inorganic contaminants remediation**
Cimò Giulia, De Pasquale Claudio, Conte Pellegrino, Alonzo Giuseppe, *University of Palermo - Palermo, Italy*

S3.4.02 **Effects of biochar application on sorption, leaching and plant uptake of trace elements in different agricultural soils**
Kloss Stefanie, Zehetner Franz, *University of Natural Resources and Life Sciences - Vienna, Austria*
Oburger Eva, *University of Natural Resources and Life Sciences - Tulln, Austria*
Buecker Jannis, Wimmer Bernhar, *Austrian Institute of Technology - Tulln, Austria*
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Soja Gerhard, *Austrian Institute of Technology - Tulln, Austria*

S3.4.03 **Sorption of mercury by biochar produced from malt spent rootlets: effect of pyrolysis temperature**
Manariotis Ioannis, Kamenidou Charoula, Karapanagioti Hrissi, *University of Patras - Patras, Greece*

S3.4.04 **Impacts of biochar on the phytostabilization of contaminated soils with ryegrass**
Rees Frédéric, Germain Cyril, Morel Jean-Louis, *INRA – University of Lorraine - Vandoeuvre-lès-Nancy, France*

S3.4.05 **Heavy metal bioavailability in the biofertilizers derived from sewage sludge**
Sabiene Nomeda, Paulauskas Valdas, Zaleckas Ernestas, *Aleksandras Stulginskis University - Kaunas, Lithuania*

S3.4.06 **Impact of novel biofilter material on degradation of pesticides**
Mukherjee Santanu, Tappe Wolfgang, Weihermüller Lutz, Burauel Peter, Vereecken Harry, *Forschungszentrum Jülich GmbH - Agrosphere Institute (ICG 4/IBG3) - Jülich, Germany*

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USE OF BIOCHAR FOR INORGANIC CONTAMINANTS REMEDIATION

Anthropogenic activities alter the natural flow of materials and introduce novel chemicals into the environment thereby causing serious soil and water pollution Indeed, many industries produce aqueous effluents containing toxic substances, especially heavy metals The presence of these contaminants in the environment is a great issue because of their toxicity and bioaccumulation ability which affect human life and the environment Various physicochemical and biological techniques have been used to remove the heavy metals from waste waters, including chemical precipitation, ion exchange, chemical coagulation, electrolytic methods, membrane processes, and adsorption Biochar is a carbonaceous material obtained from the pyrolysis of plant and animal biomasses Due to its high porosity, it could be effectively used as a remediation tool to retain inorganic contaminants A comparative study between the removal efficiencies of Cu (II) and Ni (II) from synthetic wastewater by using adsorption onto biochars produced from chicken manure, conifers and poplar wood wastes was conducted to assess their ability in the removal of heavy metal from aqueous solutions The results showed that chicken manure biochar proved to have the highest removal efficiencies (up to 90% of removal) for both Cu (II) and Ni (II) ions The sorption ability of chicken manure biochars that underwent various degrees of carbonization (chars formed by pyrolysis at 350 and 500°C) was also investigated Higher pyrolysis temperatures lead to the disappearance of certain surface functional groups (e g , aliphatic) and the formation of others (e g , aromatic) These differences leads to a different adsorption behavior

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EFFECTS OF BIOCHAR APPLICATION ON SORPTION, LEACHING AND PLANT UPTAKE OF TRACE ELEMENTS IN DIFFERENT AGRICULTURAL SOILS

Soil remediation strategies have been increasingly studied as human activities may be accompanied by trace metal inputs into the soil Biochar (BC) as a potential remedial soil additive comprises intrinsic properties that may strongly affect trace element mobility In addition, metal retention may further be influenced in the longer term since BC surface was found to be altered in the soil due to oxidation processes In a controlled greenhouse experiment we investigated the effects of different BCs on an acid Planosol in terms of leaching and plant uptake of soil-derived trace elements (Al, As, Se, Cd, Cu, Pb, Ni, B, Mo) The same was done for a specific BC (woodchips) for three different soil types (Planosol, Cambisol, Chernozem) We found that BC application strongly affected leaching and plant uptake of the investigated metals in various directions In addition, we carried out Cu and Cd sorption experiments with the above mentioned Planosol At this, we compared the sorption behavior not only in terms of different BC types, but also in terms of BC aging by comparing soil immediately after BC addition to that of 15 months after BC incorporation The results showed that all BC types strongly enhanced metal sorption; in addition, sorption potential further increased after 15 months This may be attributed to the formation of functional groups on the BC surfaces due to oxidation, which we currently further test on the pure initial and soil-aged BCs using Fourier transform infrared spectroscopy (FTIR) and synchrotron-based x-ray absorption spectroscopy (XAS)

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SORPTION OF MERCURY BY BIOCHAR PRODUCED FROM MALT SPENT ROOTLETS: EFFECT OF PYROLYSIS TEMPERATURE

Biochar is obtained from the incomplete combustion of carbon-rich biomass under oxygen-limited conditions. Various organic-rich wastes including wood chips, animal manure, and crop residues have been used for biochar production. One of the main applications of biochars is the removal of metals from aqueous solutions (i.e. mercury, and lead). Mercury is one of the heavy metals of particular concern due to its toxicity even at relatively low concentrations and thus, its removal from aqueous systems is desirable. Malt spent rootlets (MSR) is a by-product formed during beer production; it is inexpensive and has very good properties as sorbent for various metals. The objective of the present work was to evaluate the effect of temperature pyrolysis of MSR on biochar surface area and pore size, and Hg(II) sorption capacity. MSR was pyrolyzed at temperatures of 300, 400, 500, 600, 750, 850, and 900oC, under limited oxygen conditions. To evaluate the sorption capacity of biochars batch experiments were conducted, and isotherms were constructed. Samples were agitated for 24 h at 25oC, at an optimum pH of 5, a biochar dose of 0.3 g/L, and mercury initial concentration ranging from 10 to 200 mg/L. Mercury was measured following a colorimetric determination with Michler's thioketone method. The mercury sorption capacity was affected by pyrolysis temperature, and it was increased by increasing the temperature. The maximum sorption capacity was 100-110 mg Hg(II)/g biochar at a temperature range of 750-850oC. The increase of temperature resulted in significantly increased BET surface areas.

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HEAVY METAL BIOAVAILABILITY IN THE BIOFERTILIZERS DERIVED FROM SEWAGE SLUDGE

Sewage sludge(SS) utilization still remains the problem worldwide. As this waste product is rich in organic matter and nutrients it can be used for the production of biofertilizers. However, utilization of sewage sludge is often limited by its low quality characteristics, such as elevated levels of heavy metals, organic micropollutants and pathogens. SS on-land application can form an important part of a comprehensive, integrated waste management system that emphases resource conservation through source reduction, recycling and reuse.
But there is no universally accepted and used SS treatment technology. It can be processed using aerobic composting, anaerobic digestion or both methods can be used sequently. Composting provides a simple but cost effective alternative treatment method for biowaste disposal by decomposing organic matter, producing a pathogen free stabilised and nutrient rich product. Quality of the final product – biofertilizer can be improved by adding nutrient elements and additives that stabilize heavy metals.
In this research biofertilizers was produced from SS using aerobic composting and anaerobic digestion, also using other waste products for nutrients optimization (meat bone meal processed with phosphoric acid), additives reducing heavy metal content (sawdust) or limiting their mobility (cement kiln dust). Heavy metal chemical leaching from the initial biofertilizer components, from biofertilizers, and their mixtures with soil samples of different texture (sandy and clay) were carried out. Finally, vegetative experiments were performed in order to evaluate heavy metal bioavailability and to predict environmental safety of the biofertilizers produced.

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IMPACT OF NOVEL BIOFILTER MATERIAL ON DEGRADATION OF PESTICIDES

To overcome the problem of point sources pollutions on farms stemming from improper handling, spillages and leakages during filling and cleaning of spraying equipment, an environmental friendly and low-cost technology filter system is under development. A suitable ratio of biomixtures (soil, biochar and digestate) will be used in the final technical setup of biofilter. Therefore different fundamental processes like microbial respiration, sorption-desorption, degradation, and transport /retardation behavior of three radiolabelled pesticides (Bentazone, Boscalid and Pyrimethanil) will be investigated. Respirometric measurements of microbial activity revealed that CO2 evolution was significantly suppressed after the addition of biochar. The exact driving mechanism for this suppression is still under investigation. In this presentation, I will focus on the influence of the above mentioned organic amendments on soil microbial respiratory activity and pesticides degradation.

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IMPACTS OF BIOCHAR ON THE PHYTOSTABILIZATION OF CONTAMINATED SOILS WITH RYEGRASS

Biochar has been regarded as a promising carbon sequestration and fertilizing agent in soils Its ability to sorb pollutants also offers new possibilities to remediate contaminated sites However, very few studies have investigated the actual effect of biochar on the transfer of heavy metal to plants In order to evaluate the potential of biochar in this context, we examined the effect of a wood-derived biochar at different amendment rates on the growth of ryegrass in one acid and one basic soil, both similarly contaminated by Zn, Pb and Cd from smelter industry After 12 weeks of growth in one-liter pots, both roots and shoots were harvested, weighted and analyzed for their total trace element content In addition, we also sampled the pore solution during the first weeks and analyzed soil samples after harvest to monitor changes in pH and in metal or nutrient availability The increasing addition of biochar lead to an increase of pH on both soils and a continuous decrease of Zn, Pb and Cd concentration in the soil solution, which resulted in a reduced transfer of metals to the plants Positive effects of biochar on the plant growth were observed on both soils, but the increasing addition of biochar after 0 5 % on the basic soil resulted in a decrease of shoot biomass, which we attributed to a decrease of nutrient absorption The ability of biochar to reduce the phytotoxicity of heavy metal contaminated soils may therefore be counterbalanced by the limitation of nutrient availability to

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S3.5. **18 October, h. 15:00 – 16:30 (Room B)**

Title: **MANAGEMENT STRATEGIES AND ENVIRONMENTAL RISKS OF MANURES AND BY-PRODUCTS FROM AGRO-INDUSTRIES IN SUSTAINABLE AGROECOSYSTEMS**

***Chairpersons*:** Ewald Schnug, *Julius Kühn Institute - Braunschweig, Germany*
Francesco Montemurro, *CRA-SSC - Metaponto, Italy*

S3.5.01 **Biochar – a curse or a blessing?**
Schnug Ewald, Panten Kerstin, *Julius Kühn-Institute - Braunschweig, Germany*

S3.5.02 **Saline water and municipal solid organic waste compost: effects on yield of maize crops and soil responses**
Ventrella Domenico, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura-Bari, Italy*
Leogrande Rita, Lopedota Ornella, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - Metaponto, Italy*
Vitti Carolina, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - Bari, Italy*
Montemurro Francesco, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - Metaponto, Italy*

S3.5.03 **Effect of feedstock and fermentation parameters on nitrous oxide emission potentials of biogas digestates in soil**
Chuqing Duan, Eich-Greatorex Susanne, Dörsch Peter, *Norwegian University of Life Sciences - Aas, Norway*

S3.5.04 **Biogas digestates affect biological soil characteristics**
Eichler-Loebermann Bettina, Bachmann Silvia, *University of Rostock - Rostock, Germany*

S3.5.05 **Biochar from solid fraction of pig manure: evaluation of phosphorus release rate**
Godbout Stéphane, Joahnn Hernando Palacios, Patrick Brassard, *IRDA - Quebec, Canada*
Line Rochefort, *University Laval - Phytopathology - Quebec, Canada*
Lise Potvin, Patrick Dubé, Jean-Pierre Larouche, *IRDA - Quebec, Canada*
Rémy Pouliot, Sandrine Hogue-Hugron, *University Laval - Quebec, Canada*

S3.5.06 **Agronomic and environmental effects of raw and digested livestock slurries**
Mantovi Paolo, *Centro Ricerche Produzioni Animali - Reggio Emilia, Italy*
Monaco Stefano, Sacco Dario, *University of Turin - Turin, Italy*
Rossi Lorella, *Centro Ricerche Produzioni Animali - Reggio Emilia, Italy*
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BIOCHAR – A CURSE OR A BLESSING?

The term ‘biochar’ is nowadays commonly used to describe charcoal produced in a pyrolytic process, where biomass is heated in an oxygen-depleted environment. A variety of feedstock such as e.g. wood chips, straw, rice husk and sewage sludge as well as production conditions (temperature, pressure, time) impacts on the chemical and physical characteristics of biochar. Originally biochar thought to be a by-product of the biomass to liquid process for the production of oil and gas and therefore a ‘waste’ in itself to be disposed of. The focus changed to the production of biochar because of the increasing demand for biochar with oil and gas as a side product. The application of biochar on agricultural soils claims to contribute e.g. to carbon sequestration, greenhouse gas mitigation, nutrient supply, water retention and soil structure. Many of these claims are made with reference to the highly fertile ‘terra preta de Indio’ soils of the Amazonian region which contain high amounts of black carbon dating as far back as 8,000 BC, but are not finally evaluated for other soils and climate regions. Additionally, many questions about biochar as source or sink for heavy metals and polycyclic aromatic hydrocarbons and the resulting environmental risks remain. Secondary influence like e.g. effects of the replacement of straw incorporation by biochar application on soil structure and fauna are not yet investigated.

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SALINE WATER AND MUNICIPAL SOLID ORGANIC WASTE COMPOST: EFFECTS ON YIELD OF MAIZE CROPS AND SOIL RESPONSES

The field experiment was carried out in Southern Italy from 2007 to 2010 adopting a two-year rotation of tomato and maize. In this paper the results of maize cultivation were reported, with the aim to investigate the effects of different water qualities and fertilizers on yield and soil properties. The treatments compared were: mineral N fertilizer and irrigation with fresh water (FWF); mineral N fertilizer and irrigation with saline water (SWF); Municipal Solid Organic Waste (MSW) compost and irrigation with fresh water (FWC); MSW compost and irrigation with saline water (SWC); unfertilized control and irrigation with fresh water (FW0); unfertilized control and irrigation with saline water (SW0).
At harvest, yield, grain moisture content, dry matter, grain protein, starch and fat content were determined. The results of experiment indicated that MSW compost could substituted the mineral fertilizer, in fact in the treatments with compost the average grain yield increased of the 11% compared with treatments with mineral fertilizer. Furthermore, in maize the MSW compost applied as amendment mitigated the adversely effects of saline water, in fact, the SWC presented an increase of the 19% respect to average grain yield of SWF and SW0.
At the end of the experiment, application of compost significantly increased the TOC, in particular the FWC and SWC treatments showed an average increase of 27% compared to the mean TOC value of FWF and SWF. Furthermore, compost application decreased the electrical conductivity in SWC treatment respect to the SWF ones (-11%).

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EFFECT OF FEEDSTOCK AND FERMENTATION PARAMETERS ON NITROUS OXIDE EMISSION POTENTIALS OF BIOGAS DIGESTATES IN SOIL

Biogas residues (digestates) are commonly considered as a valuable resource, because of their high content of plant available N and P, potentially replacing synthetic fertilizers in food and biomass production. However, adding easily degradable organic material with low C:N ratios to soils may stimulate the emission of GHGs, in particular of nitrous oxide (N2O). Here, we report laboratory incubation experiments with three Norwegian soils differing in texture (sand, loam, silt) amended with biogas digestates from various mixtures of feedstocks (manures, wood, fish wastes, bagasse) at a rate of 120 kg N ha-1. The digestates differed in pH, lignin:N, C:N, mineral N content and concentrations of pollutants (trace metals and organics). Lab-scale incubation with automated headspace analysis of O2, N2, CO2, CH4, N2O and NO was conducted under oxic and anoxic conditions. The results suggest that the digestates have little direct effect on N2O production in soils rich in mineral N, but that the relatively high amount of ammonium in the liquid phase of the digestates can be a significant source of nitrification-derived N2O under fluctuating oxygen conditions. The instantaneous potential for digestate-induced N2O emission seems thus to be controlled by the amount of water and degradable carbon added (both of which control soil pO2) and to a lesser extent by the quality of the digestate's dry matter. The latter has long term effects comparable to those of compost or other low C:N amendments and is reported in a companion study (this session).

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BIOGAS DIGESTATES AFFECT BIOLOGICAL SOIL CHARACTERISTICS

Due to increasing generation of biogas in Europe large amounts of biogas digestates occur, which contain essential plant nutrients and organic matter. The reuse of these residues in agriculture is an important measure to close nutrient cycles and to improve the sustainability of bioenergy production. However, with the digestates mainly hardly degradable organic compounds are applied which may have consequences for the soil biota. The effects of different biogas digestates on soil biological parameters (activity of dehydrogenase, alkaline and acid phosphatase, microbial bound phosphorus (P)) were investigated in pot and field experiments. Dehydrogenase activity, as an indicator for the metabolic activity of soil microorganisms, and the activity of alkaline phosphatase was up to 50 % lower after application of the biogas residue in comparison to undigested materials. After field applications of digestates in 3 consecutive years (equivalent to 5 t of organic matter per ha) the microbial activity was not different from the mineral fertilizer treatment without any organic matter supply. This indicates that the organic matter applied with digestates did not stimulate soil microorganisms. Likewise, the values of microbial bound P were lower when digestates instead of unfermented materials were applied. Though, these facts did not negatively affect the P nutrition of the plants. In all experiments biogas digestate application improved plant P uptake and P availability in soil. However, in long-term negative impacts on the P turnover in soil and P supply to plants can be expected.

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BIOCHAR FROM SOLID FRACTION OF PIG MANURE: EVALUATION OF PHOSPHORUS RELEASE RATE

Due to a new regulation in Québec (Canada) restricting phosphorus fertilisation, pig producers are required to manage their manure in excess. For few producers, the solid-liquid separation and the energetic valorisation of the solid fraction by pyrolysis appear as a sustainable way of management. Biochar produced from pyrolysis, which concentrates P, could be easily transported outside of regions in phosphorus excess and be used as fertilizer in cultures or in rehabilitation projects such as in peatlands restoration. For the latter, biochar could replace the phosphate rock that is usually used as a fertilizer in peatlands to facilitate Polytrichum spores germination, a nursing plant for Sphagnum establishment. However, in order to promote adequately their growth, the phosphorus needs to be slowly released. The objective of this study was to develop a laboratory analytical method in order to determine the leaching rate of phosphorus from biocharin the presence of Sphagnum mosses. Samples of moss were immersed in demineralised water, mixed up with biochar and incubated under aerobic and anaerobic conditions at two different temperatures (20°C and 30°C). Phosphorus from the aqueous phase was analyzed during 14 weeks. The total leachable phosphorus from biochar was 6660 mg/kg in 18 hours (TCLP-1311 method). However, under the conditions of incubation, 80 to 94 % of leachable phosphorus was released in 14 weeks, i.e. 381-446 mg/kg per week. This leaching rate method could be used in future studies, in order to evaluate the potential of biochar as a fertilizer from other different sources and the doses to be applied.

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AGRONOMIC AND ENVIRONMENTAL EFFECTS OF RAW AND DIGESTED LIVESTOCK SLURRIES

A research activity was carried out to compare the chemical characteristics of raw and digested cattle slurries and to quantify the early carbon dioxide (CO2), nitrous oxide (N2O) emissions and soil N availability after the application to soil of solid and liquid fractions from raw material and from digested or codigested material Laboratory experiments were set up under controlled conditions to carry out an anaerobic digestion process and aerobic incubation of manured soils The different manures were applied to two different soils at the same total N level of 170 kg N ha-1 in 20 cm of soil Carbon dioxide (CO2) and nitrous oxide (N2O) emissions were measured by means of a photo-acoustic infrared gas analyzer, while inorganic N availability in manured soil was measured by soil extraction with KCl at five different dates (up to 36 days after fertilization) Results showed that solid/liquid separation of digestate allows to maintain a higher percentage of total N in form of ammonium in the clarified fraction, readily available to crops, with respect to raw slurry treatment After manure application to soils, inorganic N contents increased, on average, from 78 3 to 92 6% of total N applied with liquid fractions of manure, confirming the early high N availability to crops of this type of manure Nitrous oxide emissions were higher for liquid fractions, where they represented, on average, 2 0% of the N applied Results showed that manure treatment options reduce the amount of CO2 losses after application to soils by 10%

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S3.6a. **19 October, h. 15:00 – 16:30 (Room B)**

Title: **SMALL SCALE TREATMENT AND USE OF ORGANIC WASTES IN RURAL AREAS OF TROPICS AND SUBTROPICS**

***Chairpersons*:** Jo Smith, *University of Aberdeen - Aberdeen, Scotland*
Xu Jianming, *Zhejiang University - Hangzhou, China*

S3.6a.01 **Biochar in Zambia, Indonesia, Malaysia and Nepal: biochar technologies, mechanistic field trials, and socio-economic aspects**
Cornelissen Gerard, Hale Sarah, *Norwegian Geotechnical Institute - Oslo, Norway*
Mulder Jan, Martinsen Vegard, *University of Life Sciences - Aas, Norway*
Breedveld Gijs, Sparrevik Magnus, *Norwegian Geotechnical Institute - Oslo, Norway*

S3.6a.02 **Oil palm waste management in Indonesia: present status and future use to minimize greenhouse gas emissions**
Hadi Abdul, Satria Hasrul, Sulaiman Abrani, *Lambung Mangkurat University - Banjarmasin, Indonesia*
Nursyamsi Dedi, *Indonesia Swampland Agriculture Research Institute - Banjarbaru, Indonesia*

S3.6a.03 **Reduction of pathogenic bacteria in organic waste through production of biogas**
Harroff Lauren, *Centre for Research in Energy and Energy Conservation - Kampala, Uganda*
Tumwesige Vianney, Apsley Andrew, *University of Aberdeen – Aberdeen, Scotland, and Kampala, Uganda*
Avery Lisa, *James Hutton Institute - Aberdeen, Scotland*
Smith Jo, *University of Aberdeen - Aberdeen, Scotland*

S3.6a.04 **Evaluation of composts for improving fertility and productivity of soils in United Arab Emirates**
Alshankiti Abdullah, Gill Shagufta, *International Centre For Biosaline Agriculture (ICBA) - Dubai, United Arab Emirates*

S3.6a.05 **Nitrification, acidification and nitrogen leaching from subtropical cropland soils as affected by rice-straw-based biochar**
Zhao Xu, Wang Shen Qiang, *Institute of Soil Science, Chinese Academy of Sciences - Nanjing, China*

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BIOCHAR IN ZAMBIA, INDONESIA, MALAYSIA AND NEPAL: BIOCHAR TECHNOLOGIES, MECHANISTIC FIELD TRIALS, AND SOCIO-ECONOMIC ASPECTS

The Norwegian Geotechnical Institute (NGI) and the Norwegian University of Life Sciences (UMB) have set up four biochar field research initiatives in Zambia, Indonesia, Malaysia and Nepal. Total funding of the multidisciplinary research projects is around 5 million US$. The agronomical soil work is combined with research on biochar generation technologies and socio-economic aspects of biochar implementation, through life-cycle and cost-benefit analyses. Laboratory work is carried out on nutrient availability, plant-available water, GHG emissions and PAHs/dioxins in biochar. The main overall goal is to come to an evaluation of the overall potential of biochar in Asia and Africa.
A complete life-cycle analysis of biochar implementation in tropical countries showed that traditional earth-mound kiln technology is not to be recommended because of PM10, methane and CO emissions. Thus small-scale stoves and retort kilns have been introduced. The results of these are being integrated in life-cycle analyses and implemented via business concepts and cost-benefit analyses.
Agronomic field trials in all 4 countries have shown that biochar addition leads to up to 400% increase in yield in some places at dosages as low as 4 tons/ha, whereas it is not effective on others. The reason that the low application rate was so effective is the combination of poor, sandy soils with conservation farming, where planting is done in basins that only cover 10% of the soil surface. We hypothesize that the biochar is so effective because of a doubling of plant-available water, as well as a decrease in available Al.

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OIL PALM WASTE MANAGEMENT IN INDONESIA: PRESENT STATUS AND FUTURE USE TO MINIMIZE GREENHOUSE GAS EMISSIONS

Oil palm (Elaeis guineensis Jack) in Indonesia has been developed in big scale, including wetlands mainly with acid sulfate and peat soils A research has been carried out to elucidate the greenhouse emissions (GHGs) from current oil palm industries and alternative management of the waste to minimize GHGs The oil palm wastes were either composted, open- burned or pyrolized and the emissions of CO2, CH4 and N2O were quantified Biochar produced by pyrolisis of oil palm waste was applied on oil palm fields cultivated to oil palm with three years old on peat soil Apart from biochar, river sediment, slag and chicken manure and treatment without ameliorant were also applied as comparison Similar treatment were also applied to paddy grown in between oil palm The emissions of CO2, CH4 and N2O were quantified at bi-weekly basis The results showed that oil palm field on wetlands was acted as sources of greenhouse gas emissions Pyrolisis released CO2, CH4 and N2O, but the amounts were less than those released by open-burning Compost produced from oil palm empty bunch resulted highest quality (C/N ratio: 14 2, GWP= 319 7 g CO2eq m-2) as compare with other treatments tasted Conventional practice of oil palm cultivation resulted the highest N2O emissions The application of biochar on oil palm suppressed the N2O emissions Incertion of paddy in between oil palm trees could farther minimize GHGs emissions from oil palm industries Agronomical and social aspects of oil palm waste management will also be discussed

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REDUCTION OF PATHOGENIC BACTERIA IN ORGANIC WASTE THROUGH PRODUCTION OF BIOGAS

Anaerobic digestion treats organic wastes for safe and effective soil application while also providing energy for cooking and lighting. Many studies have focused on the reduction of bacteria through digestion in controlled, lab-based studies, but practical information from the field is unavailable.

This study examines the treatment of organic waste through nine flexible balloon digesters located at households in rural Uganda. The retention time in the digesters was a minimum of 40 days based on recommended feeding rates. In contrast to previous strictly controlled studies, families fed their digester based on available labour and resources and personal motivation. Feeding rates and retention times were therefore variable. Feed mainly consisted of cattle dung with some pig and chicken manure. Samples of the digester feed and digestate were collected over three months and analysed for Escherichia coli, total coliforms, Clostridium perfringens, and Enterococcus faecalis. The mean log reduction for E. coli (M=2.32) and total coliforms (M=4.58) were significantly greater than zero with p=6.83E-06 and p=2.78E-08, respectively. C. perfringens increased by an average of 1.86 log (p= 1.25E-04). The change in E. faecalis was not statistically significant with p=0.63.

This study demonstrates the practical functionality of anaerobic digestion in the treatment of organic waste to provide energy and a source of organic nutrients for soil in Uganda.

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EVALUATION OF COMPOSTS FOR IMPROVING FERTILITY AND PRODUCTIVITY OF SOILS IN UNITED ARAB EMIRATES

Soils in United Arab Emirates are mainly sandy with negligible organic matter content and limited inherited capability to support biological activity including plant growth without fertilization. Increase in the organic matter content of soils will appear necessary to enhance biological activity and improve soil quality and productivity.

A valuable source of organic matter is composted biosolid and waste derived from household and garden wastes. It is estimated that > 120 million tons of waste is produced in the Gulf Cooperation Countries (GCC), of which >22.2 million tons comes from municipalities and 4.6 million tons from industries. Efforts are on to divert polluting waste away from landfill disposal and maximize resource recovery including production of composts. In collaboration with the compost making industry, experiments are underway under laboratory, greenhouse, and field conditions to evaluate these composts for the improvement of soil fertility/productivity. Specific emphasis is being given to i) characterization of the compost produced & none composted sludge, ii) dynamics of available N and P, iii) microbiology, iv) dynamics of stable humus fraction, v) soil aggregation and water holding capacity, and vi) plant productivity with emphasis on plants more responsive to compost application. The paper will describe some of the initial results of the studies mentioned.

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NITRIFICATION, ACIDIFICATION AND NITROGEN LEACHING FROM SUBTROPICAL CROPLAND SOILS AS AFFECTED BY RICE-STRAW-BASED BIOCHAR

Currently no study has examined the effect of biochar on nitrification in acidic arable soils, which contributes to NO3- leaching and soil acidification We conducted a 42-day aerobic incubation and a 119-day weekly leaching experiment to investigate nitrification, N leaching and soil acidification in two subtropical soils applied with 300 mg N kg-1 ammonium sulfate or urea and 1 or 5 wt% rice straw biochar Over aerobic incubation, NO3- accumulation enhanced with increasing biochar application and as a result, pH decreased in the two soils relative to the initial soil pHs Under leaching condition, 5 wt% biochar caused no increase of NO3- but an reduction in N leaching compared with N treated only soils Consistent lower recoveries of added N from the incubation (KCl extractable N) and leaching experiment (leaching plus KCl extractable N) were observed following 5 wt% biochar application compared to the N treated only soils Incorporating biochar into acidic arable soils accelerates nitrification and thus weakens the liming effect of biochar, implicating the necessary of taking nitrification induced acidification into consideration in the short-time or lone-term evaluation of the liming effect of biochar in Chinese highly fertilized acidic soils However, the enhanced nitrification did not necessarily result in increase of NO3- leaching; on the contrary, application of biochar has a potential of reducing N leaching due to reduced availability or mobility of added N Further studies using 15N tracer are need to investigate N fate in biochar-treated acidic arable soils at both field plot and laboratory scales

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S3.6b. **19 October, h. 17:00 – 18:45 (Room B)**

Title: **SMALL SCALE TREATMENT AND USE OF ORGANIC WASTES IN RURAL AREAS OF TROPICS AND SUBTROPICS**

***Chairpersons*:** Jo Smith, *University of Aberdeen - Aberdeen, United Kingdom*
Knicker Heike, *IRNAS-CSIC - Sevilla, Spain*

S3.6b.01 **What happens to biochars after their application to tropical and subtropical soils – extrapolation of results obtained from soil profiles of typical fire-affected landscapes**
Knicker Heike, *IRNAS-CSIC - Sevilla, Spain*
Velasco-Molina Marta, *University of Santiago de Compostela - Santiago de Compostela, Spain*

S3.6b.02 **Impact of different uses of organic wastes on carbon sequestration in soils of Sub-Saharan Africa**
Smith Jo, Tumwesige Vianney, *University of Aberdeen - Aberdeen, Scotland, United Kingdom*
Semiyaga Swaib, *Makerere University - Kampala, Uganda*
Morley Nick, *University of Aberdeen - Aberdeen, United Kingdom*
Sabiiti Elly, *Makerere University - Kampala, Uganda*
Matthews Robin, *James Hutton Institute - Aberdeen, United Kingdom*
Abegaz Assefa, *Addis Ababa University - Addis Ababa, Ethiopia*
Orskov Bob, *James Hutton Institute - Aberdeen, United Kingdom*
Smith Pete, *School of Biological Science - Aberdeen, United Kingdom*

S3.6b.03 **Impact of different uses of organic wastes on soil fertility and crop production in Sub-Saharan Africa**
Smith Jo, Tumwesige Vianney, *University of Aberdeen - Aberdeen, Scotland, United Kingdom*
Semiyaga Swaib, *Makerere University - Kampala, Uganda*
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Smith Pete, *School of Biological Science - Aberdeen, United Kingdom*

S3.6b.04 **Biogas and indoor air pollution in households in Tiribogo, Uganda**
Tumwesige Vianney, *University of Aberdeen - Aberdeen, Scotland, United Kingdom and Centre for Research in Energy and Energy – Kampala, Uganda*
Harroff Lauren, *Centre for Research in Energy and Energy Conservation - Kampala, Uganda*
Apsley Andrew, Sample Sean, Smith Jo, *University of Aberdeen - Aberdeen, Scotland*

S3.6b.05 **Compost of different stability affects the molecular composition and mineralization of soil organic matter**
Eshetu Bekele, *Adama University - Adama, Ethiopia*
Peter Leinweber, Christel Baum, *Rostock University - Rostock, Germany*

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WHAT HAPPENS TO BIOCHARS AFTER THEIR APPLICATION TO TROPICAL AND SUBTROPICAL SOILS – EXTRAPOLATION OF RESULTS OBTAINED FROM SOIL PROFILES OF TYPICAL FIRE-AFFECTED LANDSCAPES OF

Since biochar amendment has been suggested only recently as a tool to improve soil fertility, field experiments on the long-term impact of this management are scarce. However, first estimates may be available by analyzing natural soils which have been exposed to frequent fire events. Aside from the Terra preta do Indio, Brazil offers other landscapes which are characterized by frequent fires caused by human activity during the last centuries and millennia. Typical systems are the Cerrado in Central Brazil, the highlands in the Planalto of Southern Brazil and some regions of the Pantanal in the Southwest of the country. Analyzing the organic matter along soil profiles in those regions revealed the presence of charcoal residues down to the C horizons. Interestingly, lower charcoal contributions were found in the top soils than in the deeper horizons, most tentatively because of efficient charcoal oxidation at the surface and the subsequent removal of the degradation products by further mineralization or by leaching to deeper soil regions. According to solid-state NMR spectroscopy, the organic matter of several deeper horizons was almost exclusively composed of charcoal residues. This observation demonstrates their preferential preservation in deep soils, possibly supported by their stabilization through the mineral phase. Our data clearly show that frequent charcoal addition can have a long-term impact on organic matter composition of deeper soil horizons. Considering that oxidized charcoal residues may also leach into the aquifer, a further evaluation of the impact of such residues on the groundwater is urgently needed.

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IMPACT OF DIFFERENT USES OF ORGANIC WASTES ON CARBON SEQUESTRATION IN SOILS OF SUB-SAHARAN AFRICA

Using bioslurry from anaerobic digestion as an organic fertilizer has great potential to increase carbon sequestration by supplying organic matter to the soil. This paper examines this potential in Sub-Saharan Africa compared to other uses of organic wastes, including burning on pyrolysis cook-stoves and composting. Measurements of loss of carbon on treatment of organic wastes indicate that the proportion of carbon lost from organic waste during treatment is greater for anaerobic digestion than for aerobic composting or pyrolysis. The stability of organic waste is increased by treatment, and is similar for composted and anaerobically digested material, but is higher for material treated by pyrolysis. Simulations using the RothC model, driven by parameters based on incubations of the organic wastes with soil, suggest that on the basis of decomposability alone, treated organic wastes sequester significantly more carbon than untreated organic wastes, and despite the differences observed in stability, unless biochar contains a high proportion of inert organic material that does not decompose at all, the potential carbon sequestration by incorporating biochar is similar to that for compost or bioslurry. However, if losses of carbon during treatment are also taken into account, incorporating bioslurry sequesters only approximately the same amount of carbon as if the organic waste had been left untreated. By contrast, incorporating compost and biochar sequesters significantly more carbon than incorporating the untreated organic waste. Predictions of carbon sequestration are compared to measurements from field experiments in Uganda.

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IMPACT OF DIFFERENT USES OF ORGANIC WASTES ON SOIL FERTILITY AND CROP PRODUCTION IN SUB-SAHARAN AFRICA

Three alternative soil amendments of organic wastes are considered: application of untreated animal manures, bioslurry from biogas digestion, composted materials, and biochar produced by pyrolysis cook-stoves. Application of untreated manures is predicted to provide high input of available nutrients, which results in an initial flush in crop growth. However, risks of losing nutrients are high because manure is usually applied before sowing to avoid reduced yields due to phytotoxicity, resulting in increased losses by leaching or volatilization. The heterogeneous nature of untreated manures can result in immobilization of nutrients by carbon-rich materials. A greater amount of nutrients are potentially available to crops from applied bioslurry. Typically 5-10% of the nitrogen is lost during anaerobic digestion, but bioslurry provides immediately available nutrients that can be applied as needed, so reducing risks of nutrient loss. Risks of nutrient losses are also lower when wastes are applied as composts, but in contrast to bioslurry, this is because the concentration of immediately available nutrients is very low, most nutrients being held in organic form that will become available only slowly over the growing season. Composts provide an option for single dose application, but a larger proportion of nitrogen is lost during composting (26-51%) than during anaerobic digestion (5-10%). Losses of nitrogen during pyrolysis are also very high (70-90%), but biochar can reduce losses of native soil nutrients by providing exchange sites that hold nutrients in the soil. Predictions of nutrient availability are compared to field measurements in Uganda.

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BIOGAS AND INDOOR AIR POLLUTION IN HOUSEHOLDS IN TIRIBOGO, UGANDA

Traditional cooking in Sub-Saharan Africa relies on biomass fuels coupled with inefficient cookstoves that both deplete natural resources and cause harmful air emissions. Emissions include fine particulate matter of less than 2.5µm in diameter (PM2.5), carbon monoxide (CO), nitrous oxide, poly-aromatic hydrocarbons, benzene and butadiene. Anaerobic digestion is one alternative that utilizes organic waste to provide a cleaner source of cooking fuel in the form of biogas while reducing dependency on biomass fuel.

This study focuses on changes in PM¬2.5 and CO concentrations resulting from the use of biogas. Nine households in rural Uganda were selected to receive flexible balloon digesters. Household air quality was measured pre- and post-installation of the digesters for 24-hour periods inside households' kitchens. A 32 percent decrease in both PM2.5¬ and CO was observed over the time interval; however, concentrations of both emissions remained above EPA and WHO recommendations. The average PM2.5 ¬concentration post-installation was 367?gm-3, and the average CO concentration post-installation was 6.2 PPM.
The EPA Air Quality Index classifies 150 ?gm-3 PM2.5 as very unhealthy and 250 ?gm-3 PM2.5 as hazardous. WHO recommends a 24-hour mean to be 25 ?gm-3 or less for PM2.5 and 6.0 PPM or less for CO.

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COMPOST OF DIFFERENT STABILITY AFFECTS THE MOLECULAR COMPOSITION AND MINERALIZATION OF SOIL ORGANIC MATTER

This study investigated the C mineralization and chemical modification of a typical tropical soil amended with regional compost of different stability Compost the samples were collected in three different phases of composting They were analyzed for their phytotoxicity and added to a tropical Nitisol at the rate of 48 t ha-1 and a control was set up without amendment The CO2-C respired was determined during 98 days of incubation and the incubated samples were taken at the start and end of incubation for molecular-chemical analysis by Pyrolysis-Field Ionization Mass Spectrometry (Py-FIMS) The fresh waste yielded a germination index (GI) < 26% indicating phytotoxicity but this disappeared in all the composts (GI > 100%) The CO2-C respired was best explained by a first order plus linear model A soil amended with a compost taken at the thermophilic phase attained the lowest overall organic C loss In general, the Py-FIMS revealed a significant enrichment of stable N-compounds during the incubation in all amended soils compared to the control Furthermore, among the compost-soil mixtures Py-FIMS indicated significantly higher increases in the proportions of carbohydrates, peptides and phenols/lignin monomers at the expense of fatty acids and sterols in soil amended with composts from the thermophilic phase Thermal volatilization curves of Py-FIMS indicated enrichments of stable N-compounds and peptides in compost amended soil In summary, application of compost shortly after reaching the high temperature phase was shown to be more efficient in organic C sequestration in a clay-rich tropical agricultural soil than mature composts

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S3.7. **20 October, h. 08:30 – 10:00**

Title: **SOIL ORGANIC MATTER AMENDMENTS: IMPACTS, BENEFITS, AND RISKS**

***Chairperson*:** Claudio Zaccone, *University of Foggia - Foggia, Italy*
Claudio Ciavatta, *University of Bologna - Bologna, Italy*

S3.7.01 **Characteristics of organic fertilizer with various mixing ratios of rice husk charcoal and their effects on mung bean and water spinach yields**
Tsunoda Mayumi, Bellingrath-Kimura Sonoko Dorothea, Tanaka Haruo, Oikawa Yosei, *Tokyo University of Agriculture And Thechnology - Fuchu, Tokyo, Japan*

S3.7.02 **Fate and effect of biogas residues on the SOM carbon after application on arable soils**
Coban Halil, Miltner Anja, Kästner Matthias, *Helmholtz Centre for Environmental Research (UFZ) - Leipzig, Germany*

S3.7.03 **The effect of long term annual compost application on the distribution and stability of soil organic matter**
De Clercq Tim, Merckx Roel, *KU Leuven - Leuven, Belgium*
Dercon Gerd, *International Atomic Energy Agency - Vienna, Austria*
Elsen Annemie, *Soil Service of Belgium - Heverlee, Belgium*
Vandendriessche Hilde, *KU Leuven - Leuven, Belgium*

S3.7.04 **Field evaluation of humic products (potassium humate as powhumus, humus wsg 56,9 and as liqhumus 18%) on eggplant and banana culture**
Dergham Yasser, *Humintech GmbH - Duesseldorf, Germany*
Chau Phillipp, *Society Agri- Venture (SAVE) - Iloilo, Philippine*

S3.7.05 **Pyrogenic organic matter primes organic matter decomposition in the short-term but does not affect soil respiration in the long-term**
Maestrini Bernardo, *University of Zurich - Zurich, Switzerland*
Herrmann Anke M., *Swedish University of Agricultural Sciences - Uppsala, Sweden*
Nannipieri Paolo, *University of Florence - Florence, Italy*
Schmidt Michael W. I., Abiven Samuel, *University of Zurich - Zurich, Switzerland*

S3.7.06 **The use of compost and biochar to increase soil organic carbon content without increasing nutrient leaching**
D'Hose Tommy, Greet Ruysschaert, Victoria Nelissen, Alex De Vliegher, Koen Willekens, Bart Vandecasteele, *Institute for Agricultural and Fisheries Research (ILVO) - Merelbeke, Belgium*

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CHARACTERISTICS OF ORGANIC FERTILIZER TWITH VARIOUS MIXING RATIOS OF RICE HUSK CHARCOAL AND THEIR EFFECTS ON MUNG BEAN AND WATER SPINACH YIELDS

“Bokashi” is an organic fertilizer made by fermenting materials such as fish meals, livestock manure, rice husk, and forest soil. Japanese farmers often mix charcoal to absorb nutrients. However, there is no scientific guideline for the optimum charcoal mixing ratio (CMR).
This study examined the effect of CMR on Bokashi. Bokashi was prepared with CMRs of 0% (C-0), 5% (C-5), 10% (C-10) and 20% (C-20). Then, the fertility of Bokashi was evaluated in pot experiments using mung bean (Vigna radiata) and water spinach (Ipomoea aquatica). Experimental plots contained no fertilizer (Cont), chemical fertilizer (Chem), chemical fertilizer mixed with charcoal (CC), C-0 (C0), C-5 (C5) and C-20 (C20) application. Experiments were conducted in Japan and Vietnam.
The cation exchange capacity (CEC) of Bokashi was not significantly different among the various CMRs tested.
In Japan, the mung bean yields for Chem, C5, and C20 were significantly higher than Cont.
In Vietnam, the grain yields of mung bean were significantly higher in CC, C5, and C20 than in Cont and Chem. The can be explained by the favorable climate conditions for grain growth combined with the effects of charcoal and the low soil CEC of 7.4 cmol.
At both sites, soil pH increased with increasing charcoal application. And, the grain yield of C5 was significantly higher than that of Cont, Chem, CC, and C0, but not significantly different from C20. Thus, it can be concluded that the CMR should be more than 5%.

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FATE AND EFFECT OF BIOGAS RESIDUES ON THE SOM CARBON AFTER APPLICATION ON ARABLE SOILS

Agricultural soils worldwide suffer from a loss of soil organic matter (SOM). This is aggravated by enhanced cultivation of bioenergy crops as the carbon input from plant residues is reduced on these areas. This practice increases the anthropogenic CO2 in the atmosphere and reduces soil fertility. One way to mitigate these effects of bioenergy crop production is the application of biogas residues (BGR). This application influences the composition and the turnover of soil organic matter. This effect will be studied by incubating 13C-labeled BGR in an arable soil from the Static Fertilization Experiment in Bad Lauchstädt, Germany. For producing these labeled residues, KH13CO3 was added to biogas reactors in order to label the active microbial biomass. The labeled BGR will be incubated in the soil for 1 year in the laboratory. During incubation, the fate of the labeled carbon will be monitored and its effects on SOM turnover and soil characteristics will be investigated using isotope mass balances and analysis of the concentration and isotopic composition of phospholipid fatty acids, phospholipid ether lipids and amino acids. This will allow to trace the fate of the BGR-derived C in soil as well as to quantify the effect of the BGR on the transformation of the natural SOM (e.g. priming effects). In conclusion, this study will investigate the impact of BGR used as a soil additive on the amount of SOM, thus contribute to recommendations about the use of BGR as fertilizers or soil additives in agriculture.

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THE EFFECT OF LONG TERM ANNUAL COMPOST APPLICATION ON THE DISTRIBUTION AND STABILITY OF SOIL ORGANIC MATTER

Soil organic matter is a major carbon pool and can play a significant role in carbon mitigation measures. It is also a crucial factor for several soil physical properties and a major nutrient source for crops. To obtain an understanding of the changes that occur in the soil following long term annual compost application, the Soil Service of Belgium started a long term field trial in Boutersem, Belgium in 1997. Here 12 different treatments (fallow, unfertilized, mineral fertilized and 9 compost treatments differing in intensity from 15 to 45 t/ha and in frequency from annual to tri-annual) were implemented in 4 repetitions. All compost amended treatments substituted (part) of the mineral nutrient requirements of the crop and had a positive influence on soil chemical and physical parameters.

The continued application of compost also has important effects on the amount, distribution and stability of the soil organic matter. To quantify this, soil samples from 5 treatments were divided into 7 fractions differing in physical and biochemical protection levels of the associated SOM. Carbon, nitrogen and their respective stable isotope concentrations were measured in all fractions. Not only did the total amount of carbon in the amended soils increase significantly over the course of the experiment, it also increased specifically in the free and occluded micro-aggregate fractions. A recently developed model based on the C/N and ?15N ratio of the SOM was used to determine its relative age and stability in all of the isolated SOM fractions.

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FIELD EVALUATION OF HUMIC PRODUCTS (POTASSIUM HUMATE AS POWHUMUS , HUMUS WSG 56,9 AND AS LIQHUMUS 18%) ON EGGPLANT AND BANANA CULTURE

Humic substances (humic and fulvic acids) play a vital role in soil fertility and plant nutrition. Their physical, chemical and biological influences on soil and plant growth are well known. Two humic substance products (potassium humate in powder form as Powhumus or Humus wsg 56.9 and in liquid form as Liqhumus 18%) of the Humintech Company (Germany) were tested in field experiments on banana culture (Musa acuminate, var. Williams) and eggplant culture (Solanum melongena, Var. Casino) in the Philippines. Potassium humate (Powhumus, Humus wsg 56.9%) when added to eggplant as foliar and soil applications increased significantly the number and the weight of fruits per hectare. Liqhumus 18% was tested in a nursery of banana plant in an effort to reduce the application rate of SOP (potassium sulfate). Growth parameters (plant height, leaf emission, stem girth, leaf length and leaf width) were monitored and the results showed that Liqhumus 18% when added to 50% SOP was significantly better than 100% SOP alone across all parameters.

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PYROGENIC ORGANIC MATTER PRIMES ORGANIC MATTER DECOMPOSITION IN THE SHORT-TERM BUT DOES NOT AFFECT SOIL RESPIRATION IN THE LONG-TERM

Biochar is considered as a good soil amendment to increase soil fertility and carbon (C) storage, however controversial results have been found on its effect on native soil organic C 1,2 and nitrogen (N)3,4 We incubated rye-grass derived biochar (pyrolysis at 450°C under a flux of N2) enriched in 13C (?13C 3057‰) in a mineral cambisol for 158 days at 25°C Biochar and soil organic C decomposition, incorporation of biochar into microbial biomass, gross and net N processes, and the phenol-oxidase and protease activities were measured consecutively throughout the experiment We found that 3 4% C-biochar decomposed in 158 days, confirming findings on the relatively short turnover time of grass derived biochar5 Biochar induced a strong positive priming effect during the first 18 days, which we classify as an apparent priming effect (ie due to a high microbial turnover time) followed by a second phase of negative priming effect This alternation of priming effect plus the CO2 efflux derived from biochar decomposition resulted in no significant difference in the cumulated total soil respiration at the end of the incubation The initial increase of native soil organic matter mineralization was associated with higher gross N mineralization, resulting in higher mineral N content at the end of the incubation Therefore we conclude that the addition of biochar did not affect total soil respiration but increased mineral N content However, we believe that processes underlying priming effect needs further clarification before soil organic C stocks in biochar amended soils can be predicted by

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THE USE OF COMPOST AND BIOCHAR TO INCREASE SOIL ORGANIC CARBON CONTENT WITHOUT INCREASING NUTRIENT LEACHING

Carbon addition to soil is beneficial for a wide range of chemical, physical and biological soil properties However, the restricted use of organic fertilizers related to the nitrate directive constrains the built-up of stable soil organic carbon (SOC) Both compost and biochar have high contents of stable carbon and can be incorporated in the soil to improve soil quality Therefore, two long term experiments (BOPACT and BIOCHAR) were established on nearby fields at ILVO to investigate if SOC, overall soil quality and crop yield can be increased by adding compost, biochar or biochar/compost blends to the soil without increasing N leaching BOPACT (started in spring 2010) has a strip split plot design with three factors and four replications The factors are 1) slurry application (cattle vs pig slurry), 2) tillage practices (ploughing vs non-inversion tillage), and 3) compost application (0 vs 2 ton C/ha year) BIOCHAR (started in spring 2011) has a completely randomized design with four replicates comparing the application of a woody biochar (Romchar) with a control treatment In the fall of 2012, the application of another woody biochar (Refoak650) was included in the experiment Our results indicated that for both compost and biochar (Romchar) application the change in SOC content was significantly ($p<0$ 05) higher compared to no amendment after three and one year, respectively Moreover, both amendments did not increase the risk for N leaching in fall As the experiments are still ongoing, we will continue to monitor the SOC evolution, nutrient dynamics and crop growth

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S3.8. **20 October, h. 10:30 – 12:15**

Title: **LONG-TERM SURVIVABILITY OF BIOCHAR AND DIGESTATES IN SOILS AND SOIL CARBON SEQUESTRATION WITH AGRICULTURAL IMPLICATIONS - MYTH OR REALITY?**

***Chairpersons*:** Claudio Zaccone, *University of Foggia - Foggia, Italy*
Xing Baoshan, *University of Massachusetts, Amherst - Amherst, USA*

S3.8.01 **Does the use of biogas digestates cause high nitrous oxide emissions?**
Eich-Greatorex Susanne, Dörsch Peter, Sogn Trine A., *Norwegian University of Life Sciences - Aas, Norway*

S3.8.02 **Suppression of damping-off caused by rhizoctonia solani by biochar, a soil-applied carbon sequestering agent**
Kumar Jaiswal Amit, *The Hebrew University of Jerusalem - Rehovot, Israel*
Frenkel Omer, Elad Yigal, Graber Ellen R., *Agricultural Research Organization (ARO), The Volcani Center - Bet Dagan, Israel*

S3.8.03 **Reduction of nitrous oxide emissions by biochar amendment to soil: the role of PH**
Obia Alfred, *Norwegian University of Life Sciences - Aas, Norway*
Cornelissen Gerard, *Norwegian Geotechnical Institute - Oslo, Norway*
Mulder Jan, *Norwegian University of Life Sciences - Aas, Norway*
Hale Sarah, *Norwegian Geotechnical Institute - Oslo, Norway*
Dörsch Peter, *Norwegian University of Life Sciences - Aas, Norway*

S3.8.04 **Phosphorus recycling: anaerobic digestate materials connecting recovery with re-use**
Shepherd Jessica, Buss Wolfram, Heal Kate, Sohi Saran, Peters Clare, *University of Edinburgh - Edinburgh, Scotland*

S3.8.05 **Effect of varying concentrations of biochar on CH4 emission and methanogenic community in paddy ecosystem**
Singla Ankit, *Chiba University - Matsudo, Japan*
Dubey Suresh, *Banaras Hindu University - Varanasi, India*
Inubushi Kazuyuki, *Chiba University - Matsudo, Japan*

S3.8.06 **Biochar as alternative to activated chars for priority micro-pollutant waste water depuration**
Slijepcevic Ana, Favre Boivin Fabienne, *University of Applied Sciences of Western Switzerland - Fribourg, Switzerland*
Piantini Umberto, *University of Applied Sciences of Western Switzerland - Sion, Switzerland*

S3.8.07 **Potential mechanisms of biochar to decrease soil nitrous oxide emission**
Xing Baoshan, *University of Massachusetts, Amherst - Amherst, USA*
Zheng Hao, Zhenyu Wang, *Ocean University of China - Qingdao, China*

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DOES THE USE OF BIOGAS DIGESTATES CAUSE HIGH NITROUS OXIDE EMISSIONS?

Digestate from biogas production based on co-digestion of Salix and manure was used as fertilizer in pot experiments with three different soil types and Italian ryegrass as a crop. The soil types studied were loam, silt and sand. The digestate was used as a liquid in its original form, as a liquid with added zeolite to bind nutrients in the liquid phase, and as a more solid sludge after sieving. These three treatments were compared to a mineral fertilizer control, cattle manure and cattle manure with zeolite. The amounts of digestate and manure added were in all cases equivalent to 120 kg N ha-1. After the first cut, all pots were fertilized with mineral N fertilizer equivalent to 60 kg N ha-1, respectively. The control received the same amount of mineral fertilizer.
Yields differed little between treatments in the loam and silt, whereas the organic treatments (digestate, cattle manure) increased yields in the sand relative to the mineral fertilizer control. Soil type clearly influenced N2O emissions: initially, the loam soil had the by far highest emissions both with liquid digestate and manure (with and without zeolite), whereas emissions were virtually absent in the sand. Increases in N2O emissions after the first week occurred in the loam with all organic treatments and in the sand with the liquid digestate and manure. Adding zeolite did not result in lower N2O emissions in the loam but had some effect in the sand.

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SUPPRESSION OF DAMPING-OFF CAUSED BY RHIZOCTONIA SOLANI BY BIOCHAR, A SOIL-APPLIED CARBON SEQUESTERING AGENT

The soil application of biochar, the solid carbon-rich product of biomass pyrolysis, not only provide a long-term repository of carbon to mitigate climate change, but also improves soil quality, nutrient retention, and crop productivity Recently, biochar was found to reduce severity of foliar diseases and soilborne diseases in various crops Biochar characteristics are expected to affect its disease suppression capability, as there is a profound variability in the physical and chemical properties of biochar depending on the initial feedstock and production parameters The aim of this research was to explore the influence of biochar produced from different feedstocks and at different production temperatures on its ability to suppress the soilborne pathogen, Rhizoctonia solani, in cucumber Biochar prepared from two feedstocks (Eucalyptus wood (EUC) and Greenhouse waste (GHW)) each produced at 350 and 600ºC were tested for their suppressive ability against damping-off at concentrations of 0, 0 5, 1, and 3% (w: w) In general, biochar addition at relatively lower concentrations suppressed damping-off, whereas, at higher concentrations, biochar was ineffective or even increased the disease as compared with the control Biochars produced at both low and high temperatures were equally effective against various disease parameters However, suppression of disease was affected by the feedstock type There was a significant interaction between feedstock and concentration for the final damping-off and other disease parameters, indicating that each feedstock had an optimum concentration for disease control The most effective dose for suppressing disease was 1% for EUC biochar and 0 5% for GHW biochar

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REDUCTION OF NITROUS OXIDE EMISSIONS BY BIOCHAR AMENDMENT TO SOIL: THE ROLE OF PH

Biochar application to soil has been recurrently reported to reduce N2O emissions, but the mechanisms mediating the suppression are not clear. One mechanism could be the pH-increasing effect of biochar in soils.
Here we report laboratory experiments exploring the alkalizing effect of two different biochars in acidic tropical agricultural soils and their impact on denitrification stoichiometry. Untreated, water-leached and acid-leached rice husk and cacao shell biochars were added to soil.
Biochar did not show toxicity to biological activities measured from oxygen uptake. Untreated biochar strongly reduced N2O emissions and increased N2 emissions. The effect was stronger with increasing biochar dose. Cacao shell biochar showed a stronger effect compared to rice husk biochar. These effects were consistent with pH increases due to biochar types and doses.
Rice husk biochar leached for its ashes with distilled water resulted in a weaker effect on N2O emission, but the suppression pattern across doses remained. Acid-leached rice husk biochar resulted in significant N2O suppression for high doses (5% & 10%) only. Both water and acid-leached cacao shell biochar resulted in significantly suppressed N2O emission at a 2% dosage but not at higher doses (5% & 10%).
Our results suggest that, biochar induced pH increases could be one of the main mechanisms for suppression of N2O emission.

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PHOSPHORUS RECYCLING: ANAEROBIC DIGESTATE MATERIALS CONNECTING RECOVERY WITH RE-USE

A reliable source of phosphorus is essential for the stability of global food supply, but the natural phosphorus cycle has become "broken" by human activity. Feeding the increasing human population relies on finite mined phosphorus to maintain agricultural yields, while the phosphorus enrichment of aquatic environments from human wastes and fertiliser run-off can lead to eutrophication. A new, more sustainable phosphorus cycle connecting recovery with re-use must be realised. The utilisation of functionalised waste products as materials to both recover phosphate from wastewater or agricultural run-off and return it to soil presents a sustainable solution to this phosphorus cycling imbalance.

To date, biochars produced from anaerobic digestate (AD) feedstocks represent some of the only materials to exhibit significant phosphate sorption properties after pyrolysis. The addition of mineral-containing waste may also improve the functionality of these materials. The presentation will discuss the development of novel biochar materials from AD and also investigation of their phosphate sorption and release mechanisms to identify structure-activity relationships and inform the future development of such materials.

Biochar samples produced from AD and AD-mineral waste mixtures at 450 and 550°C were analysed for chemical and physical properties, phosphate sorption capacity, hydraulic conductivity and their effect on plant germination to assess the viability of the materials as phosphate filters and agricultural fertilisers. Suitability of these materials as fertilisers will be further evaluated through nutrient and contaminant leaching studies in soil, and in pot trials with various crop species.

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EFFECT OF VARYING CONCENTRATIONS OF BIOCHAR ON CH4 EMISSION AND METHANOGENIC COMMUNITY IN PADDY ECOSYSTEM

Biochar is believed to have a positive impact on the soil properties and plant yield. Due to the presence of C, it can also enhance CH4 emission in paddy soils. A microcosm experiment was conducted to determine the effect of different concentrations of biochar on CH4 emission and methanogenic community in paddy vegetated soil. Biogas digested liquid was used as N source @ 120 kg N/ha in each treated soil. Four treatments in triplicate were as follows: 1) Control: without biochar; 2) BL, biochar @ 180 kg C/ha (C/N 1.5); 3) BM, biochar @ 360 kg C/ha (C/N 3.0); 4) BH, biochar @ 720 kg C/ha (C/N 6.0). Biochar was applied as basal dose only; while N was applied in 3 split doses in each treated soil. The addition of biochar increased CH4 emission than untreated and it significantly increased with increase in biochar concentration. Biochar application increased soluble organic content of the soil. It also increased NH4+-N content of soils probably by providing more reducible conditions in soils. Biochar application decreased NO3--N content of soils. Denaturing gradient gel electrophoresis showed no differences in banding pattern for methanogens which suggested no change in methanogenic community in biochar treated soils. Biochar application had positive impact on plant variables such as shoot weight, panicle number and weight of panicles. Plant biomass increased with increase in biochar concentration but differences were not significantly different between BM and BH treated soils.

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BIOCHAR AS ALTERNATIVE TO ACTIVATED CHARS FOR PRIORITY MICRO-POLLUTANT WASTE WATER DEPURATION

Waste water depuration in Switzerland now addresses some priority pollutants that were formerly not considered in the Swiss standards. Wastewater treatment plants must now be able to eliminate 80% of pharmaceuticals and personal care products. Wastewater treatment plants tend to use activated chars to fulfil these requirements. The use of local sources of Biochars produced from wood wastes is an alternative to the importation of activated chars for waste water depuration. After characterizing the local sources of biochars for their reactivity towards the targeted pollutants, we performed (i) batch experiments comparing activated chars and Biochars for their ability to decrease the priority pollutant content of a solution, with respect to the new Swiss requirements and (ii) real treatment plant condition experiments with waste waters to assess the performance of biochars depuration properties under operational conditions. The compared properties of activated chars and local Biochars are discussed in the frame of (i) the surface properties of the different char sources, (ii) the conformity of the depuration to the new Swiss rules requirements, (iii) the issues that may raise in real waste water treatment plants conditions and (iv) the production of a sustainable sorbent for waste water treatment.

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POTENTIAL MECHANISMS OF BIOCHAR TO DECREASE SOIL NITROUS OXIDE EMISSION

Application of biochars to agricultural soils is suggested as an effective way for improving soil quality and mitigating greenhouse gas emission, which has generated great interest from scientists and policy makers. However, extensive use of biochar to mitigate nitrous oxide (N2O) emission is limited by the lack of understanding on the exact mechanisms altering N2O emissions from biochar-amended soils. Therefore, N2O emission from an agricultural soil was examined through adding a batch of biochars produced from giant reed (Arundo donax L.). Moreover, the remaining compounds, PAHs and phenolic compounds (PHCs), in the biochars were evaluated for their roles in N2O emissions from biochar-amended soils. N2O emission from the biochar-amended soils was pyrolytic temperature-dependent, and the reduction order of N2O emission by the biochar (BC) was: BC200 ? BC600 > BC500 ? BC300 ? BC350 > BC400. Reduced denitrification in the biochar-amended soils was the main reason for suppressing N2O emission. The PAHs in the low-temperature biochars (300-400 °C) also played a major role in reducing N2O emission, but not for the high-temperature biochars (500-600 °C). The removal of PHCs from the low-temperature (200-400 °C) biochars surprisingly resulted in N2O emission reduction, but the mechanism is still unknown. In conclusion, giant reed biochars could be added to soil to mitigate N2O emission, thus possibly global warming.

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W3. **18 October, h. 17:00 – 18:45**

Title: **END O SLUDG**

***Chairpersons*:** Le Son, *United Utilities Group PLC - Warrington, UK*
Marañon Elena, *University of Oviedo - Gijón, Spain*

W3.01 **End-o-sludg project overview**
Le Son, *United Utilities Group PLC - Warrington, UK*

W3.02 **Response to pre-treatments and digestion intensification of sewage sludge**
Marañon Elena, Negral Luis, Fernández-Nava Yolanda, Castrillón Leonor, *University of Oviedo - Gijón, Spain*

W3.03 **Evaluating biosolids as a valuable phosphorus resource to meet crop requirements**
Holmes James, *Home Grown Cereals Authority - HGCA - Warwickshire, UK*
Sakrabani Ruben, Pawlett Mark, Deeks Lynda, *Cranfield University - Cranfield, UK*
Chaney Keith, Smith Grace, *HAUC - Newport - Shropshire, UK*

W3.04 **The application of organo mineral fertiliser to arable and grass silage crops**
Chaney Keith, *Harper Adams University College - Newport - Shropshire, UK*
Sakrabani R., *Cranfield University - Cranfield, UK*
Smith G., *Harper Adams University College - Newport - Shropshire, UK*
Pawlett M., Deeks L.K., *Cranfield University - Cranfield, UK*

W3.05 **End-o-sludg: end of waste**
Le Son, *United Utilities Group PLC - Warrington, UK*

W3.06 **Sustainability assessment of wastewater treatment technologies, sewage sludge production and its application to land**
Sakrabani Ruben, Sandars Daniel, Williams Adrian,*Cranfield University - Cranfield, UK*
Albella David, Fernandez Natalia C., *HIPSITEC - Oviedo, Spain*
Evans Rob, Howarth Richard, *Sustainable Resource Solutions Limited - Agfa House - Leeds, UK*
La Fuente Jose M. G., *COGERSA - La Zoreda - Gijón, Spain*

W3.07 **Use of anaerobic digestates in the grass-turfs industry: a long-term (2 year) field experiment**
Pawlett Mark, Tibbett Mark, *Cranfield University - Cranfield, UK*

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END-O-SLUDG PROJECT OVERVIEW

END-O-SLUDG, an FP7 project involving 14 European partners, aims to identify and develop innovative systems to improve sludge management. In organizing END-O-SLUDG we categorise the important management steps as:

• Sludge Reduction – Reduce the amount of sludge whilst maximising resource recovery
• Sludge Treatment – Working to achieve greater treatment efficiency whilst improving the quality of the sludge for recycling
• Product Transformation – Creating value-added sludge products
• End of Waste – Developing the market for new products by addressing technical performance, economic and legal issues
• Sustainability – Technology assessment addressing health risks, economic and environmental impacts etc.

Technical developments include novel processes for reducing the quantity of sludge arising from wastewater treatment, more efficient sludge treatment and further sludge processing after digestion. While the Organo-Mineral Fertiliser development is highly advanced with products in farm trials, others including DAF for enhanced primary treatment and probiotic for E. coli suppression are showing very promising results. The success of these new processes would provide effective solutions to deal with the rapid rise in sludge production and the need to address the public health, regulations, and the environment in the context of EU climate change mitigation and energy policies by moving toward maximum value recovery and end of waste.

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RESPONSE TO PRE-TREATMENTS AND DIGESTION INTENSIFICATION OF SEWAGE SLUDGE

One of the aims of the European Project END-O-SLUDG is the reduction of the amount of sewage sludge produced in sewage plants. This goal is due to major restrictions to landfill disposal imposed by European regulations. As part of the project, the intensification of the anaerobic digestion of sewage sludge is investigated. The promotion of the anaerobic digestion firstly achieves an improved result in the energy yield (recovered as methane) and, simultaneously, a more stabilized digestate (a direct consequence of the carbon mineralization). As anaerobic digestion is a biological process, the degree of stabilization will depend on the biodegradability of the substrate. Hydrolysis represents the rate-limiting step for the degradation of sewage sludge. Consequently, any pre-treatment entailing an acceleration of this stage will have the mentioned benefits. Ultrasound disruption, endogenous enzymatic hydrolysis (42ºC, 48 hours) and combinations of these pre-treatments were applied. The hydrolysis/solubilisation of sludge and final conversion into methane and digestate was studied in the short term (72 hours), in batch reactors (one month) and in continuous regime. The results depend on the characteristics and type of sewage sludge (primary, secondary or mixed).

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EVALUATING BIOSOLIDS AS A VALUABLE PHOSPHORUS RESOURCE TO MEET CROP REQUIREMENTS

Across the EU, close to 10 M tonnes of biosolids are produced annually. Biosolids have total phosphorus (P) content ranging from 5 – 7% w/w and can be exploited as an alternative renewable source of P compared to rock phosphate which will be a limited resource in coming years. However the challenge lies in quantifying how much of the total P in biosolids is bioavailable to crops. Managing P in soil is challenging as its most available fraction in soil solution is small and many factors (such as pH, iron, aluminium, calcium) can affect its availability. Currently farmers apply P based on a soil P index which cannot go above a certain threshold to minimise any potential pollution as runoff and eventually euthrophication of watercourses. The End-o-Sludg project tackles this by considering conventional method such as Olsen-P and newer approach using the Diffusive Gradient in Thin-Films (DGT). Plot scale field trials have been carried out in some locations in the UK to evaluate the amount of P taken up by crops using these two techniques. DGT is associated only with soil solution whilst Olsen-P can provide estimate of P in this fraction and surface adsorbed. The combined approach of using both techniques will enable us to harness the collective strength and fully exploit biosolids as a valuable resource of P for crops.

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THE APPLICATION OF ORGANO MINERAL FERTILISER TO ARABLE AND GRASS SILAGE CROPS

The END-O-SLUDG project aims to identify and develop technologies to improve municipal waste management, whilst also lowering the Greenhouse Gas emissions associated with the sewage sludge treatment process. Currently approximately 9.4 million tonnes of biosolids (sewage sludge) are disposed of in the EU, with a figure of 1.3Mt in the UK. Recycling biosolids to agricultural land is considered a sustainable option in comparison to incineration. This project aimed is to produce an organo mineral fertiliser (OMF) from biosolids and urea that can be applied effectively with agricultural fertiliser spreaders to arable and grassland crops. Plot and field scale trials have been carried out over a five year period on wheat, oilseed rape, barley and grass cut for silage comparing the crop response to OMF and ammonium nitrate fertilisers. These have been conducted on a clay loam soil in Cheshire (NW England) and sandy loam soil in Bedfordshire (Central England). Results show comparable yield associated with OMF and conventional fertilisers. There was also a build-up of organic matter from plots applied with biosolids and a residual effect of available nitrogen and phosphorus in soil after harvest. This indicates a slow release of nutrient from biosolids which could be considered by farmers in the nutrient management plan for subsequent years. Assessments on the earthworm populations, on the experimental plots, suggest that numbers were not affected by the applications of biosolids. This is an indicator that potentially toxic elements were not negatively impacting upon the soil biota.

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END-O-SLUDG: END OF WASTE

END-O-SLUDG is a pan-European initiative that seeks to mitigate the increased production of sewage sludge through its recovery into quality products whilst taking into consideration the need to address public health, regulatory compliance and environmental issues. A key aim of the project is the achievement of End of Waste (product) status for the outputs. To achieve product status through EU law requires the combination of complementary legal and technical arguments which by their very nature are complex. The current status and progress for gaining End of Waste for the outputs of END-O-SLUDG will be discussed with particular emphasis on one potential 'product' generated within the process namely, organo-mineral fertiliser (OMF). By examining in detail a range of aspects of OMF production, its use in the marketplace and environmental impacts a successful application for End of Waste status is considered achievable.

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SUSTAINABILITY ASSESSMENT OF WASTEWATER TREATMENT TECHNOLOGIES, SEWAGE SLUDGE PRODUCTION AND ITS APPLICATION TO LAND

The application of sewage sludge to land is variable in the EU, with the UK recycling nearly 68% One approach in the End-o-Sludg project is evaluating the sustainability of novel technologies to reduce its production and instead to derive valuable by-products from sludge treatment processes This includes evaluating crop response and consequent potential displacement of fertiliser requirements, energy generation, pathogen risks and heavy metal contamination of soil associated with sludge application Social, political, geographical, economic and legal aspects are also addressed The underlying approach used is environmental Life Cycle Assessment (LCA) as described by the International Standards ISO 14040:2006 and 14044:2006 The advantage of LCA is that it adopts a mass and energy balance approach over the cradle to grave process cycle from waste water production all the way to the safe recycling and disposal of its constituents These are all related to the functional unit, defined as “safe utilisation of wastewater arising per capita of population” This avoids the pollution swapping and displacement that is possible if a piecemeal approach is adopted A comparative LCA will be applied in this project Three median baseline waste water treatment systems have been defined, covering a range of scales, representative of around 80% of European demand The End-O-Sludge technologies will become available between 2015-2040 The sustainability evaluation will be applied to several scenarios that will be relevant to most of the EU and a case study developed that will be trialled with an independent waste management organisation for the coming 25 years

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USE OF ANAEROBIC DIGESTATES IN THE GRASS-TURFS INDUSTRY: A LONG-TERM (2 YEAR) FIELD EXPERIMENT

This research aims to investigate the feasibility of using the liquid fraction of anaerobic digestate (AD) in the grass turfs industry as an alternative fertiliser. There is potential for AD to be used in the UK grass-turfs industry, given that the area covered by sports-turfs alone was 174,434 ha (2012). Two field trials were established in 2012 growing ryegrass. Locations were selected due to the different local climatic conditions and soil types. A suitable AD was identified following a scoping study (based on the PAS 110 Quality Protocol) from food source wastes. AD was applied at 100 and 200 kg N/ha/y, and effects will be compared to an untreated control and a mineral fertiliser applied at 100 kg N/ha/y. Fertiliser application will continue until September 2013. Effects of the AD on turf-grass quality (sward density, disease incidence, turf colour, chlorophyll content, leaf nutrients), and soil chemical (PTEs, available and total nutrients, organic matter), biological (root biomass, microbial biomass, microbial activity as multiple substrate induced respiration, mycorrhizal colonisation and human pathogens) and physical (saturated hydraulic conductivity, water release characteristics) parameters will be observed during 2013. AD is analysed (PAS110 protocol) prior to application. This will allow the generation of a data-base such that we will be able to observe variability of generated from one source. For user-confidence it is important that any variability of the AD is described. Ultimately this research will assess the value of AD as a fertiliser, and determine potential environmental and public health impacts.

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4. CERTIFICATION, REGULATION AND MARKETING OF BIOCHARS, COMPOSTS AND DIGESTATES

S4.1. **19 October, h. 08:30 – 10:00** *Sponsored by the* ***International Humic Substances Society (IHSS)***

***Title*:** **QUANTITATIVE DETERMINATION, APPLICATIONS AND PLANT RESPONSE OF COMMERCIAL HUMIC MATERIALS**

***Chairpersons*:** Dan Olk, *USDA-ARS, Ames-IA, USA*
Claudio Ciavatta, *Università di Bologna - Bologna, Italy*

Plenary Lecture 1: **The plant growth promoting action of humic substances involves substancial and coordinated changes in the plant distribution of the main phytoregulators**
Garcia-Mina Jose M., *G. Roullier - R&D and University of Navarra - R&D - Pamplona, Spain*
Olaetxea Maite, *University of Navarra - Pamplona, Spain*
Mora Verónica, Baigorri Roberto, Fuentes Marta, Bacicoa Eva, Zamarreño Angel M., *G Roullier - R&D - Pamplona, Spain*

Plenary Lecture 2: **On-farm evaluation of a humic product in Iowa (U.S.) maize production**
Olk Dan, Dinnes Dana, *U.S. Dept. of Agriculture - Ames, USA*
Callaway Chad, *Ag. Logic Distributors - Conrad, USA*
Raske Mike, *Innovative Crop Solutions - Radcliffe, USA*

S4.1.01 **Italian official methods for quantitative determination of humic acids and fulvic acids in commercial products**
Ciavatta Claudio, *University of Bologna - Bologna, Italy*
Sequi Paolo, *Agricultural Research Council - DAF - Roma, Italy*

S4.1.02 **Evaluation of a proposed standard procedure for the determination of humic acids and fulvic acids in commercial products**
Lamar Richard, *Horizon Ag - Logan, USA*
Olk Dan, *U.S. Dept. of Agriculture - Ames, USA*
Mayhew Lawrence, *Eco Agri-Minerals - Spring Green, USA*
Bloom Paul, *University of Minnesota - St. Paul, USA*

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Bacicoa Eva - G Roullier - R&D - Pamplona, Spain

Zamarreño Angel M - G Roullier - R&D - Pamplona, Spain

THE PLANT GROWTH PROMOTING ACTION OF HUMIC SUBSTANCES INVOLVES SUBSTANCIAL AND COORDINATED CHANGES IN THE PLANT DISTRIBUTION OF THE MAIN PHYTOREGULATORS

A number of studies have demostrated the ability of humic substances to improve plant growth by mechanisms that involve both nutritional and developmental aspects. In this presentation we try to present and discuss the main results obtained about the effects of humic substances in the rhizosphere and within the plant.
In summary these results show that the impact of humic acids on root surface causes inter-related changes in the concentration in roots of relevant phytoregulators such as NO, IAA, ethylene, ABA and cytokinins. However, these effects seem to play different roles in the whole action of humic substances on plant growth. All these aspects are discussed in the presentation.

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Raske Mike - Innovative Crop Solutions - None - Radcliffe, USA

ON-FARM EVALUATION OF A HUMIC PRODUCT IN IOWA (U.S.) MAIZE PRODUCTION

The benefit to maize (Zea mays L) production of a humic product derived from lignite was evaluated for three years under conventional crop management in Iowa (U S) farmers' fields The liquid product was applied at a rate of 3 6 L ha-1 as a foliar spray mixed into routine pesticide applications during early stages of crop growth In each of three years, hand-sampled corn plants collected at physiological maturity in 30 to 35 farmers' fields across Iowa showed a significant increase in grain weight with product application in 70 to 80% of the cases, covering a range of soil types Mean increases were 630-940 kg ha-1 A limited number of yield increases estimated by mechanical combine were typically 310-630 kg ha-1, about 5% of normal yield levels Grain weight increases were associated with longer, thicker, and heavier cobs and slightly larger stover biomass Plant nutrient concentrations were not affected at harvest In-season measurements in some farmers' fields associated product application with increased leaf area, earlier pollination, extended grain filling, and delayed senescence, i e extended duration of photosynthesis and delayed rotting Limited visual observations indicated root proliferation, especially lateral roots Ongoing data assessment will identify any environmental factors of product efficacy, an issue that remains unexplored in the humic product literature Initial studies of alfalfa (Medicago sativa L) found biomass increases with product application of 7 to 29% The humic product increased economic yield in maize fields by amounts that were agronomically modest but agronomically significant

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ITALIAN OFFICIAL METHODS FOR QUANTITATIVE DETERMINATION OF HUMIC ACIDS AND FULVIC ACIDS IN COMMERCIAL PRODUCTS

Determination of humic substances (HS) content declared on the label or on accompanying documents of commercial products is fundamental to protect consumers and to avoid frauds In Italy the market of humic products is relevant and actually Italian law (D Lgs 75/2010) allows to commercialize solid and fluid humic-containing products, e g peats, leonardites, lignites, composts, manures, and related humic extracts Since 2000 official methods have been approved (Official Journal Italian Republic, No 21, January 2001; Ministerial Decree of 21 12 2000, Supplement No 6) dealing with the: -Determination of extracted organic carbon in NaOH + Na4P2O7 or already extracted (i e fluid or solid humic extracts fertilizers); -Fractionation and quantification of the humified organic carbon (HA+FA); -Determination of the degree of humification (DH%) and the humification rate (HR%) These official methods are used to control commercial fertilizers containing HS by the ICQRF (Central Inspectorate Department of the Protection of the Quality and Prevention of Frauds) of the of the Italian Ministry of agriculture, foodstuffs and forestry policies in order to check compliance with the declaration and any other provision under the law of fertilizers Irregular samples can be subject to administrative or most severe proceedings Generally speaking, a method to be adopted by the ICQRF should be easy and quick to apply, cheap, and available for many laboratories The Italian official methods have been developed by taking into account such requirements The presentation will give specific details on the extraction and fractionation of organic carbon from commercial humic products

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Bloom Paul - University Of Minnesota - Soil, Water And Climate - St. Paul, USA

EVALUATION OF A PROPOSED STANDARD PROCEDURE FOR THE DETERMINATION OF HUMIC ACIDS AND FULVIC ACIDS IN COMMERCIAL PRODUCTS

A constraint to growth of the commercial humic products industry has been the lack of a widely accepted procedure for determining humic acid and fulvic acid concentrations of the products, which has raised regulatory issues. On behalf of the U.S.- based Humic Products Trade Association, we developed an improved procedure that measures humic acids and fulvic acids gravimetrically. The humic acid is isolated by the traditional acidification to pH 1 of a base extract, although solution C and salts must be diluted to specified concentration ranges. The fulvic acid is defined as the hydrophobic material that is adsorbed onto a DAX-8 resin column when the base- and acid-soluble material is passed through the column. Following separation both the humic acid and fulvic acid fractions are oven-dried and weighed. The method has high precision, indicating good reproducibility in discriminating between humic acids and fulvic acids. This method can distinguish humic acids and fulvic acids from several potential adulterants, including amino acids and carbohydrates. However it cannot distinguish lignosulphonates from fulvic acids.

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S4.2. **19 October, h. 15:00 – 16:30 (Room A)**

Title: **ECONOMIC AND QUALITY DETERMINANTS TO FOSTER THE BCD INDUSTRY: MARKETS, INVESTMENTS, AND POLICY MEASURES**

***Chairpersons*:** Maurizio Prosperi, *University of Foggia - Foggia, Italy*
Aleksza László, *Hungarian Compost Association - Hungary*

S4.2.01 **Assessing the economic value of biochar for agricultural purposes: a private and public perspective**
Prosperi Maurizio, Giannoccaro Giacomo, Libutti Angela, *University of Foggia - Foggia, Italy*

S4.2.02 **Uncomposted dung as a source of commercial humic-like products for arid countries**
Alrefai Jamal, Abaalkheel Issa, *King Abdulaziz City for Science and Technology - Petrochemicals Research Institute - Riyadh, Saudi Arabia*
Rovira Pere, *Forest Technology Centre of Catalunya - Solsona, Spain*

S4.2.03 **Biochar-based technosols : evaluation of their potential for different effluent depuration applications**
Boivin Pascal, Guiné Véronique, Sauty Antoine, *University of Applied Sciences Western Switzerland Technology, Architecture And Landscape (HEPIA) –Jussy - Switzerland - Agronomy - Geneva, Switzerland*

S4.2.04 **New methodology to assess the humic quantity and quality of organic substances contained in commercial products for agriculture**
Fuentes Marta, Baigorri Roberto, *Roullier Group TAI - R&D and University of Navarra - R&D - Pamplona, Spain*
Gonzalez-Gaitano Gustavo, *University of Navarra - Pamplona, Spain*
Garcia-Mina Jose M., *Roullier Group TAI - R&D and University of Navarra - R&D - Pamplona, Spain*

S4.2.05 **Technogenic hydrocarbons in arctic tundra soils of the Island Bolshoy Liakhovsky (Novosibirskie Islands)**
Kachinskiy Vladimir, *Moscow State University - Moscow, Russia*

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ASSESSING THE ECONOMIC VALUE OF BIOCHAR FOR AGRICULTURAL PURPOSES: A PRIVATE AND PUBLIC PERSPECTIVE

Despite of growing interest in biochar, there is a lack of study dealing with its economic value The expected advantages of biochar use in agriculture is twofold: the improvement of techno-economic efficiency of water irrigation and fertilizers, in terms of lower input application for obtaining the same output level, and the reduction of environmental impacts This study attempts to estimate the economic value of using biochar in agriculture, considering both a private and a public perspective The first is based on the private cost-benefit analysis derived from comparing the extra cost deriving from the purchasing, distribution, and application into the soil, compared with the savings in terms of irrigation and lower fertilizers' application The second, refers to the comparison (mostly in qualitative terms) between the social cost of biochar application (e g training and extension services for farmers, economic incentives for the diffusion of the innovation), the social benefits deriving from lower use of natural resource (i e irrigation water) and fertilizers, and the reduction of environmental pollution An empirical exercise referred to the Foggia province (Italy) will be presented in order to discuss about the critical issues and the possible effects of introducing biochar in intensive farming systems based on horticultural crops A methodology based on a linear programming model is built, in order to perform a quantitative study, based on the available technical and economic data The analysis will consider both a short term and a long term perspective, and private and public cost-benefit analysis will be performed

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UNCOMPOSTED DUNG AS A SOURCE OF COMMERCIAL HUMIC-LIKE PRODUCTS FOR ARID COUNTRIES

Liquid humic amendments, usually applied for fertigation, are widely used in many countries. While leonardite is the main substrate for obtaining these products, there is a growing concern about obtaining these products from plant-derived residual materials, rich in lignin and polyphenolics, thus making possible an economically interesting residue valorisation. Composting these residues is a required step for converting them into a source of humic substances. In arid countries the obtention of liquid humic products from sources other than leonardite faces two main challenges: (i) these countries are often devoid of forest areas capable of supplying lignin-rich plant residues in big amounts; (ii) since in these countries water is poorly available (or very expensive, if obtained from desalination of sea water), composting at a commercial or industrial scale is very difficult. It is compulsory to find alternative sources, yielding humic (or similar) compounds without any previous composting. Here we present the main results obtained with sheep and cow dung, two materials available at a commercial scale in Saudi Arabia. Both were extracted with KOH at a variety of concentrations (from 0.25 to 2M), times (from 20 to 120 minutes), temperatures and pressures (from 100 to 150ºC). The obtained extracts have properties similar to those of humic substances, even though they reflect a low degree of humification as shown by their fluorescence behaviour and optical properties. Sheep dung, much easier to extract than cow dung, apparently is much more promising as a source of commercial humic amendments.

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BIOCHAR-BASED TECHNOSOLS : EVALUATION OF THEIR POTENTIAL FOR DIFFERENT EFFLUENT DEPURATION APPLICATIONS

The use of soils in depurating systems called Biobeds is of growing interest for the depuration of pesticide-contaminated effluents, is now envisioned for extended applications: industrial cooling water effluents, road runoff waters. Biobeds are made of a mixing of soil and organic substrate The development of Biobeds is facing several limitations with respect to: the use of renewable material sources; the stability of the organic material; the recycling potential of the substrate; and the hydrodynamics and biogeochemical properties of the substrate Moreover, while the depuration of some solute contaminated effluents emphasizes the need for large reactivity and appropriate contact time between effluent and substrate, the depuration of effluents contaminated with colloid size micro-particles requires appropriate filtration properties based on silt size porosity and negligible preferential flows Finally, the new generation of Biobeds tends to be greened, which allows enhancing the depuration properties and/or increase the lifetime of the substrate Biochar from wood waste produced in Lausanne show a good potential to tackle these issues by creating technosols substrates This was tested with respect to: the build up of horticultural substrate with increasing biochars rates together with; the design of substrate porosity combining the targeted air/water, permeability and contact time properties; their ability to support the growth of different ornamental vegetation; and the efficiency of the corresponding technosols to depurate solute or colloid-particles contaminated waters Our results show that biochar-based substrates may find a large range of applications in vegetalised structures dedicated to the depuration of different effluents.

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Garcia-Mina Jose M - Roullier Group TAI And University Of Navarra - R&D - Pamplona, Spain

NEW METHODOLOGY TO ASSESS THE HUMIC QUANTITY AND QUALITY OF ORGANIC SUBSTANCES CONTAINED IN COMMERCIAL PRODUCTS FOR AGRICULTURE

The official and classical method (SOM) for the quantification of humic substances (HS) in many occidental countries is principally based on the determination of organic carbon in both the alkaline extract of the organic material or product (total organic carbon), and the extract containing the humic acids that have been obtained by precipitation at acidic pH (humic acid-organic carbon). Finally, the concentration of fulvic acid is normally evaluated by the difference between the values of total organic carbon and humic acid- organic carbon. Therefore, it becomes clear that this analytical approach implies that all organic product with pH-dependent solubility features similar to those of humic and fulvic acids will be considered as a humic substance independently of its real humic chemical-nature.
In this work, we propose an alternative analytical approach to both quantify and asses the humic-chemical nature of organic substances presented as humic substances in natural or commercial marketed products. This new approach involves both analytical-structural techniques and chemometric analysis. The results obtained allow the determination of those structural-analytical parameters that should be used to asses the humic nature of organic substances present in comercial and pilot products for agricultura or animal nutrition.

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TECHNOGENIC HYDROCARBONS IN ARCTIC TUNDRA SOILS OF THE ISLAND BOLSHOY LIAKHOVSKY (NOVOSIBIRSKIE ISLANDS)

The arctic tundra soils polluted by technogenic hydrocarbons were studied on the peninsula Kigilyakh of the island Bolshoy Lyakhovsky (Novosibirskie islands) Soils of three technogenic transformed sites were studied: "The former military base", "Gore Malakatyn", "The settlement of geologists" Natural and technogenic soils formation in sites are different The site "The former military base" is located on a summit surface (heights over see level 50-60 m) Bituminous gley criosols on cryogenic loamy were investigated The soil sampling was conducted from the source of hydrocarbonic pollution in the direction to hypsometric lower sites Lateral soil profile was about 2 km Soil sequence includes bituminous gley criosols on a summit surface, bituminous criosols on slope, young and organic gley soils of the expanded bottom Soils of the island are polluted mainly by a mixture of diesel fuel and transformer oil Level of hydrocarbonic pollution changes from 100 to 80 000 mg/kg The highest levels of soil pollution are obsevered near sites with the high amout of empty container (to 10 000 barrels) Difference on hydrocarbons fractions ratios (C14-C23) / (C24-C34) between soils of the autonomous and lower positions reaches by 2 times; in the radial direction this difference varies from 2 to 10 times More contrast accumulative and eluvial - illuvial type of radial distribution of heavier hydrocarbons is observed in the conditions of continuous permafrost in a profile of loamy soils Less contrast accumulative type of radial distribution is representative low-molecular weight hydrocarbons The biodestruction coefficient (Ci15+Ci16) / (Ci15+Ci16) of hydrocarbons

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PS1. PRODUCTION TECHNOLOGIES OF BIOCHARS, COMPOSTS AND DIGESTATES BY CONVERSION OF SOLID AND FLUID BIOWASTES/BIOSOLIDS

19 October, h. 08:00 – 20:00

PS1.01 **Flash and slow pyrolysis applied to heavy metal contaminated sorghum bicolor biomass resulting from phytoremediation**

Al Chami Ziad, *Mediterranean Agronomic Institute of Bari – CIHEAM - Valenzano (BA), Italy*
Amer Nasser, *GCSAR - Swaida Research Center - Swaida, Syria*
Smets Koen, Yperman Jan, *Hasselt University - CMK - Diepenbeek, Belgium*
Dumontet Stefano, *University of Napoli "Parthenope" - Napoli, Italy*
Jaco Vangronsveld, *Hasselt University - CMK - Diepenbeek, Belgium*

PS1.02 **Efficient and problem-free home composting**

Contin Marco, Cudini Andrea, Bertoni Aldo, De Nobili Maria, *University of Udine - Udine, Italy*

PS1.03 **Co-digestion of sewage sludge and organic fraction of MSW: analysis of the digestate organic quality**

Gigliotti Giovanni, Di Maria Francesco, Sordi Alessio, Cirulli Giuseppe, Cucina Mirko, Ricci Anna, Massaccesi Luisa, *University of Perugia - Perugia, Italy*

PS1.04 **Management of urban biodegradable waste in Puglia: features and critical issues in Italian context**

Placentino Claudia Marcella, Bruno Emanuela, Busseti Francesco, Lacarbonara Filomena, Gramegna Domenico, Blonda Massimo, Assennato Giorgio, *ARPA Puglia - Bari, Italy*

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FLASH AND SLOW PYROLYSIS APPLIED ON HEAVY METAL CONTAMINATED SORGHUM BICOLOR BIOMASS RESULTING FROM PHYTOREMEDIATION

Disposal of heavy metal contaminated biomass is still an unresolved problem. Fate of heavy metals during the pyrolysis process is of prime importance concerning its applications on a contaminated biomass. This study focuses on Ni and Zn fate during flash and slow pyrolysis applied on contaminated biomass resulting from phytoremediation. Flash and slow pyrolysis were performed at 450 °C Sorghum bicolor (L.) Moench shoots with moderate concentrations of Ni and Zn. Biomass and pyrolysis products were chemically analyzed with focus on the metal distribution. Mass and energy balances were determined. Metal concentrations in the pyrolysis oils were below detection limits and almost all metals were found in the char. In fact, 99 % of Ni and 98 % of Zn were recovered in the char when the slow pyrolysis process was applied, while in flash conditions both metals are found back in the char and the heating transfer medium “sand”. In addition, the percentages of char and oil were higher in slow pyrolysis compared to flash pyrolysis. Energy recovery in the char from slow pyrolysis was higher than flash pyrolysis. Flash and slow pyrolysis can likely offer a valuable processing method for heavy metal contaminated biomass, thus limiting the waste disposal problem associated with metals phytoremediation. It also allows to economically valorize contaminated soils for production of biomass that can be converted to energy and/or other products with a higher added value. However, more in depth investigations are required to valorize the obtained pyrolysis products.

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EFFICIENT AND PROBLEM-FREE HOME COMPOSTING

Home composting of food waste materials challenges potential adepts with seriously offsetting problems, such as bad odours, proliferation of insects and poor nutrient balance, which marketed products are unable to solve. Here we describe results obtained during a public test trial of a patented additive that reduces emission of bad smelling volatile substances, inhibits growth of larvae and improves the nutrient balance as well as nutrients content of the compost.
The public trial was held during a home composting course organized by the municipality of Martignacco (Italy). Twelve composters were set up on the city hall lawn and citizens were invited to cooperate in the mixed composting of garden and food waste. Six of the composters were treated with the product patented by the University of Udine (European Patent application "Composition for enhancing composting processes", publication number EP2452930). After approximately six moths, composters were dismantled and the compost analyzed.
The direct involvement of population raised a wide awareness on the correct management of organic domestic wastes. The use of the patented product showed an almost completely inhibition of odour emission, a strong reduction of flies (assessed by chromatic traps) and an increased compost maturity. The fertilizing properties of compost were assessed by either chemical analyses and plant tests.

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Ricci Anna - University Of Perugia - Department Of Agricultural And Environmental Science - Perugia, Italy

Massaccesi Luisa - University Of Perugia - Department Of Agricultural And Environmental Science - Perugia, Italy

CO-DIGESTION OF SEWAGE SLUDGE AND ORGANIC FRACTION OF MSW: ANALYSIS OF THE DIGESTATE ORGANIC QUALITY

Biodegradable waste represents an important source for chemical and nutrients recovery but also for renewable energy production. Organic waste has a direct origin, from solid wastes by different human activities, and an indirect origin from waste water treatment plants (WWTP). The treatment of waste water in WWTP leads to the production of a large amount of sludge as a consequence of the organic pollutant removal from the liquid medium. Both these materials can be exploited as chemical, nutrient and renewable energy source.
This study focuses the attention on the effect that the anaerobic co-digestion of sewage sludge with organic waste have on the organic quality of the digestate.
Experimental runs have been performed by the aid of a large scale laboratory anaerobic digester. Starting from the sludge produced by an existing WWTP different organic fraction of municipal solid waste (OFMSW) has been gradually added for simulating co-digestion process. All the process parameters as gas flow rate, temperature, pH, electrical conductivity (EC), total solid (TS), volatile solids (VS), BOD, COD, mineral and organic N, total P, heavy metals and volatile fatty acids (VFAs) has been steadily monitored. In the ingestate and digestate were carried out further more detailed analysis on the quality and stability of the organic matter and a characterization of water extractable organic carbon (WEOC) who have shown a certain evolution of organic matter. Particular attention has been focused on the agronomic quality of the different digestates obtained after the variation of the amount of OFMSW introduced.

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MANAGEMENT OF URBAN BIODEGRADABLE WASTE IN PUGLIA: FEATURES AND CRITICAL ISSUES IN ITALIAN CONTEXT

Management of urban biodegradable waste in Puglia:
features and critical issues in Italian context

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In accordance with objectives of Directive 1999/31/EC, composting of the organic fraction in municipal solid waste (OFMSW) reduces the amount of biodegradable waste disposed to landfill. This is a fundamental and synthetic quality indicator of urban waste management. In Italy, composting is constantly increasing due to the development of sorted waste collection, with enhancement for organic waste quality. Nonetheless, very different percentages of source-separated organic waste are obtained in Italian territory. Apulia region contributes to the general improvement in organic waste treatment.
An analysis of management of urban biodegradable waste in Puglia during the last few years is performed with respect to the national state. In particular, the number and capacity of composing plants are discussed taking into account technologies, performances, waste production, input and output of bio-stabilisation process.

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PS2. ANALYSIS AND CHARACTERIZATION OF BIOWASTES, BIOCHARS, COMPOSTS AND DIGESTATES

19 October, h. 08:00 – 20:00

PS2.01 **Characterization of alternative sources of biochar for agricultural use in Brazil**

Abreu Cleide Aparecida, Coscione Aline Renee, Bibar Paula, *Instituto Agronomico - Campinas, Brazil*
Andrade Cristitano, *Embrapa - Meio Ambiente - Solos - Jaguariuna, Brazil*

PS2.02 **Static procedure for composting olive mill waste**

Roberto Altieri, Esposito Alessandro, Castellani Francesco, Stanzione Vitale, *CNR - ISAFOM - Perugia, Italy*
Fidati Laura, *University of Perugia - Perugia, Italy*
Chilosi Gabriele, *Università della Tuscia - DIBAF - Viterbo, Italy*
Federici Ermanno, *University of Perugia - Perugia, Italy*

PS2.03 **The model structure of compost particle**

Arroyave Carlos, Pelaez Carlos, *Universidad de Antioquia - Medellín, Colombia*
Melo Wanderley, *Universidade Stadual Paulista - Jaboticabal, Brasil*

PS2.04 **Qualitative and quantitative changes of selected chemical and spectral properties of humic substances during composting of municipal wastes**

Bekier Jakub, Jamroz Elzbieta, Kocowicz Andrzej, Medynska-Juraszek Agnieszka, Weber Jerzy, *Wroclaw University of Environmental and Life Sciences - Wroclaw, Poland*

PS2.05 **Potential suppressiveness and effect on photinia fraseri growth by a composted amendment from olive mill wastes**

Chilosi Gabriele, Dell'Unto Davide, Martignoni Diana, Aleandri Maria Pia, Vannini Andre, *University of Tuscia - Viterbo, Italy*
Federici Ermanno, Fidati Laura, *University of Perugia - Perugia, Italy*
Altieri Roberto, Esposito Alessandro, *CNR - ISAFoM - Perugia, Italy*
Spagnesi Renzo, Lotti Martina, *Vivai Sandro Bruschi - Pistoia, Italy*

PS2.06 **Elemental and FT IR characterization of humic acids during the composting process of coffee by-products**

D'Orazio Valeria, Mondelli Donato, *University of Bari - Bari, Italy*
Ceglie Francesco G., Verrastro Vincenzo, *CIHEAM - IAMB - Valenzano (BA), Italy*

PS2.07 **Molecular analyses of bacterial community dynamics during the static composting of olive mill waste**

Federici Ermanno, Fidati Laura, Cenci Giovanni , *University of Perugia - Perugia, Italy*
Esposito Alessandro, Altieri Roberto, *Consiglio Nazionale Delle Ricerche - Perugia, Italy*

PS2.08 **Effect of the crude glycerol addition on two-phase anaerobic digestion for urban wastewater sludge treatment**

Francioso Ornella, Pisi Annamaria, *University of Bologna - Bologna, Italy*
Ferrari Erika, *University of Modena Reggio Emilia -Modena, Italy*
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Salomoni Cesarino, Bonoli Mattia, Caputo Armando, Palenzona Domenico, *Biotec Sys Srl - Bologna , Italy*

PS2.09 **Zinc sorption of compost materials**

György Füleky, Dénes Kovács, *Szent István University - Gödöllő, Hungary*

PS2.10 **Hydrophilic and hydrophobic fractions of dissolved organic matter from different feed-in mixtures and their corresponding digestates**

Malerba Anna Daniela, *University of Bari – Bari, Italy*
Kaiser Klaus, *Martin Luther University Halle-Wittenberg Halle (Saale), Germany*
Tambone Fulvia, Adani Fabrizio, University of Milan – Milan, Italy Provenzano Maria Rosaria, University of Bari – Bari, Italy

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Manya Joan J., Marti Clara, Laguarta Sergio, Ortigosa Miguel A., Mateo Noemi, *University of Zaragoza - Huesca, Spain*

PS2.12 **Chemical, physical and biological evaluation of the surface properties of a biochar treated with an organic solvent**
Marsala Valentina, De Pasquale Claudio, *University of Palermo - Palermo, Italia*
Vaccari Francesco, *IBIMET-CNR - Firenze, Italy*
Pozzi Alessandro, *AGT Advanced Gasification Technology S.r.l. - Arosio (CO), Italy*
Valagussa Massimo, *Minoprio Analisi e Certificazioni S.R.L - Vertemate con Minoprio, Italy*
Pellegrino Conte, Alonzo Giuseppe, *University of Palermo - Palermo, Italy*

PS2.13 **The visual incorporation of Fe into humic acids during the composting of wheat straw**
Medina Jorge, *Universidad de la Frontera - Temuco, Chile*
Monreal Carlos, Chabot Denise, Schnitzer Morris, *Agriculture and Agri-Food Canada - Eastern Cereal and Oilseed Research Center - Ottawa, Canada*
Borie Fernando, González María Eugenia, Cornejo Pablo, *Universidad de la Frontera - Temuco, Chile*

PS2.14 **Effects of inorganic materials on some chemical properties of composted wheat straw residues**
Medina Jorge, *Universidad de La Frontera - Temuco, Chile*
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Borie Fernando, Gallardo Bastián, González María Eugenia, Curaqueo Gustavo, Cornejo Pablo, *Universidad de la Frontera - Temuco, Chile*

PS2.15 **Evaluation of enzymatic activities from saprophytic fungi inoculated wheat straw residues during composting**
Medina Jorge, Orellana Luis, *Universidad de la Frontera - Temuco, Chile*
Monreal Carlos, *Agriculture and Agri-Food Canada - Eastern Cereal and Oilseed Research Center - Ottawa, Canada*
García Susana, Meier Sebastián, Borie Fernando, Cornejo Pablo, *Universidad de La Frontera - Temuco, Chile*

PS2.16 **Analysis of biochars from Amazonian dark earth: comparison with commercial and natural samples**
Pagano Marcela, Jorio Ado, Cancado Luis, Takahashi Jaqueline, *Universidade Federal de Minas Gerais - Belo Horizonte, Brazil*

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Parillo Rita, Ventorino Valeria, Aliberti Alberto, Pepe Olimpia, Testa Antonino, *University of Napoli "Federico II" - Napoli, Italy*

PS2.18 **Characterization of non-extracted thermal biomass conversion products by mass- and X-ray absorption spectroscopies**
Peter Leinweber, Gerald Jandl, *University of Rostock - Rostock, Germany*

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Provenzano Maria Rosaria, Malerba Anna Daniela, *University of Bari - Bari, Italy*
Buscaroli Alessandro, *CIRSA - Ravenna, Italy*
Fabbri Claudio, *CRPA - Reggio Emilia, Italy*
Senesi Nicola, *University of Bari - Bari, Italy*

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Provenzano Maria Rosaria, Malerba Anna Daniela, *University of Bari - Bari, Italy*
Buscaroli Alessandro, *CIRSA - Ravenna, Italy*
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PS2.21 **Fourier transform infrared spectroscopy associated to Fourier self deconvolution of spectra applied to the characterization of digestates obtained from different organic substrates**
Provenzano Maria Rosaria, Malerba Anna Daniela, *University of Bari - Bari, Italy*
Buscaroli Alessandro, *CIRSA - Ravenna, Italy*
Fabbri Claudio, *CRPA - Reggio Emilia, Italy*
Senesi Nicola, *University of Bari - Bari, Italy*

PS2.22 **Response to Ph changes of fluorescence spectra of digestates from municipal solid waste and sewage sludge under mesophilic and thermophilic conditions**
Provenzano Maria Rosaria, Malerba Anna Daniela, *University of Bari - Bari, Italy*
Buscaroli Alessandro, *CIRSA - Ravenna, Italy*
Fabbri Claudio, *CRPA - Reggio Emilia, Italy*
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PS2.23 **Zn sorption behaviour of soils containing charcoal with different age**
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Senesi Giorgio, Dell'Aglio Marcella, *CNR - IMIP - Bari, Italy*
De Giacomo Alessandro, *University of Bari - Bari, Italia*
De Pascale Olga, *CNR - IMIP - Bari, Italia*
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Miano Teodoro, *University of Bari - Bari, Italia*
Zaccone Claudio, *University of Foggia - Foggia, Italia*

PS2.25 **Characterization of biochar volatile matter and it's influence on plant germination**
Taupe Natalie, *University of Limerick - Limerick, Ireland*
Dela Piccolla Cristiano, *Universidade de São Paulo - Piracicaba - São Paulo, Brazil*
Kwapinski Witold, Leahy J.J., *University of Limerick - Limerick, Ireland*

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CHARACTERIZATION OF ALTERNATIVE SOURCES OF BIOCHAR FOR AGRICULTURAL USE IN BRAZIL

Biochar has been studied for several applications, such as soil quality improvement, both as a fertilizer and conditioner, slow release of mineral nitrogen fertilizers Considering this scenario it is desirable to understand how the final product characteristics can relate to its application compared to the initial biomasses potential The aim of this work was to characterize the chemical composition of biochar obtained from different organic residues, to compare it to its original biomass and to evaluate its use considering fertilizer and soil conditioner regulation in Brazil Samples of tannery sludge (TS), sewage sludge (SS), organic compost (OC), sugarcane filter cake (SC), coffee grounds (CG), chicken manure (CM), fungi mycelia (FM) and eucalyptus husk (EH) were pyrolyzed at two temperatures, 400 and 700 oC, in order to obtain the biochar samples All samples, including the biomasses, were analyzed in triplicate for pH, volatile and total solids, organic carbon, total and inorganic nitrogen, totals content of macro, micronutrients and heavy metals; P soluble in citrate and cation exchange capacity (CEC) for organic samples , in a total of 28 attributes The data was submitted to the analysis of variance and Tukey's test for data average comparison Also, all values were compared to Brazil's Agriculture Ministry fertilizers and soil conditioner standards in order evaluate if biochar based products could be applied directly to the soil as such amendments. The results showed the concentration of metals due to biomasses pyrolysis was the most restrictive to its soil ue.

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STATIC PROCEDURE FOR COMPOSTING OLIVE MILL WASTE

The activity deals with a novel static composting procedure set-up by ISAFOM-CNR at farm scale and carried out in gas-permeable polyethylene bags (1 m3), aiming at bioremediation of olive mill waste (OMW). OMW was thoroughly mixed with hygroscopic additives, such as waste wool and straw, to avoid leaching. The use of bags as planned has not required forced aeration nor watering of OMW mixture for the period of the static storage.
During trial, temperature profiles were taken through an experimental tailor-made device with 45 thermistors arranged in a vertical section mesh placed into the bag; data were then automatically collected every 15 minutes with the Arduino-based system. Oxygen was monitored in the exhausted air extracted from the bags periodically.
Oxygen and temperature profiles showed patterns similar to those reported for standard composting systems. The process caused drastic degradation of organic matter associated to high humic carbon content, with optimal C:N in the end product for agronomic purposes. The compost also showed drastic reduction in polyphenols and low phytotoxicity. Dynamic and static respirometric tests (DRI, SOUR, OD12) stated high biological stability of compost at the end of storage while data on chemical-physical and microbiological properties satisfied the standard requirements set by regulators for compost.

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THE MODEL STRUCTURE OF COMPOST PARTICLE

Compost is very often used as fertilizer and soil conditioner and there are many researches about the variables for an optimal process, to define the endpoint of the process, the product quality. Nowadays the research is guided to propose structures for the substances like humic that are found inside the compost and used as maturation parameter.
In this research it was proposed a structural model for the compost's particle based on physic, chemical, biological, enzymatic and instrumental parameters from hundred samples of commercial compost produced in Medellin, Colombia. To generate the model structure it was used an alternative one similar to that used by Pauli for the soil particle. The resulted model differentiated two principal components for the basic elements, the "matrix", that includes substances like humines, forming organic minerals complexes that respond to the cationic exchange capacity, as well substances like humic acids, more condensated, and the "surrounding", containing microorganisms as fungus and bacteria in aqueous suspension, enzymes, substances like fulvic acids, gases and substances like humic acids less condensed. These results are according with the information from solvents extraction of different polarity and pH values.

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QUALITATIVE AND QUANTITATIVE CHANGES OF SELECTED CHEMICAL AND SPECTRAL PROPERTIES OF HUMIC SUBSTANCES DURING COMPOSTING OF MUNICIPAL WASTES

Object of investigation was raw material, obtained from selectively collected municipal organic wastes (MOW), as well as was pre-composted in KNEER bioreactor (30 days) and than stabilized on a pile for next 60 days. Samples for analysis were collected after 1, 7, 30, 62 and 85 day. The following characteristics were measured: temperature, moisture, total nitrogen (TN), total organic carbon (TOC), humic and fulvic acids (CHA and CFA). Additionally, the following properties of humic acids were determined: elemental composition (C,H,N,O), IR spectra (400 cm-1 – 4000 cm-1), 13C NMR spectra (300Mhz, 0 – 210 ppm) to determine aliphatic(CAli), aromatic (CAro) and carboxylic (CCar) carbon, and the aromaticity (?).
Obtained results indicated decreasing of TOC and an increasing of TN during composting, as well as an increase of humic acids content. Changes in elemental composition during composting indicated an increase of C, N and O. IR spectra indicated a decrease of aliphatic structures and an increase of aromatic structures, as well as functional groups containing nitrogen. The 13C NMR indicated the domination of CAli in fresh material which systematically decreased during composting, while CAro increased. Share of CCar was the lowest and stabilized after 7 days. These results pointed out, that during the course of composting an increase of aromaticity (?) took place.

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POTENTIAL SUPPRESSIVENESS AND EFFECT ON PHOTINIA FRASERI GROWTH BY A COMPOSTED AMENDMENT FROM OLIVE MILL WASTES

Olive mill wastes (OMW) from two-phase extraction system have become problematic to be managed and represent a serious environmental problem SAN-SOIL is a composted amendment from OMW potentially useful as a peat surrogate in the preparation of growing media for potted plants The aim of this work was to test the potential in suppressiveness of such compost by the characterization of population of antagonistic fungi and bacteria and the suitability for nursery production of the ornamental Photinia fraseri cv “Red Robin”, grown in substrate with different composition, substituting peat with 33%, 66%, 100% SAN-SOIL with or without chemical fertilization; fungi and bacteria belonging to the genus Aspergillus, Penicillium, Bacillus, Pseudomonas, were isolated and identified morphologically and molecularly A number of fungal species had antagonistic properties in vitro toward the Photinia soil-borne pathogens Sclerotinia sclerotiorum and Phytophthora cactorum Sterilised “tea compost” was also obtained from the different substrates and assayed against the two pathogens to test potential antimicrobial activity of their abiotic components Their in vitro effect on pathogens growth depended on the substrate composition ranging from weak inhibition to weak promotion Potting mix amended with the highest proportions of compost (66 % and 100 % of peat replaced) and in absence of chemical fertilization, was able to support an optimal growth of Photinia plants produced over the period, with no phytotoxicity effects Based on these observations, SAN-SOIL compost is confirmed as an effective substitute of peat in potting mix, due to its potential suppressiveness and nutritional support of plant growth

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ELEMENTAL AND FT IR CHARACTERIZATION OF HUMIC ACIDS DURING THE COMPOSTING PROCESS OF COFFEE BY-PRODUCTS

Humic acids (HAs) generated during the composting of coffee chaff, coffee grounds and pruning residues were studied by elemental analysis and Fourier Transform Infrared (FT IR) spectroscopy. Two piles were prepared (initial C/N ratio = 28) consisting of two different mixtures: pile A, a mixture of coffee chaff, coffee grounds and pruning residues (respectively, 280,100,600 kg); and pile B, a mixture of coffee chaff and pruning residues (respectively, 305,600 kg). The composting process was performed for 120 days, monitoring a set of chemical parameters. Sampling has been carried out after 1 day (A1 and B1), 16 days (A2 and B2), 30 days (A3 and B3), 63 days (A4 and B4), 91 days (A5 and B5), and, finally, 120 days (A6 and B6). The elemental composition of these HAs has shown that C and H levels decreased while O and N levels increased as composting progressed. Consequently, the C/N ratio decreased and the C/H and O/C ratios increased, suggesting the loss of aliphatic groups and the formation of more stable HAs. These results are confirmed by FT IR spectra of the HAs at different stages of composting, characterized by a decrease of the peptidic and aliphatic structures and an increase of the aromatic structures. After 120 days of composting the HA from pile B shows characteristics similar to those of native soil humic fractions, whereas the stabilization of HA from pile A seems to be slower, probably due to the presence of coffee grounds that delay the early mineralization processes.

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MOLECULAR ANALYSES OF BACTERIAL COMMUNITY DYNAMICS DURING THE STATIC COMPOSTING OF OLIVE MILL WASTE

Static composting of olive mill waste (OMW) can be regarded as an easy and convenient way for the disposal and valorisation of such agroindustrial by-product. We investigated the bacterial community dynamics during OMW composting by applying a culture-independent molecular approach based on denaturing gradient gel electrophoresis (DGGE) profiling and Illumina next generation sequencing (NGS) of amplified 16S rRNA genes.
DGGE analysis indicated the presence of a very high bacterial diversity in both the OMW and the composting mixture and the occurrence of a rapid succession of different bacterial populations throughout the process. Indeed, only few populations were shared among all the samples, while most seemed peculiar of the different phases of biotransformation of OMW into mature compost.
NGS analysis allowed the identification of these populations. Actinobacteria were abundant in the OMW, declined at the beginning of the active/thermophilic phase and then represented the predominant populations during the curing/mesophilic phase. Interestingly, while in the OMW most Actinobacteria belonged to the family Microbacteriaceae, the compost in the curing phase featured a high abundance of Pseudonocardiaceae, mostly represented by the moderately halophilic Prauserella genus. As expected, the most abundant populations found in the active phase, when the temperature reached 60°C, were the Bacilli, particularly those belonging to the thermophilic, spore-forming Geobacillus genus. Finally, the compost in the maturing phase was mainly characterized by an even distribution of bacteria belonging to the orders Actinomycetales, Sphingobacteriales, Burkholderiales, Xanthomonadales and Rhizobiales.

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EFFECT OF THE CRUDE GLYCEROL ADDITION ON TWO-PHASE ANAEROBIC DIGESTION FOR URBAN WASTEWATER SLUDGE TREATMENT

Crude glycerol, a by-product from biodiesel refineries, can be converted into methane in anaerobic digestion facilities (such as the ones treating municipal wastewater sludge), which results in a sensible boost of biogas production. Glycerol loading rate is generally considered a limiting factor, since overloading may decrease or even stop methane production in conventional single-stage plants. In an effort to overcome this limitation and increase the maximun organic loading rate, a two-phase anaerobic digestion scheme was applied to estimate the glycerol co-digestion impact on a pilot plant treating urban wastewater sludge.
From an analytical standpoint, crude glycerol effect was evaluated on soluble chemical oxygen demand (SCOD), total suspended solids (TSS), volatile suspended solids (VSS), volatile fatty acids (VFA), non volatile fatty acids, biogas production, volatile organic compounds (VOC), and on the sludges morphology by scanning electron microscopy (SEM). Glycerol addition boosted biogas yields and considerably changed the VOC composition in methanogenesis phase, while no trace of VFA was found. In conclusion, crude glycerol can be successfully added at high loading rate (over 4.40 kgCOD mc-1 d-1) to a two-phase anaerobic digestion process, thus representing an effective way to increase the energetic output of a wastewater treatment plant (+139%) without impairing process stability.

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ZINC SORPTION OF COMPOST MATERIALS

Recently compost materials are often used to remove the heavy metals from the waste-and storm waters The maximum amount of Zn sorbed by the compost materials is between 11-13 mg/g and 30-35 mg/g of Cu Usually the Langmuir equation fits the best to sorption data, but sometimes Freundlich isotherm is better The objective of this paper is to determine the Zn sorption capacity of „fresh" and „mature" compost materials, and to calculate the resistance of sorbed Zn against hot water percolation (HWP) 12 compost materials, prepared and analysed in BGK (Germany), were used in the experiment The five compost samples with No5 were considered as "fresh" and the seven samples with No7 were considered as "mature" ones according to the German qualification system 1 g of compost was equilibrated with 20 cm3 solution containing 0, 500, 1000, 2000, 5000 and 10000 ?g Zn, respectively for 19 hours The samples were centrifuged and filtered When desorption was determined 20 g compost samples was treated with a solution containing 100 mg Zn in 400 cm3 After 2 hours shaking the solution was filtered and the compost was dried 10 g of this compost was measured into the container of the hot water percolation apparatus 10 times 100 cm3 percolates were collected Langmuir isotherm was fitted to zinc sorption data In the case of zinc desorption the first order kinetic reaction was used The maximum amount of sorbed zinc is very high both in the "mature" and "fresh" compost materials The calculated zinc

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HYDROPHILIC AND HYDROPHOBIC FRACTIONS OF DISSOLVED ORGANIC MATTER FROM DIFFERENT FEED-IN MIXTURES AND THEIR CORRESPONDING DIGESTATES

Dissolved Organic Matter (DOM) was extracted from a number of feed-in mixtures and their corresponding digestates, and fractionated into a hydrophilic and a hydrophobic fraction. For all samples, the portion of the hydrophobic fraction increased from ingestates to digestates, likely due to the fast utilization by microorganisms of easily degradable components of the hydrophilic fractions. More than 70% of the DOC was with the hydrophilic fraction for digestates obtained from a 1:1 mixtures of the organic fraction of municipal solid waste and sewage sludge processed under mesophilic and thermophilic conditions. The temperature of the process appeared not to influence the distribution of DOC between the hydrophilic and the hydrophobic fractions.
Digestates obtained from energy crops, poultry manure, stomach residue, and others agro-industrial residues sampled at different sections of the digestion plant had more DOC with the hydrophobic fraction. This went along with larger contents of aromatic moieties in the feed-in materials, which seemingly concentrated in the digestate. The DOC content of the hydrophobic fractions increased progressively from the first digester to the storage tank.

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ORGANIC CARBON POOLS AND BIODEGRADABILITY IN TWO CONTRASTING SEMIARID SOILS OF TPOMW-DERIVED BIOCHAR

Biochars obtained from slow pyrolysis of two-phase olive mill waste (TPOMW) were evaluated to analyze their biodegradability in two types of soils The biochars were produced at a pyrolysis peak temperature in the range of 400–600 °C and under an absolute pressures varying from 0 1 to 1 0 MPa Particle size distribution (Pmpa), pH, electrical conductivity (EC), total organic carbon (TOC), soluble organic carbon (SOC), oxidable organic carbon (OxOC) and resistant organic carbon (ROC) were analyzed from each type of biochar A short-term incubation study was carried out to evaluate the effect of two selected types of biochar addition to soil on CO2 emission Two semiarid agricultural soils, with low organic matter content and contrasted properties were selected (calcareous and gypseous soil types) Threes treatments for each soil were tested: soil (control); soil + 5% biochar (600 °C;0 1 MPa); soil + 5% biochar (600 °C; 1 0 MPa) CO2-C was periodically measured throughout the experiment (30 days) Highest pressure biochar have a ROC content up to 10 and 14% higher over to the samples produced at the same temperature but at lesser pressure On average, calcareous soils evolved higher carbon dioxide efflux than gypseous ones The estimated mean residence time (MRT) of C in the biochars varied between 600 and 1200 days representing the active or relatively labil C pool components Nevertheless, it is likely to increase under field conditions On the other hand, the influence of biochar on soil pH after the addition and incubation is relatively

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CHEMICAL, PHYSICAL AND BIOLOGICAL EVALUATION OF THE SURFACE PROPERTIES OF A BIOCHAR TREATED WITH AN ORGANIC SOLVENT

Biochar is a porous, recalcitrant material with several potential applications in agriculture and in environmental remediation Biochar applications in soils improve fertility and contribute to reduce the amount of atmospheric carbon dioxide through the mechanisms of C sequestration Different studies showed that biochar properties depend on the original biomass and on the conditions used for the biochar achievement Physico-chemical biochar properties can be also modified through physical or chemical treatments which may change superficial area and dynamic interaction with liquids The aim of this study is to investigate changes in water interaction on biochar surface after treatment with organic solvents Two different treatments have been applied to a biochar sample obtained from poplar wood Firstly, biochar has been in contact with acetone till complete evaporation Secondly, biochar has been washed with the same solvent The latter was removed by filtration The non-treated, and the two treated samples were water saturated and analyzed by fast field cycling (FFC) NMR relaxometry Results showed a significant longitudinal relaxation rate reduction in the treated samples These were explained by modifications of the surface properties following acetone treatments Modifications of biochar surface properties affected also germination and growth of some plants, as well as water retention of biochar amended soils This study combines for the first time chemical, physical and biological investigations for the understanding of the properties of a biochar from an industrial thermochemical process Recognition of such properties is of paramount importance for addressing the correct use of biochar in environmental applications

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THE VISUAL INCORPORATION OF FE INTO HUMIC ACIDS DURING THE COMPOSTING OF WHEAT STRAW

Composting is an aerobic-microbial mediated process. The resulting humified organic matter is used as a suitable amendment for agricultural or degraded soils. In order to promote the humification process and compost stabilization some inorganic materials such as allophane and metallic oxides have been used elsewhere. In this study we characterized humic acids (HAs) extracted from a wheat straw residue inoculated with saprophytic fungi (Trametes versicolor) and co-composted with iron oxide during 18 weeks. The extracted HAs were characterized under Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) imaging at two different pHs (5 and 9). At pH 5, the SEM analysis indicated that globular structures of HAs prevailed, some of them aggregating within a large network. Conversely, at pH 9, long tubular and dendritic shaped of HA structures prevailed. The HAs extracted from wheat straw co-composted with metal showed the formation of dendritic conglomerates with Fe inclusions indicating the formation of stable organo-mieral complexes. TEM images at scales of 1 to 200 nm showed iron nanoparticles (~20 nm) incorporated into the HA matrix and also forming nano- to micro-size aggregates. We conclude that Fe and pH have an important role in controlling the morphology of HAs and their stabilization.

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EFFECTS OF INORGANIC MATERIALS ON SOME CHEMICAL PROPERTIES OF COMPOSTED WHEAT STRAW RESIDUES.

Composting is an important bioprocess for stabilizing crop residue carbon (C) via humification. Composts from agricultural residues are degraded relatively fast under field conditions. In order to improve the C stabilization of wheat straw, composting studies were conducted included the addition of metallic oxides for altering C stabilization via changes of chemical properties of humic acids (HAs). Wheat straw was inoculated with saprophytic fungi (Trametes versicolor, Coriolopsys rigida, Trichoderma harzianum and Pleurotus ostreatus) and co-composted with Fe-Al oxides for 18 weeks. Organic matter (OM) transformation and composition was characterized using physico-chemical parameters such as E4 /E6 ratios; and functional groups by FTIR. The E4 /E6 ratio was lower in the Fe-oxide treatment than in the untreated straw at the end of composting. The latter indicates that HA substances presented a higher molecular weight than the HAs extracted at the beginning of composting. Information obtained from FTIR spectra suggests that Fe in the compost was preferentially bound to carboxylic groups of HAs, and that Fe addition resulted in preferential decomposition of aliphatic structures while aromatic structures were preserved. At the end of composting, total acidity and the content of functional groups (COOH, OH and CO) were greater in the Fe treated straw.
These results indicate that the activity of added fungi enhanced the composting and stabilization process of C in wheat straw by altering some chemical properties of HAs.

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EVALUATION OF ENZYMATIC ACTIVITIES FROM SAPROPHYTIC FUNGI INOCULATED WHEAT STRAW RESIDUES DURING COMPOSTING

Composting of wheat straw, material that is resist to biodegradation involves the transformation of organic materials through successive microbial activities into a more stable and complex organic matter Microorganisms such as some saprophytic fungi are capable of decomposing lignin The ligninolytic degrading system of white-rot fungi is efficient and includes phenol oxidases, peroxidases and hydrogen peroxide The effects of saprophytic fungi (Trichoderma harzianum; Pleurotus ostreatus; Coriolopsys rigida and Trametes versicolor) inoculation of wheat straw on selected enzyme activities were studied during 18 weeks of composting Fungal inoculation was complemented with the addition of Iron (III) oxide The activities of Lacassa (LAC); Manganese peroxidasa (MnP); and ?-glucosidase were measured The pH of compost increased from 4 at the beginning to >9 by the end of the process, evidencing a high fungal activity at the initial stages of composting At the end of composting, T versicolor showed the highest activities for LAC (about 3 0 U/ml) and MnP (0 350 U/ml) relative to those shown in composted straw treated with other fungal species Straw inoculated with T harzianum and C rigida showed highest activity for ?-glucosidase (~4 5 U/ml), an enzyme that helps depolymerize cellulose Addition of Iron (III) oxide to composting increased the LAC and MnP (~2 times) activity for T versicolor In comparisson, Aluminum oxide increased the ?-glucosidase activity in the presence of C rigida inoculation, but its activity decreased for T harzianum inoculation treatment These results show that wheat straw inoculation with saprophytic fungi in combination with metal oxides

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ANALYSIS OF BIOCHARS FROM AMAZONIAN DARK EARTH: COMPARISON WITH COMMERCIAL AND NATURAL SAMPLES

To elucidate the morphological aspects and the functionality of biochar is a challenge to solve the CO2 problem, the C stability in soils and the effects of biochar addition on plants and soil microorganisms Increasing interest on biochar and Amazonian Dark soil “Terra Preta de Índio” (TPI) for sustainable agriculture pointed the need to give greater consideration to the structure and composition of C, as several questions have not been totally answered In the present study an archaeological site at Manaus State, Brazil, was selected to detect changes in molecular form of black BC through TPI soil depth (0- 20, 20-40, 40-60, 60-80 and 80-100 cm) Moreover, the C structure and chemical properties were compared with Commercial biochar and natural samples (turf and compost) We also asses the abundance of Actinobacteria, Bacteria groups, total fungi and arbuscular mycorrhizas along the five soil depths We show that TPI-carbon structure was not affected by soil depth, being more related to the natural samples and differ from the Vegetal charcoal which is manipulated at higher temperatures With regard to soil microorganisms, abundance of Actinobacteria / fungi, bacteria and arbuscular mycorrhizas decreased with increasing depth Among the isolated fungi Ascomycetes and Glomeromycetes dominated The isolated Ascomycetes were previously associated to C sources and distinct AMF species occupy the topmost and deep soil strata The TPI soil contain high microbial abundance and diversity, which can be used as a model in exhaustive fertilization studies of agronomic plants in order to elucidate the biochar effect

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CHESTNUT COMPOSTING: A STUDY ON MICROBIAL COMMUNITIES EVOLUTION

The composting process of an organic matrix largely depends on microbial activity, whose the process dynamic succession is not yet completely defined This paper reports a study regarding qualitative and quantitative evaluation of microbial communities in different time points in a composting biomass from chestnut trees cleaning material The study involved molecular and microbiological techniques Molecular analysis of microbial communities were based on culture-independent methods DNA directly extracted from samples were taken at different decomposition time points and amplified by PCR The amplicons obtained were used to evaluate the genetic diversity of bacterial end fungi communities, by using the technique of DGGE During the first phase the decomposition process, 6 months, data obtained from the analysis showed very high similarity levels both about bacterial and fungal populations Well separated bands were cut and sequenced Sequences obtained were compared to the GenBank nucleotide data library using the BLAST software Three main functional groups of the carbon cycle were investigated: hemicellulolytic, cellulolytic and ligninolytic The values of the counts in the first sampling, for all groups, were between counts 8-9 log CFU/g Whereas past 195 days, the values of the counts were slightly lowered for hemicellulolytic and cellulolyitic groups while for ligninolytic values are decreased up to 5 log CFU/g The monitoring process also included the detection of physicalchemical parameters such as the temperature, pH, and water activity of the mass The study shows the relation between microbial activity, variation of the physical-chemical parameters and the progress of the biomass degradation process

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CHARACTERIZATION OF NON-EXTRACTED THERMAL BIOMASS CONVERSION PRODUCTS BY MASS- AND X-RAY ABSORPTION SPECTROSCOPIES

The chemical-analytical characterization of the feedstuff and the corresponding thermal conversation products (e.g. biochars and hydrochars) is essential for process control and improvement, and assessing the fate of the biochars in soil. It is demonstrated how an untargeted mass spectrometric fingerprinting by pyrolysis-field ionization mass spectrometry (Py-FIMS) enables to ascertain the degree of chemical alterations in thermal conversion processes. For a range of various feedstuff, Py-FIMS clearly showed that the kind of biomass residue influenced the chemical composition of the corresponding hydrochars more strongly than, e.g., process duration (Jandl et al., 2013). Ongoing research is expanding these data sets by involving materials from technologically advanced hydrothermal conversation techniques, and complementary C- and N-speciations by synchrotron-based, X-ray absorption near-edge fine structure (XANES) spectroscopy. Finally, our in-house mass spectra library is explored to find out and visualize fundamental differences in organic matter composition among humus-containing A-horizons of mineral soils (long-term humification), composts (short-term humification), and thermal biomass conversion products (no humification, thermal biomass conversion).

Reference

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DIFFERENTIAL SCANNING CALORIMETRY APPLIED TO THE STUDY OF DIGESTATES OBTAINED FROM DIFFERENT ORGANIC SUBSTRATES

Digestates obtained from a 1:1 mixture of the organic fraction of municipal solid waste and sewage sludge under mesophilic and thermophilic conditions evidenced a shift of the high temperature exotherm toward higher temperature with respect to feed-in material indicating stabilization attained by the OM during the process. A further shift of this exotherm toward higher temperature associated to lower enthalpy values were observed for thermophilic digestates with respect to mesophilic digestates. These results were explained by a major degradation of OM attained under stronger operative conditions. Lower enthalpy values were calculated for both mesophilic and thermophilic digestates with respect to feed-in mixtures. DSC applied to digestates obtained by energy crops, poultry manure, stomach residue and others agro-industrial residue sampled in different sections of the digestion plant showed a strong exotherm at lower temperature indicating lower thermal stability of the substrate. Lower enthalpy values of the high-temperature exotherm were calculated for digestates sampled from the storage tank, whereas higher ?H values were calculated for digestates retrieved from the second digester.

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FLUORESCENCE SPECTROSCOPY APPLIED TO THE CHARACTERIZATION OF DIGESTATES OBTAINED FROM DIFFERENT ORGANIC SUBSTRATES

Fluorescence spectroscopy was applied to the characterization of a number of digestates obtained by various mixtures of organic waste. Different results were obtained for digestates produced by anaerobic digestion of a 1:1 mixture of the organic fraction of municipal solid waste and sewage sludge under mesophilic and thermophilic conditions. Under thermophilic condition emission maxima located at higher ? than those obtained under mesophilic conditions were observed. In general, higher fluorescence intensity (FI) were obtained in emission spectra of digestates as compared to their corresponding substrates, whereas FI of digestates under thermophilic condition were lower than those of digestates under mesophilic conditions. Digestates obtained by energy crops, poultry manure, stomach residue and others agro-industrial residue sampled in different sections of the digestion plant exhibited an increase of FI values of the peak at highest ? in synchronous-scan spectra from the first digester to the storage tank.
Excitation emission matrix (EEM) of all digestates revealed a typical peak characterized by very low excitation ? (250-265) and relatively high ? (410-442) which could not be included in the classification of EEM peaks reported in literature for natural organic matter and therefore it was referred to as peak E. Our results indicated that this peak can be used to identify and characterize digestates with respect to other different samples of natural OM.

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FOURIER TRANSFORM INFRARED SPECTROSCOPY ASSOCIATED TO FOURIER SELF DECONVOLUTION OF SPECTRA APPLIED TO THE CHARACTERIZATION OF DIGESTATES OBTAINED FROM DIFFERENT ORGANIC SUBSTRATES

A number of digestates obtained from various mixtures of organic wastes were analyzed by FTIR spectroscopy. A general evidence emerging from FTIR spectra was the large variability in the composition of fresh organic substrates both in terms of chemical complexity and seasonal variations. FTIR spectra of the organic fraction of municipal solid waste reflected their chemical composition rich in proteins, fatty acids, carbohydrates and phenolic groups whereas those of sewage sludge samples indicated a notable content of inorganic materials which obviously were found unchanged in digestates. Digestates obtained by energy crops, poultry manure, stomach residue and others agro-industrial residue sampled in different sections of the digestion plan reflected the high content of protinaceous materials from poultry manure and stomach residues in the feed-in mixtures.
Fourier Self Deconvolution (FSD) of FTIR spectra proved to be very useful in evidencing changes in relative intensity of peaks both in feed-in mixtures and in digestates.

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RESPONSE TO PH CHANGES OF FLUORESCENCE SPECTRA OF DIGESTATES FROM MUNICIPAL SOLID WASTE AND SEWAGE SLUDGE UNDER MESOPHILIC AND THERMOPHILIC CONDITIONS

The wide range of fluorophore responses to pH available in the literature reflects the complex nature and heterogeneous composition of natural organic matter so that the study of fluorescence spectra to pH changes is not an easy task. However, since early 80's it is well known that humic substances tend to have a linear structure at high pH and coil up when pH decreases so that changes in fluorescence intensity and/or wavelength values with changing pH can be attributed to conformational changes in the molecules hiding or exposing fluorescing parts. In general, more rigid structures provide better fluorescent yields since a spherocolloidal configuration could mask some fluorophores inside their structure. Here the response to pH changes (4, 6, 8, 10) of fluorescence spectra of digestates produced by anaerobic digestion of a 1:1 mixture of the organic fraction of municipal solid waste and sewage sludge under mesophilic and thermophilic conditions was studied. Our results showed that emission spectra of digestates exhibited a shift to higher ? and a general increase of FI up to pH 8 and a more or less slight decrease of FI from pH 8 to pH 10. The response to pH modifications of synchronous-scan spectra was more complex and articulated.

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International Conference
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Production, Characterization, Regulation, Marketing, Uses and Environmental Impact
October 17 to 20, 2013 - Bari (Italy)

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ZN SORPTION BEHAVIOUR OF SOILS CONTAINING CHARCOAL WITH DIFFERENT AGE

Charcoal is relatively recalcitrant and has a long residence time in soil. Soils enriched with charcoal contain higher concentrations of nutrients and greater amount of stable organic matter. Concerning heavy metal adsorption, organic matter has an important role in soils.
The objective of our research was to investigate the effect of charcoal on the characteristics of soil Zn adsorption.
Samples were taken from sites where charcoal was produced 25, 35 and 80 years ago (CC25, CC35 and CC80) in the North-Eastern part of Hungary,in a beech forest. The soil is a brown forest soil. Samples were taken from the depth where charcoal has been mixed with the original soil and pieces of charcoal were still visible.
During the adsorption experiments, 2-2 grams of the samples have been shaken with 20-20 mL ZnSO4 solution for 8 hours at 22 C in centrifuge tubes in a rotary shaker. The shaking solution was applied on each sample with six different concentrations, from 0 to 5000 Zn mg/kg adsorption load. The Zn concentration of the equilibrium solution was measured by atom adsorption spectrophotometer. Langmuir adsorption isotherm was fit onto the experiment points.
According to our results, the sorption capacity of samples CC25 and CC35 were higher than that of the control samples. Two term Langmuir isotherms were fitted to the data which assumes two parallel sorption processes . The CC80 behaved similarly to the control sample and the process is well characterised by using one term Langmuir adsorption isotherm.

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Zaccone Claudio - University Of Foggia - Department Of The Sciences Of Agriculture, Food And Environment - Foggia, Italia

LASER INDUCED BREAKDOWN SPECTROSCOPY APPLIED TO THE DETERMINATION OF SELECTED NUTRIENT ELEMENTS AND HEAVY METALS IN COMPOSTS USED AS SOIL AMENDMENT

Laser-Induced Breakdown Spectroscopy (LIBS) is a fast and reliable technique suitable for the simultaneous qualitative and quantitative analysis of major and trace elements in samples of various nature and origin In last decades, the use of compost as an organic amendment has become a very common, cheap and sustainable agricultural practice to provide soil with organic matter and nutrients, although the content of heavy metals in compost may often represent a risk for its agronomic use In the present work, the detection and concentration of selected macro- and micronutrients and heavy metals, including Al, Ca, Cr, Cu, Fe, K, Mg, Mn, Na, Pb, Sr, and Zn, in two commercial composts of different origin have been measured comparatively by LIBS and conventional Induced Coupled Plasma - Optical Emission Spectroscopy (ICP-OES) techniques In general LIBS data are in good agreement with the corresponding ICP-OES data The best correlation of LIBS values with ICP-OES values are obtained at the laser wavelength of 532 nm for Al, Ca, K, Mg, Mn and Na, and at the wavelength of 355 nm for Cr, Cu, Fe, Pb, Sr and Zn In conclusion, our results confirm the feasibility of LIBS for the quantitative analysis of several elements in composts with several advantages including no need of (or minimal) sample preparation, rapidity and relatively low costs, showing promising for further applications However, a number of instrumental and substrate factors still need to be optimized to obtain a better performance for accuracy and precision of LIBS analysis for each

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CHARACTERIZATION OF BIOCHAR VOLATILE MATTER AND IT'S INFLUENCE ON PLANT GERMINATION

The aim of this study is to investigate the volatile matter (VM) content and composition in chars derived from animal manure with special emphasis on polycyclic aromatic hydrocarbons (PAHs) and their effects on seed germination and plant growth Pyrolysis of dry poultry litter and cow manure was performed at 400 and 600°C in a zero oxygen environment at a heating rate of 20 °C min-1 and a retention time of 60 min The char yields were 47 and 32 w/w% respectively for poultry litter The low temperature chars were high in volatile matter; also evident through their intense and unpleasant smell One gram of each char was milled and subjected to solid-liquid extraction via Soxhlet and Accelerated Solvent Extraction (ASE) using solvents from low to high polarity The extracts are further fractionated by means of liquid-liquid extraction and column chromatography The isolated organic compounds are identified using gas chromatography - mass spectrometry (GC-MS) Germination tests of lettuce seeds provide information on the toxicity of the extracted volatile matter The biochars are applied to two different soils in order to observe the plant growth of lettuce in a natural growth environment Biochar characterization includes proximate and ultimate analysis; pH; cation exchange capacity; specific surface area; scanning electron microscopy and 13C solid-state nuclear magnetic resonance spectroscopy It is assumed that the high VM influences plant growth in a negative way, and that the formation of organic toxic compounds is less dependent on the feedstock, but is more influenced by the process conditions

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PS3a. SUSTAINABLE USES, APPLICATIONS AND ENVIRONMENTAL IMPACT OF BIOCHARS, COMPOSTS AND DIGESTATES

18 October, h. 08:00 – 20:00

PS3a.01 **Compost performance during successful transition to organic farming**

Abdelrahman Hamada, *Faculty of Agriculture, Cairo University - Giza, Egypt*
Cocozza Claudio, *University of Bari "Aldo Moro" - Bari, Italy*
Olk Daniel, *USDA-ARS - Ames, IA, USA*
Venterela Domenico, *C.R.A - Bari, Italy*
Montemurro Francesco, *C.R.A - Metaponto, Italy*
Miano Teodoro, *University of Bari "Aldo Moro" - Bari, Italy*

PS3a.02 **Composting time of chicken litter with biochar for organic fertilizer production**

Abreu Paulo Giovanni De, Corrêa Juliano Corulli, *Embrapa Suínos e Aves - Concórdia, Brasil*
Franz Izaura, UnC- *Campus Concórdia - Concórdia, Brasil*
Mattei Rosemari Martini, Feddern Vivian, Abreu Valéria Maria Nascimento, *Embrapa Suínos e Aves - Concórdia, Brasil*

PS3a.03 **San-soil project: new peat-free potting soil improvers from zero-miles olive mill waste recycling**

Altieri Roberto, Esposito Alessandro, Castellani Francesco, Stanzione Vitale, *CNR - ISAFOM - Perugia, Italy*
Federici Ermanno, Fidati Laura, Cenci Giovanni, *University of Perugia - Perugia, Italy*
Chilosi Gabriele, Aleandri Maria Pia, Martignoni Diana, Dell'Unto Davide, *University of Tuscia - Viterbo, Italy*
Bruschi Sandro, Spagnesi Renzo, Lotti Martina, *Vivai Sandro Bruschi - Pistoia, Italy*
Giambi Alessandro, Frosini Leonardo, *Vivai GIEFFE - Pistoia, Italy*
Romano Baldacci, *Vivai Baldacci, Pistoia, Italy*
Riccardo Pretelli, *Frantoio PAM, Produttori Agricoli Montalbano, Pistoia, Italy*

PS3a.04 **Biochar in growing media: role of particle size on liming capacity and physical properties**

Bedussi Floriana, Crippa Laura, Zaccheo Patrizia, *University of Milano - Milano, Italia*

PS3a.05 **Compost changed soil organic matter molecular composition: a study by PY-GC/MS and PY-FIMS**

Bekele Eshetu, *Adama University - Adama, Ethiopia*
Peter Leinweber, Gerald Jandl, *Rostock University - Rostock, Germany*

PS3a.06 **Confirmatory path analysis to clarify the effects of compost amendments on soil chemical and biological properties**

Bellino Alessandro, Baldantoni Daniela, *University of Salerno - Fisciano (SA), Italy*
De Nicola Flavia, *University of Sannio - Benevento, Italy*
Iovieno Paola, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - Pontecagnano (SA), Italy*
Zaccardelli Massimo, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - Battipaglia (SA), Italy*
Alfani Anna, *University of Salerno - Fisciano (SA), Italy*

PS3a.07 **Agronomically-efficient use of anaerobically digested grapemarc distillery effluents as organic amendments**

Brunetti Gennaro, *University of Bari - Bari, Italy*
Farrag Karam, *National Water Research Center (NWRC) – Il Cairo, Egypt*
Plaza Casar, *Superior de Investigaciones Científicas - Madrid, Spain*
Senesi Nicola, *University of Bari - Bari, Italy*

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PS3a.08 **Dried and pirolyzed swine effluents as n source for crops: influence on Italian ryegrass yields in greenhouse tests**

Castelli Fabio, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - Bovolone (VR), Italy*
Marchetti Rosa, Sghedoni Lidia, Marino Antonio, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura – San Cesario Sul Panaro, Modena, Italy*

PS3a.09 **Does biochar application increase soil fertility and tomato production under organic farming in Mediterranean conditions?**

Cavoski Ivana, Al Chami Ziad, Jarrar Mohammad, *Mediterranean Agronomic Institute of Bari – CIHEAM - Valenzano, Italy*
Dumontet Stefano, *University of Napoli "Parthenope" - Napoli, Italy*
Mondelli Donato, *University of Bari "Aldo Moro" - Bari, Italy*

PS3a.10 **Development of a biocatalyst based on the immobilization of candida rugosa lipase on biochar derived of oat hulls**

Cea Mara, Abarzua Macarena, Alvarez Daniela, Gonzalez María Eugenia, Gonzalez Alvaro, Navia Rodrigo, *University of la Frontera - Temuco, Chile*

PS3a.11 **The mixed composted amendment in the improvement of soil fertility in horticulture in central Italy: mineralization potential and productive response**

Chilosi Gabriele, Righi Lorenzo, Atti Luca, Marinari Sara, Moscatelli Maria Cristina, Aleandri Maria Pia, Reda Roberto, Vannini Andrea, *University of Tuscia - Viterbo, Italy*
Filippi Alessandro, *Kyklos Srl - Roma, Italy*

PS3a.12 **Bioaccumulation in earthworms (Eisenia Andrei) of polycyclic aromatic hydrocarbons (PAH) from biochar**

Contin Marco, *University of Udine - Udine, Italy*
Sesso Michela, Barbieri Pierluigi, *University of Trieste - Trieste, Italy*
Malev Olga, De Nobili Maria, *University of Udine - Udine, Italy*

PS3a.13 **Ammonia stripping from digestate to reduce the soil N load and nitrate leaching**

Contin Marco, Petris Raffaela, Goi Daniele, Rizzardini Claudia Bruna, De Nobili Maria, *University of Udine - Udine, Italy*

PS3a.14 **Relating chemical properties of four biochars to its biochemical recalcitrance**

De La Rosa Jose Maria, Paneque-Carmona Marina, *Instituto de Recursos Naturales y Agrobiología de Sevilla (IRNAS-CSIC) - Seville, Spain*
Schmidt Hans-Peter, *Delinat-Institut Für Ökologie Und Klimafarming - Arbaz, Switzerland*
Almendros Gonzalo, *Museo Natural de Ciencias Naturales, MNCN-CSIC - Madrid, Spain*
Knicker Heike, *Instituto de Recursos Naturales y Agrobiología de Sevilla (IRNAS-CSIC) - Seville, Spain*

PS3a.15 **Use of compost in projects of COSWAND (conservation of soil and water in Andean countries)**

Lobo Deyanira, *Facultad de Agronomía, Universidad Central de Venezuela, and UNESCO Chair on Eremology, Ghent University, Belgium*
Gabriels Donald, *UNESCO Chair on Eremology, Ghent University, Belgium, and Ganda Publi Productions, Belgium*

PS3a.16 **The role of compost dissolved organic matter (DOM) on pyrene removal from cultivated soils**

D'Orazio Valeria, Senesi Nicola, *University of Bari - Bari, Italy*

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Eich-Greatorex Susanne, Sogn Trine A., *Norwegian University of Life Sciences - Aas, Norway*

PS3a.18 **Utilization of anaerobic digestate from biogas production as crop nutrient source and for improving soil quality**
Fabiani Arturo, Lagomarsino Alessandra, Vignozzi, Valboa Giuseppe, Papini Rossella, Simoncini Stefania, Piccolo Raimondo, Pastorelli Roberta, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - Firenze, Italy*

PS3a.19 **Influence of municipal solid waste compost on the phytoremediation of chromium in soil polluted with multiple heavy metals**
Farrag Karam, *National Water Research Center, Ministry of Water Resources And Irrigation - Il Cairo, Egypt*
Brunetti Gennaro, Senesi Nicola, *University of Bari - Bari, Italy*

PS3a.20 **Production and application of olive pomace compost on cropping systems: a case of study**
Ferri Donato, Tittarelli Fabio, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - Bari, Italy*
Verrastro Vincenzo, *CIHEAM-MAIB - Istituto Agronomico Mediterraneo - Bari, Italy*
Montemurro Francesco, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - Metaponto , Italy*

PS3a.21 **Phylogenetic and functional changes in the microbial community of a semiarid restored soil after 25 years**
Garcia Carlos, Bastida Felipe, Albaladejo Juan, Hernandez Teresa, *CEBAS-CSIC - Espinardo-Murcia, Spain*

PS3a.22 **Promoting pesticide efficacy in saturated systems by inclusion on biochars**
García - Jaramillo Manuel, Cox Lucia, Hermosín Maria Del Carmen, Cornejo Juan, *IRNAS - CSIC - Seville, Spain*

PS3a.23 **Contribution of compost in the abatement of phytotoxicity of a municipal landfill leachate**
Gattullo Concetta Eliana, Loffredo Elisabetta, Castellana, Senesi Nicola, *University of Bari - Bari, italy*

PS3a.24 **Production of a controlled-release nitrogen fertilizer using biochar produced from agroforestry wastes**
González Maria Eugenia, Medina Jorge, Cea Mara, González Aixa, Araya Karla, Diez María Cristina, Navia Rodrigo, *Universidad de la Frontera - Temuco, Chile*

PS3a.25 **Evaluation of different polymers as coating agent on the leaching potential of a nitrogen controlled release fertilizer developed using biochar as support material**
González Maria Eugenia, Medina Jorge, Cea Mara, González Aixa, Diez María Cristina, Monreal Carlos, Navia Rodrigo, *Universidad de la Frontera - Temuco, Chile*

PS3a.26 **Phosphorus from anaerobic digestate: dynamics in soil and plant availability**
Grigatti Marco, Cavani Luciano, Marzadori Claudio, Ciavatta Claudio, *University of Bologna - Bologna, Italy*

PS3a.27 **Pot experiments with anaerobic digestate (summary)**
Gulyás Miklós, Szegi Tamás, Füleky György, *Szent István University - Gödöll, Hungary*

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Hernandez Teresa, *CEBAS-CSIC - Espinardo-Murcia, Spain*
Brunetti Gennaro, *University of Bary - Bari, Italy*
Garcia Encarna, Garcia Carlos, *CEBAS-CSIC - Espinardo-Murcia, Spain*

PS3a.29 **Agronomic valorization of digestates from the methanogenic digestion of residues from the pretreatment of domestic used vegetal oils for obtaining biodiesel**
Hernandez Teresa, *CEBAS-CSIC - Espinardo-Murcia, Spain*
Chocano Carmen, Garcia Carlos, *CEBAS-CSIC - Espinardo-Murcia, Spain*

PS3a.30 **The microbial use of fermentation in agriculture**
Hold Annika, Bölter Manfred, Hartung Eberhard, Holthusen Doerthe, Horn Rainer, Ohl Susanne, Voelkner Amrei, *Christian-Albrechts-University of Kiel - Kiel, Germany*

PS3a.31 **Compost amendments vs mineral fertilization under greenhouse: effects on soil biological quality and on productivity and nutrient contents of different cultivars of lettuce and endive**
Iovieno Paola, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - Pontecagnano (SA), Italy*
Morelli Raffaella, Cicatelli Angela, Baldantoni Daniela, Alfani Anna, Castiglione Stefano, *University of Salerno - Fisciano (SA), Italy*

PS3a.32 **Effects of digestate applications on germination and biomass yield of maize (Zea Mays) in different soils**
Jablonowski Nicolai David, *Forschungszentrum Jülich GmbH - Jülich, Germany*
Robles-Aguilar Ana, *University of Malaga - Malaga, Spain*
Ratouis Perrine, *EPFL - Lausanne, Swiss*
Herrmann Katja, *University of Cologne - Cologne, Germany*
Wolff Wilfried, Temperton Vicky, Roeb Gerhard, *Forschungszentrum Jülich GmbH - Jülich, Germany*

PS3a.33 **Composting of biochars: improvement of sorption properties and nutrient retention**
Jablonowski Nicolai David, Borchard Nils, *Forschungszentrum Jülich GmbH - Jülich, Germany*
Prost Katharina, *University of Bonn - Bonn, Germany*
Spokas Kurt, *USDA - St. Paul, USA*
Kautz Timo, *University of Bonn - Bonn, Germany*
Möller Andreas, *Federal Institute for Geo-Science and Natural Resources - Hannover, Germany*
Siemens Jan, *University of Bonn - Bonn, Germany*

PS3a.34 **Root growth and yield of spring wheat influenced by different biochars**
Katharina Reibe, Thomas F. Döring, Frank Ellmer, *Humboldt University - Berlin, Germany*

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Krümmelbein Julia, Dietrich Nils, Raab Thomas, *Brandenburg University of Technology - Cottbus, Germany*

PS3a.36 **Organic carbon content and chemical attributes of a cambisol after biochar application**
Leal Otávio, Dick Deborah, *UFRGS - Porto Alegre, Brazil*
Lombardi Kátia, *UNICENTRO - Irati, Brazil*

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Leita Liviana, *CRA-Agricultural Research Council - Gorizia, Italy*
Valentini Massimiliano, *CRA-Agricultural Research Council - Roma, Italy*
Ciavatta Claudio, *University of Bologna - Bologna, Italy*
Sequi Paolo, *CRA-Agricultural Research Council - Roma, Italy*

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Libutti Angela, Garofalo Pasquale, Monteleone Massimo, *University of Foggia - Star*Energy Research Group - Foggia, Italy*

PS3a.39 **Enhancement of switchgrass (Panicum Virgatum L.) growth by compost application**
Loffredo Elisabetta, Traversa Andreina, *University of Bari - Bari, Italy*
Palazzo Antonio J., *ERDC- CRREL - Hannover, USA*
Bashore Terry L., *HQ ACC/A3A, Airspace, Ranges, - Langley AFB, VA, USA*
Senesi Nicola, *University of Bari -Bari, Italy*

PS3a.40 **Effects of compost addition on combined sorption/bioremoval of endocrine disruptors from a municipal landfill leachate**
Loffredo Elisabetta, *University of Bari - Bari, Italy*
Castellana Giancarlo, Senesi Nicola, *University of Bari -Bari, Italy*

PS3a.41 **Soil organic matter and levels of Cu and Zn in a soil with compost of swine manure applications**
Lourenzi Cledimar Rogério, Ceretta Carlos Alberto, *Federal University of Santa Maria - Santa Maria, Brazil*
Scherer Eloi Erhard, *Epagri/Chapecó - Chapecó, Brazil*
Tiecher Tadeu Luis, Cancian Adriana, Schapansky Dênis Eduardo, *Federal University of Santa Maria - Santa Maria, Brazil*
Dick Deborah Pinheiro, *Federal University of Rio Grande do Sul - Porto Alegre, Brazil*

PS3a.42 **Compost and plants for soil restoration: Biorem European Project**
Macci Cristina, Doni Serena, Peruzzi Eleonora, Masciandaro Grazia, *CNR - ISE - PISA, Italy*

PS3a.43 **The effects of ingestates compositions on the quality of liquid digestates**
Makádi Marianna, *University of Debrecen - Research Institute of Nyíregyháza - Nyíregyháza, Hungary*
Berényi-Üveges Judit, *National Food Chain Safety Office - Budapest, Hungary*
Tomócsik Attila, *University of Debrecen - Research Institute Of Nyíregyháza - Nyíregyháza, Hungary*
Gulyás Miklós, *Szegi Tamás, Szent István University - Gödöll, Hungary*

PS3a.44 **Hydrological character of reconstituted and natural soils: comparison of physical analysis and pedotransfer functions**
Manfredi Paolo, *M.C.M. Ecosistemi S.r.l. - Podenzano, Loc. Gariga, Italy*
Cassinari Chiara, *Università Cattolica del Sacro Cuore - Piacenza, Italy*
Bosoni Andrea, *M.C.M. Ecosistemi S.r.l. - Podenzano, Loc. Gariga, Italy*
Trevisan Marco, *Università Cattolica del Sacro Cuore - Piacenza, Italy*

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Manfredi Paolo, *M.C.M. Ecosistemi S.r.l. - Podenzano, Loc. Gariga, Italy*
Cassinari Chiara, *Università Cattolica del Sacro Cuore - Piacenza, Italy*
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Trevisan Marco, *Università Cattolica del Sacro Cuore - Piacenza, Italy*

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Marchetti Rosa, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - San Cesario sul Panaro, Modena, Italy*
Castelli Fabio, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - Bovolone (VR), Italy*
Orsi Anna, Faeti Valerio, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - San Cesario sul Panaro, Modena, Italy*

PS3a.47 **Effect of biochar application on bioavailability and uptake of heavy metals by barley (Hordeum Vulgare L.)**
Medynska-Juraszek Agnieszka, *Wroclaw University of Environmental and Life Sciences - Wroclaw, Poland*
Joner Erik, Rasse Daniel, Pierre-Adrien Rivier, *Norwegian Institute for Agricultural and Environmental Research - Ås, Norway*

PS3a.48 **Efficiency of biochar soil amendments for reducing copper and zinc mobility and uptake by red clover (Trifolium Pretense L.)**
Medynska-Juraszek Agnieszka, Cwielag-Piasecka Irmina, *Wroclaw University of Environmental and Life Sciences - Wroclaw, Poland*

PS3a.49 **Evaluation of biochar environmental toxicity using animal bioassay tests**
Menta Cristina, Visioli Giovanna, Conti Federica D., Malcevschi Aliosha, Pinto Stefania, *University of Parma - Parma, Italy*

PS3a.50 **Rock phosphate dissolution through sulphur addition during on-farm composting**
Mihretehab Habte T., *University of Basilicata - Potenza, Italy*
Ceglie Francesco G., Aly Adel, *IAMB - CIHEAM - Valenzano (Ba), Italy*

PS3a.51 **Short-term effects of different organic fertility management on soil chemical, biochemical and biological indicators**
Mondelli Donato, *University of Bari, Bari, Italy*
Aly Adel, *IAMB - CIHEAM - Valenzano (Ba), Italy*
Dumontet Stefano, *University of Napoli "Parthenope", Napoli, Italy*

PS3a.52 **Management of pruning for energy and soil fertility: a win-win solution in a Mediterranean olive farm**
Monteleone Massimo, Garofalo Pasquale, Libutti Angela, *University of Foggia - Star*Energy Research Group - Foggia, Italy*

PS3a.53 **Nitrogen balance and use efficiency, vegetable crop yields in two out of six years of an open field trial amended with municipal organic fraction compost**
Morra Luigi, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - Scafati, Italy*
Pizzolongo Gaetano, *University of Napoli "Federico II" - Portici, Italy*
Mascolo Massimino, *Consiglio per la Ricerca e la Sperimentazione in Agricoltura - Scafati, Italy*

PS3a.54 **Environmentally sound use of compost water extract**
Orosz Viktória, Makádi Marianna, Tomócsik Attila, *University of Debrecen - Research Institute Of Nyíregyháza - Nyíregyháza, Hungary*
Füleky György, *Szent István University - Gödöll, Hungary*

PS3a.55 **Biochar application in water and soil remediation**
Rao Maria A., Cesarano Gaspare, Scelza Rosalia, *University of Naples "Federico II" - Portici, Italy*
De Pasquale Claudio, Alonzo Giuseppe, Conte Pellegrino, *University of Palermo - Palermo, Italy*

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COMPOST PERFORMANCE DURING SUCCESSFUL TRANSITION TO ORGANIC FARMING

The transition from conventional to organic farming is the most difficult period facing organic growers Compost application together with leguminous crop are basic practices in organic farming Addition of good quality composts may improve the physico-chemical properties of soils, as well as affect positively microbiological and biochemical properties, which can exert a great influence on plant productivity In this study, the effect of the organic soil management on labile soil organic matter, carbohydrates and amino compounds was investigated Soils samples were collected from compost or fertilizer treated-fields during the transition to organic farming (2009-2011) in fields in Foggia and Metaponto, South of Italy At both sites, compost application rate was calculated to meet crop requirement of N and P for wheat and lentil, respectively In Metaponto compost was applied as amendment (13 3 Mg/ha) for both crops Different fractions of organic matter were separated including the light fraction (LF), the particulate organic matter (POM) and the mobile humic acid (MHA) Soil and their relevant fractions were characterized for their carbohydrates and amino compound content Compost-A contributed to higher yield production with both lentil and wheat than did the compost-N or fertilizer in 2010 and 2011 Compost application contributed to significantly greater quantities of LF, POM and MHA than did fertilizer application Compost treatment with both crops contributed to greater MHA masses than the fertilizer treatment but greater MHA masses were found with either compost or fertilizer after the lentil crop than after durum wheat The LF-C accounted for 5 8%

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COMPOSTING TIME OF CHICKEN LITTER WITH BIOCHAR FOR ORGANIC FERTILIZER PRODUCTION

The aim of the work was to determine composting time of chicken litter with different conditioners after six flocks for organic fertilizer production To perform composting, chicken litter without conditioner was used (control sample), 10% phosphogypsum, 10% biochar, urease inhibitor, 10% zeolite and 10% superphosphate in interaction with raising fermentative times which correspond to 0, 10, 20, 40 and 80 days after the beginning of composting The experimental design was in randomized blocks with 4 repetitions Litters were weighed and disposed in windrows arranged in approximately 0 80 m height and 1 7 m width Sampling was performed in 4 points of the windrow to form the whole sample, in which N, P and K analysis were done To achieve the ideal levels of moisture (55%), 40 L of water were added on the composting biomass Each two weeks, turnings in each windrow were performed The inner temperature of the windrows was verified at days 0, 13, 20, 15, 38, 46, 53, 60, 67, 75 and 80 After 20 days composting, nitrogen content stabilizes on phosphogypsum, biochar and zeolite substrates, what represents compost maturity This compound may then be utilized or commercialized as an organic fertilizer On the other substrates as control, urease inhibitor and superphosphate, no effect was significant regarding N stabilization, what allows inferring about the need for equal time or above 20 days to stabilize N forms Biochar application allows more N, P and K content in chicken litter after composting, what leads to higher efficiency in

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SAN-SOIL PROJECT: NEW PEAT-FREE POTTING SOIL IMPROVERS FROM ZERO-MILES OLIVE MILL WASTE RECYCLING

Peat is widely used for potted plant production in nurseries and accounts for a significant portion (30-50%) of the growth media Pistoia district accounts more than 5000 hectares of nursery farms which yearly use about 200000 m3 peat Because of concerns about destruction of peat bogs, other organic materials have been investigated for their potential as substitutes for peat From 2001 EC releases Ecolabel certification to only nursery farms that use peat-free growing media, promoting recycling of organic waste materials Among them, compost shows good properties, especially when obtained from olive mill waste (OMW), whose disposal is of particular concern for potential soil and water-table pollution SAN-SOIL project attempts to bring together the interests of local olive millers with those of nursery farmers, evaluating the production and use of compost from OMW used as peat surrogate in the preparation of growing media for potted plants The experiments have been carried out at farm scale in Pistoia, involving 3 big nurseries and an olive mill in the production of 50 m3 of mature OMW compost tested in the production of 60000 potted plants belonging to 27 different species SAN-SOIL aims at: 1) reduction of peat and fertilizer use in the nursery farms, with consequent saving of money; 2) reduction in the use of pesticides, thanks to the suppressiveness of OMW compost; 3) higher environmental sustainability of both plant nursery and olive industry 4) Ecolabel certification for peatfree nurseries 5) valuable zero-miles recycling of dangerous industrial waste streams, such as OMW

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BIOCHAR IN GROWING MEDIA: ROLE OF PARTICLE SIZE ON LIMING CAPACITY AND PHYSICAL PROPERTIES

Ongoing research projects are concerned on the use of biochar in soilless systems but at now few scientific studies are reported in literature. Biochar can be used to convert the acidity of the peat, to improve the aeration and increase the retention capacity of nutrients, in this context biochar texture can represent an important factor.
The aim of this study is to evaluate the role of particle size on the behavior of a biochar from pine wood when used as a component of growing media. Three particle-sized fractions (B1=10-6 mm; B2= 6-3,3 mm; B3= <3,3 mm) and three volumetric dosages are tested by mixing biochar with a white peat (0, 30% and 40% of biochar). Water availability, air filled porosity and shrinkage are determined together with pH, electrical conductivity and soluble nutrients. The effects of biochar on plant growth are tested by using bioassays with different endpoints: (UNI-EN 16086-2:2012), barley test (ISO 11269-1:2012) lettuce (ISO 11269-2:2012). In order to discriminate between the liming effect of biochar and its effects on the physical properties, a lettuce test is performed on the mixtures previously limed with calcium carbonate to pH 6.5.
The results of this study indicate that biochar acts as a liming material in neutralizing peat acidity inducing at the same time positive effects on plant growth.

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COMPOST CHANGED SOIL ORGANIC MATTER MOLECULAR COMPOSITION: A STUDY BY PY-GC/MS AND PY-FIMS

Changes in the molecular composition of soil organic matter (SOM) resulting from compost application are not sufficiently known at the molecular scale even though this is major issue for soil fertility and soil carbon sequestration. Therefore, the present study investigated effects of long-term compost application in comparison to mineral fertilizer on the molecular composition of SOM in a 34-year-old experiment. Soil samples were taken after 19 and 34 years of constant management and analyzed by Curie point Pyrolysis-Gas Chromatography/Mass Spectrometry (Cp Py-GC/MS) and Pyrolysis-Field Ionization Mass Spectrometry (Py-FIMS). In general, compost application increased the organic carbon (C) content. The Cp Py-GC/MS revealed larger relative intensities of alkylphenols/lignin monomers at the expense of carbohydrates in the compost treatments. Py-FIMS indicated higher proportions of labile n-fatty acids, lipids and sterols in the compost than in the mineral fertilizer treatment. Permanent cropping of grass between years 19 and 34 revealed similar signal patterns, which is also maintained after conversion of soil from permanent grass to arable use. Thermograms of volatilization indicated enrichments of stable (compounds volatilized in between 370 and 570°C) phenols/lignin monomers, lipids and alkylaromatics between years 19 and 34 in compost fertilized soils. This was a result of enhanced losses of compounds that are considered easily metabolized by microorganisms (e.g. carbohydrates) after compost addition as derived from Py-GC/MS and Py-FIMS. In summary, long-term application of mature compost was shown to have a positive, long lasting effect on the organic carbon sequestration in agricultural soils.

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CONFIRMATORY PATH ANALYSIS TO CLARIFY THE EFFECTS OF COMPOST AMENDMENTS ON SOIL CHEMICAL AND BIOLOGICAL PROPERTIES

Compost use is increasingly proposed as a sustainable strategy to restore the fertility of degraded agricultural soils and to reduce landfill disposal of organic wastes. The effects of compost application on a variety of soil physico-chemical and biological properties have been widely investigated, but direct and/or indirect relationships among them are far less known. Here we performed a confirmatory path analysis to infer about the causal processes involving compost amendment, soil organic matter content, nutrient concentrations, microbial activity and soil contamination. Path analysis was performed on a dataset derived from a three-year field trial we carried out in a Mediterranean intensive agricultural system, where three doses of certified municipal solid waste compost were annually applied on different plots. The R programming language was used to build a script to test thirteen hypothetical models, against the observed data. Within the above-mentioned dataset, K and Zn available concentrations, microbial respiration and total polycyclic aromatic hydrocarbon (PAH) concentrations were selected as indicative of soil nutrient availability, microbial activity and organic contamination. Our approach highlights that compost amendment directly and indirectly affects all the other variables considered in this study and is the main determinant of the observed trends. The relationships among organic matter, nutrient availabilities, respiration and PAHs are the second most important determinant, followed by the temporal dynamics of each of these variables. Our model contributes to provide an integrated view of the causal processes induced by repeated compost amendments on agricultural soil properties.

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AGRONOMICALLY-EFFICIENT USE OF ANAEROBICALLY DIGESTED GRAPEMARC DISTILLERY EFFLUENTS AS ORGANIC AMENDMENTS

In this work, the effects of the application of untreated (UG) and anaerobically digested (AG) grapemarc distillery effluents, either added with mycorrhiza (AGM) or not, were investigated on soil humic acid (HA) in field plot experiments, in comparison to HAs isolated from the amendments, the control soil and an inorganic fertilized soil. The HA isolated from UG, AG, AGM and soils were characterized for compositional, structural and functional properties by elemental and functional group analysis and ultraviolet/visible, Fourier transform infrared and fluorescence spectroscopies. Results obtained indicated that anaerobic digestion of effluents produced an extended mineralization of organic C and the stabilization of residual organic C with increasing content of HAs in the final effluent. With respect to control soil HA, HAs isolated from UG, AG and AGM were characterized by smaller acidic functional group contents, a prevalent aliphatic character and smaller aromatic polycondensation and humification degrees. The chemical and spectroscopic characteristics of native soil HA were not substantially modified by application of UG, AG and AGM to soil, which suggests the occurred incorporation of the effluent HA into native soil HA. In conclusion, these results showed the possibility of a beneficial and safe recycling of grapemarc distillery effluents as soil amendment.

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DRIED AND PIROLYZED SWINE EFFLUENTS AS N SOURCE FOR CROPS: INFLUENCE ON ITALIAN RYEGRASS YIELDS IN GREENHOUSE TESTS

Animal effluents are rich in nutrients, and their improper disposal may cause pollution of surface and groundwater In recent years, the implementation of European directives for the control of the environmental impact of agricultural practices has raised costs for the management of animal manure The need to safeguard the farmer’s income by means of cost reduction has substantially boosted research on manure treatments The drying and pyrolysis processes permit a reduction in the volume of animal effluents, and therefore a reduction of storage, transportation and distribution costs Moreover, the final product may constitute a fertilizer of good quality, due to its high content of nitrogen and phosphorus The aim of this work was to evaluate in greenhouse conditions the fertilizing value of thermally-treated animal effluents on the yield of Italian ryegrass (Lolium multiflorum Lam) grown on a loam and on a silty clay soil Above-ground biomass was measured 2 months after seeding, in pots containing 1 L soil treated with dried pig slurry (DS), pyrolyzed swine solids (BCSS), and urea (U), in amounts corresponding to 0, 100 e 200 kg N ha-1 In both soils, biomass production was higher in the U than in the other treatments The lowest biomass production was recorded for the BCSS-treated soils Treatment-related results in the short run suggest a relationship between crop yield and N availability at the time of crop N uptake The application to soil of amendments containing organic N requires an accurate timing of supply, in order to match the

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DOES BIOCHAR APPLICATION INCREASE SOIL FERTILITY AND TOMATO PRODUCTION UNDER ORGANIC FARMING IN MEDITERRANEAN CONDITIONS?

In organic farming, plant production depends almost exclusively on nutrient deriving from the decomposition of exogenous organic matter in soil which is able to provide significant quantities of several important nutrients for the plant growth. However, in the soil the timing and amount of mineralization often does not coincide with crop nutritional need, making in-season fer¬tilization necessary .The Regulation (EC) No 889/2008 on organic farming standards recognizes these needs and allows the use of a limited range fertilizers and soil conditioners (inputs) in order to meet nutritional needs of the plants and to achieve short-term economically viable yield. Short-term open field experiment was conducted at the Mediterranean Agronomic Institute of Bari (MAIB) located in Apulia region (Southern Italy) in order study the effects of different fertilization scenarios based on equilibrated nutritional requirement on tomato (Lycopersicon esculentum Mill, cv. San Marzano) production efficiency and soil chemical properties. In soil dressing phase, three mounts before planting, biochar (BCH), organic fertilizers (OF), combined treatment (BCH+OF) and control (CON) were established. In the pre-crop phase, organic and/or mineral fertilizers were incorporated into the previous treatments except CON and BCH in order to achieve balanced N, P2O5, K2O application rates for tomato plants. Different fertilization scenarios significantly increased the yields over CON and BCH, maintaining fruits quality. Main soil chemical parameters remained invariable.

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DEVELOPMENT OF A BIOCATALYST BASED ON THE IMMOBILIZATION OF CANDIDA RUGOSA LIPASE ON BIOCHAR DERIVED OF OAT HULLS

Biochar, a low-cost material derived from the combustion of organic biomass, constitutes a promising immobilization support for enzymes due to their structural properties. Biochar produced by pyrolysis of oats hulls was characterized physical and chemically and tested as support to immobilize Candida rugosa lipase. The effect of pH (4, 5, 6, 7, 8 and 9), temperature (4, 20, 30°C) and enzyme loading (2,5, 5, 10, 15, 20 mg/mL) on the immobilization process were studied. Batch experiments were done in vials of 4 ml with 100 mg of biochar were put in contact with 2 mL of enzymatic suspension under the conditions above mentioned, a previous kinetic study was realized in order to determine the equilibrium time for the immobilization. The immobilized enzymes were separated by centrifugation and the supernatant assayed for protein content to obtain the amount of immobilized enzyme. The activity of immobilized enzymes was analyzed spectrophotometrically by the hydrolysis pNPP. Protein content was estimated by the Bradford method. The quantity of lipase immobilized was higher at 30 °C. The immobilization was higher at pH values 6,0 and 7,0, and also we observed positive effect of increasing ration Enzyme/biochar over the immobilization. The activity of the immobilized enzyme at the best conditions reached values of specify activity of 2,200 U/mg of immobilized enzyme.

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THE MIXED COMPOSTED AMENDMENT IN THE IMPROVEMENT OF SOIL FERTILITY IN HORTICULTURE IN CENTRAL ITALY: MINERALIZATION POTENTIAL AND PRODUCTIVE RESPONSE

The intensification the high specialization of agriculture in coastal Latium (Central Italy) determined in last decades a strong increase in yields, accompanied however by a drastic reduction of organic matter resulting in a decrease in fertility and exposure to soil-borne diseases. The mixed composted amendment (MCA), produced by the composting plant Kyklos Srl, Aprilia (LT), is an “agricultural oriented” source of organic matter of great interest for its biological value and chemical-physical properties. The purpose of this research was to analyze the mineralization potential of the MCA in order to optimize its use as a fertilizer and evaluate the productive response of different crops including melon, cabbage, and chard. The trials were carried out on a rotation melon-cabbage in Viterbo and chard in mono-crop cultivation (spring and summer crop) in Aprilia. The yield response to increasing doses of MCA, MCA + reduced chemical fertilizer in comparison to the conventional crop was evaluated. Carbon and nitrogen potentially mineralizable increased with the incubation temperature in a controlled environment. The temperature has also influenced the ratio of the forms of mineralized nitrogen (ammonia / nitrate), recording the minimum values of N-NH4/N-NO3 at 30°C and maximum at 10°C. Melon and cabbage amended with MCA (40 t ha-1) were characterised by qualitative and quantitative parameters equivalents to that chemically fertilised. Both spring and summer chard production was significantly higher compared to conventional crop. The MCA under investigation is therefore a highly valuable product capable to support plant nutrition and productivity.

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BIOACCUMULATION IN EARTHWORMS (EISENIA ANDREI) OF POLYCYCLIC AROMATIC HYDROCARBONS (PAH) FROM BIOCHAR

Biochars contain relatively low but variable concentrations of PAH and extensive biochar application could therefore result in bioaccumulation by soil biota In this study, we analyzed PAH bioaccumulation in adult specimens of Eisenia Andrei exposed to two types of biochar: biochar from wine tree cuttings (WB) and a commercial low tar hardwood lump charcoal (CB) Pots containing a moist soil (clay or sandy-loam) received 42g biochar/kg of soil (100 t/ha) Nearly all the earthworms were found alive and in good conditions in controls after 45 days, but only 64 5% survived in the sandy soil and 78 4% in the loam soil treated with biochar The two different types of biochar tested displayed a significantly different toxicity: in fact the average survival rate was 60 9% for CB and 80 3% for WB (97 2 % in controls) The way of biochar placement had no effect on earthworm survival or PAH accumulation PAH accumulation was much larger in the sandy soil than in the clay soil and largest in soils amended with CB In this treatment, the concentration of fluoranthene in earthworms was 125 times larger that of earthworms reared in the corresponding control treatment, crysene was 368 times larger, benzo [?]fluorene 136 and benzo[?]pyrene 119 times No accumulation was found in the clay soil for PAH of large molecular weight Environmental safety of reiterated massive biochar additions should not be given for granted and require further research to assess potential impacts on soil biota and the food chain

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AMMONIA STRIPPING FROM DIGESTATE TO REDUCE THE SOIL N LOAD AND NITRATE LEACHING

Digestates, the final by-product of biogas production, have very good fertilizing properties because of their high content of nutrients (N,P,K) in available forms However, having large concentrations of not only organic N, but also of ammonia-N, their application to soil may be subject to strong limitations, especially in zones declared vulnerable to nitrates In order to optimize the recycling of plant nutrients in the soil, and to fulfil the obligations of the EU Nitrate Directive, two technologies are generally proposed: i) physical separation of solids from the liquid sludge; ii) stripping of ammonia from the liquid fraction Stripping produces digestates low in ammonia-N, whose behaviour in the soil is poorly known The aims of this work were to study the conditions that optimize the stripping of ammonia from digestates and to assess the potential soil mineralization and nitrification of the residual N and its impact on soil microbiological properties Alkalinisation and heating during air insufflation accelerates and increases the efficiency of ammonia-N stripping, removing on average about 2/3 of the ammonia-N A substantial reduction in the soil nitrification rates were observed during laboratory incubations, after addition of stripped digestates, mainly because the residual N left is mostly organic and relatively refractory to mineralization Most of the other soil biological parameters were not affected by addition of stripped as compared to non stripped digestate This technique may therefore conveniently be used to sustain soil nutrients recycling, improve soil physical properties by supplying partially stabilized organic matter and reduce nitrate leaching risk

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RELATING CHEMICAL PROPERTIES OF FOUR BIOCHARS TO ITS BIOCHEMICAL RECALCITRANCE

Biochar may act as a soil conditioner, enhancing plant growth by supplying and, more importantly, retaining nutrients and by providing other services such as improving soil physical and biological properties. The stability of biochar is intrinsic to fulfilling its role as a significant C sink, however newer studies on the biochemical recalcitrance of charcoal produced under oxic conditions indicated that stability of pyrogenic organic materials can be much lower than commonly assumed.
One has further to bear in mind that biochar is often the product of valorization of organic waste, derived from agriculture and forestry, such as liquid fermenter residues, crop residues, or urban wastes including sewage sludge. The variety of feedstocks and production processes are likely to cause a wide diversity in the properties of the final biochar products which may also affect their biochemical recalcitrance in soils. Hence, this study is focused on the assessment of the mobility and stability of C in a typical Mediterranean agricultural soil of four contrasting biochars produced by using different source materials and processes.
Monitoring the potential CO_2 release from the biochars and of the respective amended soils in laboratory incubation experiments using a Respicond apparatus and relating those data to the chemical nature of the samples, will enhance to the understanding of the potential of the product to contribute or to decrease CO_2 emission and thus contribute to C sequestration.

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USE OF COMPOST IN PROJECTS OF COSWAND (CONSERVATION OF SOIL AND WATER IN ANDEAN COUNTRIES)

COSWAND is a short duration course/workshop for local farmers and family members on COnservation of Soil and Water in ANDean countries', as an activity of CAZALAC under the IHP/UUNESCO Flanders Trust Funds organized within the CAZALAC (Centro del Agua para Zona Áridas y Semiáridas en América Latina y el Caribe)
The course is practical oriented with indoor and field demonstrations on soil hydrology, soil water for plant production, erosion control, irrigation systems, and use of compost to improve the physical and chemical fertility of soils. Composts from different sources were used as soil conditioners in school and community gardens of the COSWAND project.
The venue of **COSWAND 2006** was Namza (Ecuador), which is a small farmer's community in the 67 km² watershed in the Chunchi canton located between 1500 and 2600 m asl, in the central Andean zone of Ecuador. Problems of soil and water losses do exist and hence scenarios for soil and water conservation and water use efficiency are proposed. Participants, farmers and their family members and four local school teachers were participating in the course. Demonstration fields on different irrigation systems and on 'how to make organic compost' are laid out on local farms.
The **COSWAND 2008** workshop was organized in Merida, Venezuela, and brought together about 60 local farmers and family members, school youth and school teachers. Besides short introductory courses on soil properties and soil management, some practical demonstrations were organized on the effect of cover on reducing runoff and soil loss. Irrigation systems were visited and construction of infiltration trenches was demonstrated. Attention was paid to the use of compost and organic residues and local schoolboys organized the production and sale of compost for the use in tree and plant nurseries.
The **COSWAND 2012** aimed at bringing together in a local school of Villa Patarani, Altiplano, Bolivia, about 40 local farmers, including members of woman union and local politicians, and family members and some technicians and students, in a two-days' workshop. A number of field and greenhouse experiments were set up to produce local compost in combination with manure and/or fertilizers to be incorporated in low fertile soils for improving yields of quinoa.

Key words: workshop, compost, COSWAND, Venezuela, Ecuador, Bolivia, local farmers, schools, community

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THE ROLE OF COMPOST DISSOLVED ORGANIC MATTER (DOM) ON PYRENE REMOVAL FROM CULTIVATED SOILS

Phytoremediation is an efficient method for the elimination of Polycyclic Aromatic Hydrocarbons from contaminated soils, and since its efficiency is controlled by the organic matter content, the addition of organic amendments such as compost is expected to improve it. A greenhouse pot experiment was conducted to investigate the effect of compost addition on the removal of pyrene from a soil cultivated with Medicago sativa (M.s), or Brassica napus (B.n) or Lolium perenne (L.p). Pyrene concentrations were evaluated after 90 days in contaminated uncultivated amended-soil, cultivated amended-soils, and shoots and roots of the three plant species. Further, the partition coefficients of pyrene to compost dissolved organic matter (KDOM) and the molar absorptivities at 280 nm of DOM isolated from pyrene-spiked uncultivated and cultivated soils, either unamended or amended, were also measured. In cultivated soils compost addition does not appear to have a significant effect on pyrene dissipation with respect to the corresponding unamended ones, likely due to the short term experiment (3 months). On the contrary, in uncultivated soils compost addition enhances significantly pyrene dissipation, possibly by increasing microbial activity and/or promoting pyrene adsorption onto compost DOM. In fact, the high KDOM value (2.08 x 105 l kg-1) and the strong correlation measured between pyrene dissipation and DOM molar absorptivities indicate a high affinity of pyrene for compost DOM. This property appears very important in indicating that compost could be used, besides for its amendment capacity, also as a potential tool in contaminated soils remediation.

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RECYCLING NUTRIENTS FROM BIOGAS DIGESTATES BASED ON LIGNIN-RICH FEEDSTOCK – EFFECTS ON YIELDS AND SOIL CHARACTERISTICS

Different digestates from biogas production based on lignin-rich original material were used as fertilizers in pot experiments with three different soil types (loam, silt and sand) and Italian ryegrass. The digestates used were based on Salix, birch or bagasse as feedstock, mainly co-digestated with manure. Depending on the ammonium concentration in the digestate, amounts added were either equivalent to N supplied by mineral fertiliser or given at a dose of approximately 6 t ha-1, i.e. lower amounts of plant-available N than the mineral fertiliser. The ryegrass was cut three times over a period of 15 weeks. After the final harvest, soil was sampled for chemical and physical analysis.
Yields in treatments where digestates were supplied based on the same amount of available N as the mineral control generally exceeded that in the control in all soil types, at least in the first cut. When digestates where added at a dose equivalent to 6 t ha-1, yields were strongly dependent on the soil type with similar yields compared to the control in the loam and sand, and lower yields in the silt. Digestate treatments contributed to keeping the soil pH at a favourable level compared to the control. Soil physical analysis suggested that despite relatively low amounts of organic matter added with digestates, water retention properties were positively altered in the sand and to some extent also in the silt.

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UTILIZATION OF ANAEROBIC DIGESTATE FROM BIOGAS PRODUCTION AS CROP NUTRIENT SOURCE AND FOR IMPROVING SOIL QUALITY

Anaerobic digestate residues from biogas production contain mineral nutrients and organic fractions that could be returned to soil as plant fertilizer and/or organic amendment.
This study aims to explore the potential use of residues from methanisation process as nutrient source in agriculture and their impact on soil quality. The residual fractions utilized derived from anaerobic digestion of maize, triticale and sorghum silages and cattle slurry come from farms producing milk for parmesan cheese production. Digested residues were applied in a maize-triticale field on a silty-clay loam soil in the southern Po Valley (Italy). Changes in soil quality after digestate application were studied with a “holistic” approach, involving microbiological, physical and chemical aspects of soil fertility. In particular, abundance and diversity of microbial soil community, total, soluble and protected soil organic matter, CEC, main macro and micro nutrients, bulk density and aggregate stability were determined.
Soil organic C, total N and aggregate stability increased in soils treated with digestate addition. CEC did not show significant differences while, some variations occurred in the exchangeable cation pool. Molecular analysis suggested that the application of digested residues to soil contributes to substantial modifications of both bacterial and fungal community structure. No significant differences among treatments were registered in the above ground maize biomass.
The soil application of digestate can represent a valuable resource for obtaining short- and long-term benefits, in terms of increased crop production and soil amelioration.

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INFLUENCE OF MUNICIPAL SOLID WASTE COMPOST ON THE PHYTOREMEDIATION OF CHROMIUM IN SOIL POLLUTED WITH MULTIPLE HEAVY METALS

A greenhouse experiment was performed using Brassica napus as accumulator plant on a soil amended with of municipal solid waste compost and/or a bacterial strain (Bacillus licheniformis BLMB1). Treatments were: soil (T1), soil + compost 10% (T2), soil + B. licheniformis BLMB1 10% (T3), and soil + Compost 10% + B. licheniformis BLMB1 10% (T4). A significant ($P<0.001$) negative correlation (-0.806***) was found between the values of Cr3+ oxidation test and the organic carbon (OC) in the treatments. These results indicated that in soil with higher OC contents Cr3+ oxidation to Cr6+, which is environmentally more dangerous than Cr3+, is limited. Statistical analysis of B. napus vegetative parameters showed a significantly high correlation between soil OC content and plant height (0.904***), leaf area (0.902***), and dry weight (0.955***). Therefore, treatments T2 and T4 characterized by high OC inputs improved plant biomass due to the direct and indirect benefits of organic OC on soil and plant. Our data also indicated that supplying soil with OC and the microorganisms Bacillus licheniformis BLMB1 enhance the extraction and accumulation of some heavy metals in B. napus. This effect was more evident for Cu and Pb. Highly significantly correlations were found between soil OC and metal content in B. napus shoots (0.660**, and 0.658*, for Cu and Pb, respectively).

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PRODUCTION AND APPLICATION OF OLIVE POMACE COMPOST ON CROPPING SYSTEMS: THE CASE OF STUDY OF

Olive mill wastes are produced in large amounts in the Mediterranean area and their incorrect disposal may have a great impact on environments. One of the possibilities to recycle olive wastes is the composting and, in this framework, a research project (CONSSABIO - Compost for Soil Conservation and Sustainable Production in Organic Farming) was carried out with the following objectives: i) innovative system for preparation new composts with olive pomace waste as prevalent matrix; ii) management soil fertility to obtain sustainable yield in organic farming systems treated with olive pomace compost (OPC); iii) use of OPC as part of "proto-horizons", suitable for the reconstitution of degraded soils. The project activities were divided into 7 Work packages.
The experimental results showed that it is possible to assess a new technology for composting olive pomace, which allows to produce quality composts for organic farming systems. Furthermore, the findings of the project specified agronomical practices able to a suitable use of compost on four crops in rotation (chickpea-emmer, processing spinach-lettuce) and identified models for the management of soils treated with composted olive pomace wastes. The results indicate the possibility to recycle olive pomace, especially on graminaceous crop rather than on horticultural ones, since good responses were found modify the amounts, time of distribution and type of compost. Finally, the potential of OPC composted as organo-mineral components ("proto-horizons") to reduce soil degradation and a general system of "efficient recovery" of olive mills by-products were also estimated.

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PHYLOGENETIC AND FUNCTIONAL CHANGES IN THE MICROBIAL COMMUNITY OF A SEMIARID RESTORED SOIL AFTER 25 YEARS

In semiarid climates, soils are often found in pre-desertic states which constrains vegetation and organic matter inputs and ecosystem functionality. These limitations negatively influence soil microbial communities which are important drivers of biogeochemical processes and strongly influence soil quality. In order to assess the long-term impacts of soil restoration on the phylogenetic structure and metabolic functionality of soil microbial communities, a degraded soil located in a semiarid field-site in southeast Spain was amended with two different doses of organic domestic waste 25 years ago. The single low dose and high dose consisted of a 65 Mg ha-1 and 195 Mg ha-1 application, respectively. Control soils without amendment were also evaluated in the current study. Organic amendments increased soil quality due to the increase of vegetation and soil organic matter content. Pyrosequencing of 16S- and 18S-rDNA did not reveal significant differences in phylogenetic diversity between soils after long-term restoration, however principal coordinate analysis of unweighted Unifrac distances showed variation in the structure of bacterial and fungal communities with organic treatment. The numbers of Alpha-proteobacteria sequences were higher in high dose plots than in low dose and control plots, while Actinobacteria abundance diminished in the soil amended with high dose. For fungi, the number of Ascomycota sequences increased with the amount of organic supplement in the past, while Basidiomicota responded negatively to implemented restoration. Overall, long-term restoration of a degraded soil under semiarid conditions did not increase microbial diversity but heavily influenced microbial community structure and functionality.

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PROMOTING PESTICIDE EFFICACY IN SATURATED SYSTEMS BY INCLUSION ON BIOCHARS

Sorption of two pesticides (bentazone and tricyclazole) on different biochars was studied in order to improve their behavior in soil, enhancing agronomic effects and minimizing environmental risks. The specific surface area (SSA), determined by nitrogen surface sorption, and the microstructure and morphology of biochars, explored by scanning electron microscopy (SEM), were used for the characterization of an organic compost from olive oil production (CA) and 9 biochars (B1-B9) obtained by pyrolysis at different temperatures and from different organic residues. In order to evaluate the effect of dissolved organic matter (DOM) from these compost and biochars on pesticide behavior, the DOM from the amendments was extracted, quantified and characterized by fluorescence (FL) and Fourier transform infrared spectroscopy (FT-IR). The results showed that biochars had high adsorption affinity for pesticides. The affinity was mainly related to the molecular structure of the pesticide and controlled by the nature of the DOM from the amendments and their microstructure (morphology and SSA).

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CONTRIBUTION OF COMPOST IN THE ABATEMENT OF PHYTOTOXICITY OF A MUNICIPAL LANDFILL LEACHATE

The percolation of water through wastes disposed in landfill produces a leachate (LL) usually containing numerous inorganic and organic contaminants which represent a drawback for its sustainable use Several biosorption and biodecontamination processes have been recently proposed for the detoxification of liquid and solid matrices, such as LL, in order to transform them from dangerous wastes to useful resources This work evaluated the possible utilization of LL in agriculture after a novel biosorption and biodecontamination process The phytotoxicity of a diluted (1:10, v/v with water) LL, artificially contaminated with dimethoate, linuron, bisphenol A, 17?-ethynilestradiol and 4-nonylphenol, was compared to that of the same contaminated LL subjected to two decontamination treatments, biosorption (BIOSOR) alone or combined with biodegradation (BIOSOR+BIODEGR) BIOSOR was performed using PDA added or not added with a coffee compost BIOSOR+BIODEGR was performed with the same substrates surmounted by each of two white rot fungi, Pleurotus ostreatus and Stereum hirsutum Phytotoxicity of LL was assessed on lettuce and ryegrass germination With respect to the control (distilled water), lettuce germination was greatly inhibited by untreated LL, moderately inhibited after BIOSOR, and scarcely affected after BIOSOR+BIODEGR with both fungi With respect to the control, ryegrass germination was markedly reduced by untreated LL (reduction of all biometric parameters), whereas it was scarcely influenced or enhanced after BIOSOR or BIOSOR+BIODEGR treatments with both fungi (slight decrease of germination percentage and increase of fresh weight) In all cases, the presence of compost in PDA significantly increased the germination performance, with respect to PDA alone

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PRODUCTION OF A CONTROLLED-RELEASE NITROGEN FERTILIZER USING BIOCHAR PRODUCED FROM AGRO-FORESTRY WASTES

Nitrogen fertilization is a key issue in crop production. However, nitrogen fertilization has been singled out for its adverse effects on the environment. Controlled-release fertilizers (CRFs) play an important role by improving nitrogen uptake efficiency, thus mitigating environmental pollution caused by nitrogen leaching and volatilization. The purpose of this study was to develop a novel nitrogen CRF using biochar as support material.
Biochar was obtained by pyrolysis of oat hulls at 300 and 500°C (BO300 and BO500, respectively). Kinetic studies of nitrogen impregnation onto biochar were carried out in a batch reactor at 100 ± 5 °C. A factorial design with three experimental blocks and three levels of temperature and particle size was applied at different biochar: nitrogen: deionized water ratios to determine the best impregnation conditions. Subsequently, the impregnated biochar was encapsulated by using sodium alginate, acetate cellulose (AC) and ethyl cellulose (EC).
The results showed that the maximum impregnation time was 10 min for both biochars, reaching maximum nitrogen loads in the range of 290.5 to 294.5 mg N/g biochar. The most important factor in nitrogen impregnation was the temperature, whereas the interaction between these factors was not relevant. To ensure low nitrogen losses during impregnation, a best reactants ratio of 1:0.5:5 was established, using biochar with a size of less than 500 µm.
The encapsulated CRF produced by dropping a sodium alginate/biochar mixture into a calcium chloride solution showed a more regular spherical form, unlike the case of AC and EC.

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EVALUATION OF DIFFERENT POLYMERS AS COATING AGENT ON THE LEACHING POTENTIAL OF A NITROGEN CONTROLLED RELEASE FERTILIZER DEVELOPED USING BIOCHAR AS SUPPORT MATERIAL

One way to improve nitrogen uptake yield simultaneously reducing the environmental hazards is by using controlled-release fertilizers (CRFs). In this sense, biochar constitutes a promising support material for the formulation of CRF due to its physicochemical properties. In this study we evaluated the effect of different polymeric materials as coating agents on the leaching from N-CRF based on biochar.
Biochar was produced from oat hull pyrolyzed at 300°C. The N impregnation process was performed in a batch reactor at 100 ± 5 °C. The resulting product was encapsulated by using sodium alginate (SA), acetate cellulose (AC) and ethyl cellulose (EC) in different concentrations and ratios.
The leaching potential was studied in disturbed soil column experiments. The experiment was arranged in a completely randomized design with 10 fertilizer treatments × with crop × without crop×3 replications×10 events of water addition.
Leachates were collected at 15, 22, 29, 36, 43, 50, 57, 64, 71 and 78 days after establishment of AC Barrie wheat. Nitrate, nitrite, ammonia and urea were measured in the samples. After 90 days, plants were removed from the columns and separated into grain, roots and shoots in order to evaluate the productivity.
We observed less NO3-N content in leachates obtained from soil columns where the CRFs were applied compared with soil treated with urea and with the formulation (biochar-nitrogen) without polymer. However, the crop yield was negatively affected by the CRFs compared with the traditional fertilization (urea).

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PHOSPHORUS FROM ANAEROBIC DIGESTATE: DYNAMICS IN SOIL AND PLANT AVAILABILITY

In this work the digestate from an anaerobic solid state fermentation (SD) and its composted homologue (CSD) were compared to assess the course of potentially available phosphorus A soil incubation was carried out in vessel (20 mg P kg-1 soil, 25 °C, 84 days), together with a municipal waste compost (MWC) and a mineral P source as reference (Ca(H2PO4)2?H2O) Besides, a pot trial with Italian ryegrass (Lolium italiculm) was made in a growth chamber on the same soil-products combination to asses plants phosphorus availability (13-23 °C, 140 Days) The mineral source showed the highest Olsen-P throughout the soil incubation topping at 51 mg kg-1 after one week At the same sampling time, SD and CSD attained to 26 mg kg-1 (close to the control, 25 mg kg-1), only MWC had some increase (30 mg kg-1) Afterwards Olsen-P decreased in all samples to reach small final net values: -0 6, 2 2, 2 3, and 4 5 mg kg-1 in SD, CSD, MWC and Mineral, respectively Compared to mineral, SD showed constantly decreasing efficiency down to -14%, CSD after a decreasing phase recovered at the level of MWC (50%) which had conversely a constant increase Ryegrass P uptake course was similar to the soil incubation outcome: the final net uptake was -0 6, 1 0, 1 1 and 2 4 mg pot-1 in SD, CSD, MWC and Mineral, respectively The efficiency compared to mineral was -27, 40 and 46% in SD, CSD and MWC, respectively Data showed that composting increased the

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POT EXPERIMENTS WITH ANAEROBIC DIGESTATE (SUMMARY)

Farming methods and food industries generate large amounts manure and other useful raw materials that need safe disposal. Digestion of organic waste materials and subsequent application of digestate to the soil contribute to the recycling of nutrients. However this issue presents a number of new questions, including the effect of these residues in plant–soil system. So far we have only limited information about it's agricultural applications. Farmers and authorities are very skeptic in Hungary because feedstocks are very different so the endproduct will be different, too. However, this endproduct can be applied as fertilizer. Our studies were conducted to determine the effect of anaerobic digestate on soil physical and chemical properties and plant grow in a sort vegetation period. This project established in 2010 and we applied different amount of digestate in pot experiment ever since. Rye grass was planted in pots filled with different proportions of anaerobic digestate mixed with 200g soil. Emergence was used as an indication of germination. Dry leaf mass was used to measure yield. In these pot experiments the germination ratio were lower in anaerobic digestate mixtures, indicating that it could be negative effect. Digestate contains high amount of nitrogen which is present mainly ammonium form and this form can cause root depression and lower germination rates.

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CHANGES IN THE CONTENT OF SOIL HUMUS IMMOBILIZED ENZYMES 5 YEAR AFTER ORGANIC FERTILIZATION UNDER FIELD SEMIARID CONDITIONS

Immobilized enzymes play a key role in soil functionality and fertility Five years after the amendment of a degraded semiarid soil with fresh and composted urban wastes at high rates (1%, d1, and 3%, d2, of organic carbon), the total and immobilized activity of different enzymes (?-glucosidase, phosphatase, urease, polyphenol-oxidase and glycine amino-peptidase) were determined in unamended and amended soils Experimental plots (30 m2) had been set up in a degraded area, SE Spain, under semiarid climate Treated soils showed higher humic substance (HS) content than control soil, as well as higher total and HS-immobilized ?-glucosidase, phosphatase, urease, polyphenol-oxidase and glycine amino-peptidase For both, ?-glucosidase and glycine amino-peptidase the highest values of humus-enzyme activity were observed in the soils treated with compost at d2 whereas for the immobilized polyphenol oxidase the highest activity was detected in the soil treated with compost at d1 As regard immobilized urease and phosphatase activity little differences were observed between the two types of amendment (fresh or composted), soils treated at d1 showing higher amount of immobilized enzyme than those treated at d2, particularly in the case of urease All the treatments showed, in general, lower specific enzyme activity (activity per unit of organic C) than control suggesting that the new HS formed differed from that of the soil, the latter being more structured and with higher capacity for linking with soil enzymes In any case the increased amount of humus immobilized enzymes in the soil will have an important ecological effect in soil quality

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AGRONOMIC VALORIZATION OF DIGESTATES FROM THE METHANOGENIC DIGESTION OF RESIDUES FROM THE PRETREATMENT OF DOMESTIC USED VEGETAL OILS FOR OBTAINING BIODIESEL

This work was aimed to the evaluation of the effect on plant and soil quality of the digestates obtained from the anaerobic digestion of a mixture of residues proceeding from the pre-treatment and refining of used vegetal oil for obtaining biodiesel Three soils differing in their texture were treated with the digestate at rates of 40, 80 and 120 m3/ha Then, 20 seeds of barley or 1 g of ryegrass were placed in each pot containing the soil and pots were moistened and placed in a growth chamber with controlled conditions of temperature, light and humidity for one month After one month, vegetal biomass was harvested, and fresh and dry biomass weight was determined Vegetal material was analyzed for nutrient content, and parameters reflecting soil nutritional status and microbiological quality (microbial biomass C, adenosine-tri-phosphate content and soil respiration) were determined in soils The digestate contained variable amounts of macro and micronutrients, the most abundant nutrients being N (mainly as ammonium) and K, which confer them a certain fertilizer character It also contains other macro (P, K, Ca) and micro-nutrients but in a lower proportion The digestate showed a stimulant effect on plant growth, barley and ryegrass yield being higher in treated soils than in the control soil The highest plant yields were obtained at high rates (80 and 120m3/ha) in the three soils employed Digestate tended to increase soil microbial growth and activity, particularly when applied at high dose Work supported by the EU within the VALUVOIL project (LIFE+09 ENV/ES/000451)

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THE MICROBIAL USE OF FERMENTATION IN AGRICULTURE

Microorganisms are the main driving organisms in fermentation and the use of fermentation products in agricultural systems These products can be used as fertilizers but care has to be put on the amounts and quality The fermentation enriches plant material in micro- and macronutrients by degassing of CO2 and CH4 during the process Thus, high contents of residues of carbon depleted material enter the soil system not only in new physical and chemical properties but also in biology and for the soil microbial processes Although much is known on changes in macro-nutrients, only limited knowledge is available of low-molecular weight dissolved organic and inorganic matter The follow-up processes after an output of such material with high amounts of N and P will lead to changes in the microbial community and its activity We follow changes in total microbial activity in field and laboratory experiments by micro-calorimetry, total CO2-evolution and the state of the bacterial community via microscopic analyses These data will be linked to general soil properties, pH, water content, pore size and others obtained by rheology and further details of a possible change in soil structure First results of mono-fermented corn and mono-fermented wheat applied on disturbed soil samples show a tendency that the soil microorganisms are being influenced by the application and the applied amount of the digestates Analyses via epifluorescence microscopy and measurement of total CO2-evolution show an increasing number of soil bacteria and their activity in the treated samples Only the samples treated with the maximum

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COMPOST AMENDMENTS VS MINERAL FERTILIZATION UNDER GREENHOUSE: EFFECTS ON SOIL BIOLOGICAL QUALITY AND ON PRODUCTIVITY AND NUTRIENT CONTENTS OF DIFFERENT CULTIVARS OF LETTUCE AND ENDIVE

A three-year fertilization trial was carried out in Campania region (southern Italy) in a tunnel greenhouse of 800 m2, half amended annually with 15 t ha-1 (d.m.) of a certified quality compost derived from the organic fraction of municipal solid wastes (COMP) and half treated with conventional mineral fertilizers (MIN). Different cultivars (six in 2010 and four in 2011) of lettuce and seven cultivars of endive in 2012 were transplanted. At the end of the crop cycles, soil microbial biomass and respiration and three soil enzymatic activities, i.e. acid and alkaline phosphatases and FDA hydrolysis, were measured. Fresh weight of lettuce and endive heads and nutrient (Ca, K, Mg, Na) concentrations in the edible leaves were also determined.
After the first compost amendment, only FDA hydrolysis activity was significantly higher in COMP than in MIN. The weight of lettuce heads was only slightly lower (from 3.6 to 8.8 %, depending on the cultivar) in COMP than in MIN. The two successive compost applications progressively improved soil quality showing the ability of compost to sustain the crop productivity, although to a different extent for different cultivars. Regarding leaf nutrient concentrations, the analysed plants generally showed no significant differences among cultivars and between treatments.
Soil compost amendments do not determine main differences in crop yield and quality in respect to soil mineral fertilization, but improve soil biological quality.

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EFFECTS OF DIGESTATE APPLICATIONS ON GERMINATION AND BIOMASS YIELD OF MAIZE (ZEA MAYS) IN DIFFERENT SOILS

In order to evaluate the effects of digestate on the germination rate and primary biomass production of maize in different substrates, a pot experiment in the greenhouse was conducted We tested the factors digestate addition, mineral nitrogen-phosphorous-potassium (NPK) fertilizer addition and soil type each with three levels Digestate or NPK fertilizer (used as a positive control) were applied at three different application amounts to three different soil-types (loamy field soil, sandy field soil, sand; n=7) The quantity of the applied NPK fertilizer was calculated in accordance with the N:P:K content (1:0,5:1,5) in the digestate, corresponding to 80t/ha (high), 40t/ha (medium), 20t/ha (low) agricultural digestate application Soils without any treatment were considered as negative controls for comparison The germination rate was monitored daily and the aboveground biomass yield of plants was measured We found a higher and accelerated germination rate in the loamy field soil with digestate treatment in comparison to the negative control, and this positively correlated with the applied digestate amount This effect was observed in the sandy soil only at the lowest digestate treatment There was a low germination rate in the sand digestate treatment probably due to increased water repellency of the sand, reducing the infiltration and therefore water availability to the seeds Even though NPK treatment (positive control) produced the highest biomass in all cases, digestate application resulted in higher biomass yields in sandy soil and sand compared to the negative control, suggesting that digestate application may be useful for increasing fertility in low fertile soils

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COMPOSTING OF BIOCHARS: IMPROVEMENT OF SORPTION PROPERTIES AND NUTRIENT RETENTION

Biochar application to soils has been suggested to elevate nutrient sorption and improve soil fertility The impact of composting biochar together with a biologically active substrate (i e , livestock manure-straw mixture) was investigated We hypothesized that composting would alter the biochar's surface chemistry, and sorb nutrients from the compost We studied the sorption of copper (Cu(II)) on two wood-derived biochars (charcoal; gasification coke) in order to relate sorption to char properties before and after a composting period of 84 days Furthermore, we quantified changes in nutrient contents of the biochars after 175 days of composting Composting increased the biochar´s sorption potential as well as its affinity for Cu(II) Differences in the strength of sorption were observed between the two biochars: Cu+2 sorption to gasification coke was largely irreversible, whereas sorption to charcoal showed higher reversibility During composting the biochars sorbed significant amounts of organic matter and nutrients We also observed elevated amounts of soluble nitrogen (inorganic and organic), soluble organic carbon, plant available phosphorus and plant available potassium for both types of biochar following composting Composted biochar can be utilized as a remediation tool to reduce toxic Cu(II) concentrations in contaminated soils The strength of Cu(II) sorption will depend on the particular biochar's properties Furthermore, using biochar as a bulking agent for composting could reduce the leaching of organic matter and nutrients, as these components are sorbed to the biochar in a plant available form Composting of biochar could therefore improve its properties as a soil fertilizer and conditioner

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ROOT GROWTH AND YIELD OF SPRING WHEAT INFLUENCED BY DIFFERENT BIOCHARS

Over the last few years the use of biochar in agriculture has been investigated for its potential benefits regarding water holding capacity of the soil, nutrient retention, and crop yield. However, it is currently unclear how different types of biochars will influence these parameters under varied growing conditions.
To quantify the influence of Pyreg-biochar and the addition of digestate and/or nitrogen fertilizer on the yield of different crops we conducted two 3-factorial pot experiments. The three factors biochar, digestate and nitrogen fertilizer were included with two levels (“with” and “without”) and 6 replications. In the first pot experiment three crops were planted in sequence: white mustard – oat – corn. In the second experiment the sequence was oat – white mustard – corn. While significant differences between the treatments were observed in both experiments, treatments with Pyreg-biochar showed no yield increase over treatments without biochar.
To investigate the effects of different types of biochar on root growth of spring wheat rhizoboxes with the four treatments “without biochar”, “Pyreg”, “Pyro” and “HTC” were set up using 3 replicates per treatment. In a first rhizobox screening in 2012 we observed that the root growth in the biochar treatments (Pyreg, HTC) was different from the treatment without biochar. The dry mass of the root system in the biochar treatments was higher than in the treatment without biochar.

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INFLUENCE OF DIGESTATE PRODUCTS FROM ANAEROBIC ORGANIC WASTE TREATMENT PROCESSES AND THEIR EFFECTS ON SOIL PHYSICAL PROPERTIES AND PLANT DEVELOPMENT

In 2012, on 2.125 million ha energy plants were cultivated in Germany to substitute fossil fuels. The biomass is mainly used for anaerobic fermentation. This practice results in problems such as reduction of soil organic matter contents, structure degradation and following consequences, e.g. erosion. An alternative to the anaerobic fermentation of fresh or ensilaged plant biomass is the utilization of organic waste. Within a joint research project the fermentation of organic waste is investigated, including the characterization of the fermentation substrates and the fermentation residues. The fermentation residues are conditioned and agglomerated to improve their fertilizer effects and to increase their storage stability and transportability. The effect of these pellets on soil physical properties and plant development are investigated in pot experiments and on the field scale.
Organic waste includes the disadvantage of an inhomogenous quality, influenced by season and locality. Pot experiments offer the possibility to investigate larger numbers of different digestate products while field experiments over three vegetation periods allow studying long-term effects of selected digestate products. In our subproject we focus on soil physical properties influenced by application of digestate products on the field scale and within pot experiments under greenhouse conditions.
We show the experimental set-up and methods of our investigations and present first results of our ongoing study.

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ORGANIC CARBON CONTENT AND CHEMICAL ATTRIBUTES OF A CAMBISOL AFTER BIOCHAR APPLICATION

Biochar has been proposed as a soil conditioner once its application can improve soil properties such as aggregation, carbon content, water retention capacity and soil fertility. The aim of this study was to evaluate the effect of biochar on carbon content and soil fertility. The experiment was established in February 2010 at the Centro-Oeste State University, Brazil. The biochar, composed by fine residues of burned trees, was applied to an Haplic Cambisol in four doses: T1 - 0 t ha-1, T2 - 10 t ha-1, T3 - 20 t ha-1 and T4 - 40 t ha-1. Biochar was applied once on the soil surface and subsequently it was incorporated until 10 cm depth. Soil samples were collected in September 2011 in four depths: 0 - 5, 5 - 10, 10 - 20 and 20 - 30 cm. The soil carbon content, pH, P, K, Al, Ca, Mg, potential acidity (H + Al), base saturation (V%) and exchange capacity cation (CTC) were determined. The data were analyzed using SAS software (Tukey 10%). The main effect of biochar application was observed in the superficial layer (0 - 5 cm) possibly due its higher concentration in this layer, despite its incorporation until 10 cm. The higher dose (40 t ha-1) increased soil pH and P, K, Ca and C contents. The biochar composition and its reactive characteristic, which can adsorb cations, may have contributed to the observed results.

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MANY-SIDED REASONS FOR RECYCLING ORGANIC-BASED WASTES IN AGRICULTURE

The closure of organic carbon (C) and nutrients cycles in soils is a crucial process for sustainability of terrestrial ecosystems Agronomical and environmental strategies leading to the unclosure of chemical and biological cycles contrast with fondaments of systems-sustainability, as large amounts of CO2 are released into the atmosphere and less quantities of humic substances are formed; in addition, nutrients are not recycled and made available to plant uptake and microbial activity In the so called “developed countries” millions of tons of organic-based wastes are yearly produced (i e , municipal solid wastes, sewage sludge of municipal and agroindustrial origin) Organic-based wastes also contains hundred thousand tons of nutrients (mainly N, P, K): totally renewable resources The strategy to dispose organic-based wastes in landfills is failed and today opposed by EU The apparently “new strategy” of burning wastes, including those of high agronomical quality, in order to recover part of the energy could be ecologically and economically erroneous This option releases high amount of greenhouse gases - GHG (e g , CO2, NOx, SOx) and produce ashes reach in metals that in turn must be disposed in landfill because not available to plants At the same time fossil fuels (oil, methane, carbon) are used to produce new nitrogen and phosphate fertilisers In Mediterranean regions in particular soils require organic C to maintain soil fertility and to counteract the desertification processes that are increasing Water and nutrient efficiency in cultivated soils can be increased only in soils amended with organic matter.

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EFFECT OF BIOCHAR ON THE WATER RETENTION OF A SILTY-LOAM SOIL

This work was financially supported by the national programme PON art 13 and is promoted in the frame of the European 7FP “STAR*AgroEnergy” project Biochar can enhance soil water-holding capacity and water availabillity for the crops Amended soils with biochar could reduce the amount of irrigation water needed to plant growth This is particularly advantegeous in irrigated agriculture where water resource for agriculture are rather scarce Biochar can thus play a significant role in water management aiming at reduce agricultural inputs The study was aimed to evaluate biochar effect on soil water retention curve parameters Four rates of biochar application, 0% (control), 2%, 4% and 8% (w/w) where tested in a randomized experimental design with three replicates Biochar was mixed with a silty-loam soil and arranged in cylindrical containers (h=1 20 m; Ø=0 60 m) A tension disc infiltrometer was used to achieve the cumulative soil water infiltration at two pressure head (-15 and -5 cm) and to modelling the soil water retention curve Biochar didn’t affect moisture content at - 0 33 bars (field capacity), but significantly increased soil water content in the range from - 2 5 to - 15 bars water potentials for the 4% treatment and from - 3 5 bars to - 15 bar for the 2% and 8% treatments as compared with control The ability of biochar to increase soil moisture retention capacity at higher soil water potential (i e close to the wilting point) can assure crops growth even though limiting growing conditions

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ENHANCEMENT OF SWITCHGRASS (PANICUM VIRGATUM L.) GROWTH BY COMPOST APPLICATION

Switchgrass (Panicum virgatum L.) is a perennial bunchgrass native of North America originally used for soil conservation and forage production, and recently successfully employed as an energy crop and for biofuel production. The use of compost as soil amendment is justified by the increasing interest in waste recycling, the well-known benefits of this material on soil properties, and the plant protective action towards pathogens and xenobiotics. In this study, compost-based media were prepared by mixing peat (P) with each of three different composts, a green compost (GC), a mixed compost (MC) and a coffee compost (CC), at percentages of 5%, 10% and 20% (v/v). The effects of each mixture were evaluated on biometric parameters of four switchgrass populations, the octaploids Shelter, Shawnee and Dacotah, and the tetraploid Alamo. The results of the experiments, conducted in a climatic chamber under controlled conditions, showed positive effects exerted by all the mixtures on root, shoot and primary leaf lengths, and on the fresh weight of the different switchgrass populations, with respect to the use of peat only (control). In particular, GC/P and MC/P mixtures exerted the best stimulatory effects at 5% and 10% of compost, whereas CC/P mixtures produced the best results at 10% and 20% of compost. The effects of the three composts were more evident for the Shawnee population and less pronounced for the Shelter population, thus indicating the occurrence of a relationship between plant citotype and the response to the dose and origin of the compost applied.

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EFFECTS OF COMPOST ADDITION ON COMBINED SORPTION/BIOREMOVAL OF ENDOCRINE DISRUPTORS FROM A MUNICIPAL LANDFILL LEACHATE

Adsorption and biodegradation are the main mechanisms involved in the removal of organic contaminants from both solid and liquid matrices. Among sorbent materials, compost is known to significantly interact with organic and inorganic pollutants present in natural and anthropogenic matrices. Recent investigations have demonstrated that some white-rot fungi possess the capability of biodegrading phenolic endocrine disruptors (EDs) by means of their ligninolytic enzymes with low substrate specificity. This study assessed the simultaneous removal of five EDs, the xenoestrogens bisphenol A (BPA), ethynilestradiol (EE2) and 4-n-nonylphenol (NP), the herbicide linuron and the insecticide dimethoate, from a diluted (1:10 v/v with water) municipal landfill leachate (MLL) using a combined sorption/bioremoval approach. A coffee compost was added or not added (control) to potato dextrose agar (PDA) at the rate of 10% (w/w). Both substrates were inoculated or not inoculated (adsorption only) separately with the fungi Stereum hirsutum and Trametes versicolor and overlaid to the leachate by keeping the mycelium separated from the contaminated MLL. The residual amount of each ED in the MLL was monitored for 20 days by HPLC analysis and UV detection. A prompt relevant disappearance of any ED occurred in the MLL without and, especially, with fungi, which was almost complete for some EDs after 20 days. The presence of compost in PDA favoured the removal of EE2 and NP (highest Kow) in the absence of fungi (adsorption), and promoted the biodegradation of BPA, EE2 and linuron by S. hirsutum and biodegradation of EE2 and dimethoate by T. versicolor.

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SOIL ORGANIC MATTER AND LEVELS OF CU AND ZN IN A SOIL WITH COMPOST OF SWINE MANURE APPLICATIONS

Successive applications of swine manure to soil under no-tillage can alter the dynamics of soil organic matter and nutrients, especially in the uppermost soil layers The objective was to evaluate the distribution of levels of soil organic matter, Cu and Zn in the profile of a soil after six pig slurry applications under no-tillage for 71 months The experiment was conducted from September 2005 to August 2011 in an experimental area of the EPAGRI/Chapecó, southern Brazil, on a Hapludox The treatments consisted of compost with shavings and swine manure, in rates of 0, 8 and 16 t ha-1, and mineral fertilization (130-80-80 kg ha-1 of NPK) The treatments were applied before the Maize culture, in the following crop sequence: maize/ black beans/black oats all the years At the end of the experiment, soil samples were collected in layers of 0-4, 4-8, 8-12, 12-16 and 16-20 cm The levels of soil organic matter, available Cu and Zn and total Cu and Zn were evaluated The application of compost increased the soil organic matter, available Cu and Zn, being that the increase could reach the depth of 8 cm The levels of total Cu and Zn increased until the depth of 12 cm The proportion of available Cu/total Cu and available Zn/total Zn increased, especially, in the uppermost soil layers This results indicate that the surface applications of compost increases the availability of these metals in the soil and consequently the possibility of being transferred to aquatic environments, causing environmental contamination

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COMPOST AND PLANTS FOR SOIL RESTORATION: BIOREM EUROPEAN PROJECT

The BIOREM project (LIFE11/ENV/IT/000113) will demonstrate an innovative integrated methodology for the restoration and the biochemical monitoring of degraded soils.
Exogenous organic matter addition (commercial green compost) will be integrated with plants, with the purpose of recovering in faster and more effectively way degraded soils.
Between 20-25 kg/m2 of organic material will be added to the soil on the basis of its initial characteristics and Pino halepensis and Pistacia lentiscus will be alternately planted. In addition, due to the application of exogenous organic material, a spontaneously plant cover will be expected to develop on the soil in a short time.
Ten sites (about 360 m2 each) will be set up for the experimentation in Italy and in Spain. Each site will be divided in four plots (90 m2 each) and assigned to a different treatment with the aim to evaluate the single and combined effect of plants and organic amendment on soil quality improvement: i) plants, ii) organic matter, iii) plants plus organic matter, iv) no treatment (control). Each treatment will be carried out in 3 replicates (sub-plot of 30 m2 each).
The innovation of BIOREM project is the dynamic monitoring of soil status; this approach is based on the combination of traditional parameters (physical/chemical/biological), with quantitative and qualitative molecular characterization of the biochemical profile of the soil. This approach not only will give a picture of the soil status “as it is”, but also identifies the degradation level and/or the soil capability to be resilient.

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THE EFFECTS OF INGESTATES COMPOSITIONS ON THE QUALITY OF LIQUID DIGESTATES

The digestate is a by-product of methane production result of the treatment and utilization of different organic wastes. Therefore, the composition of ingestates could be very different per biogas plants depending on the technology, the size of digesters and the source and quality of the possible organic matters and organic wastes. The used materials can be very diverse like animal slurries and stable wastes, offal from slaughterhouse, energy crops, cover crops and other field residues, organic fraction of municipal solid wastes, sewage sludge etc. The agricultural field application can be an opportunity of using digestates as a plant nutrition and/or soil improvement. Therefore the macro- and microelements content, the pH and organic matter content of digestate is very important but these properties are strongly depending on the quality of ingestates and the fermentation process. On the other hand, some materials used for digestion, like sewage sludge, could cause the too high concentration of toxic elements presented in the digestate.
In our work we present some possible ingestate compositions and discuss the quality of digestates depending on the materials used for digestion. And we also try to make a rough estimation about the other applications of digestate.

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HYDROLOGICAL CHARACTER OF RECONSTITUTED AND NATURAL SOILS: COMPARISON OF PHYSICAL ANALYSIS AND PEDOTRANSFER FUNCTIONS

Reconstituted soils are soils resulted from the application of an innovative technology on degraded soils. This technology modifies the structure of the aggregates with a mechanical action combined with the addition of soil amendments, followed by stabilization of the organic matter, so it produces neoaggregates with physico-chemical and microbiological characters different from the original one.
The comparison between reconstituted and natural soils is very important for evaluating the efficacy of reconstitution treatment.
The aim of this work is to analyze the hydrological characteristics of reconstituted versus natural soil. We present the comparison of water retention curves obtained by laboratory analisys (Method Journal Suppl. Ord. 02/09/1997 OJ 173 - ISO / DIS 11274, (tensiometric box and pressure membrane extractor (Piastre di Richard)) with theoretical data of pedotransfer functions based on models of Mualem-van Genuchten and Brooks-Corey.

Keywords: hydrology, reconstituted soil, soil amendments, water retention curve, pedotransfer functions.

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COMPARISON BETWEEN PRODUCTION DATA OF CORN GROWN IN NATURAL AND RECOSTITUTED SOILS

The aim of this work is to evaluate the production data of corn grown on two different soils, one natural, and the other reconstituted, using the same doses of fertilizers but with different irrigation water.
In this way we want to examine the characteristics of water consumption of the reconstituted soils; that is soils resulting from treatment of degraded one, throught a recently developed technology that produces a new soil with interesting environmental and agronomic properties.
This technology has been financed by the European Union with the instrument LIFE + 2010 (Life 10 ENV IT 400 "New Life") by a demonstration work of five years, for the restoration of a degraded soil located in the province of Piacenza. The conceptual model of the treatment is the disgregation and reconstitution of soils by a process that operates mainly on the structural elements, on the physical incorporation of organic matrices (soil amendments) and chemical stabilization of organic carbon.
Keywords: water conservation, soil reconstituted, desertification, degraded soils, soil correction.

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DRIED AND PIROLYZED SWINE EFFLUENTS APPLIED TO A LOAM AND TO A SILTY CLAY SOIL: INFLUENCE ON SOIL NUTRIENT DYNAMICS AND CARBON DIOXIDE RELEASE

Several manure management technologies are currently being evaluated for their suitability to alleviate the problem of animal effluent disposal Among them, the drying and pyrolysis technologies appear promising because they allow the reduction of effluent volume as well as the obtaining of by-products rich in nutrients The objective of this study was to evaluate the suitability of dried pig slurry (DS) and biochar from swine solids (BCSS) to improve soil fertility, through nutrient supply and decomposition of the OM incorporated into soil In laboratory microcosms we monitored the mineral nitrogen (Nmin), and Olsen phosphorus (POls) contents, and the cumulative carbon dioxide (CO2-C) release from a loam and a silty clay soil during a 3-month incubation period Soil was amended with DS, BCSS, and urea (U) in amounts corresponding to 170 kg N ha-1, in comparison with unamended controls (CON) At the end of the incubation period, Nmin levels in BCSS soils were not significantly different from those in CON; in soils amended with DS, Nmin levels were lower than in U and in CON soils For the same N supply the DS and BCSS treatments greatly increased the POls content in soil The amount of cumulative CO2-C released from soil with DS was higher than that from CON and U; the CO2-C release from the BCSS-amended soil did not significantly differ from that of the unamended control Soil amendment with DS and BCSS enriches soils with nutrients that may be of fertilizing value for crops; however, soil reactivity to amendment

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EFFECT OF BIOCHAR APPLICATION ON BIOAVAILABILITY AND UPTAKE OF HEAVY METALS BY BARLEY (HORDEUM VULGARE L.)

A pot trial was carried out to investigate the effect of biochar produced from Miscanthus giganteus by pyrolysis on the uptake of heavy metals by barley (Hordeum vulgare L.). 60 t/ha of biochar with additional nitrogen and phosphate application was added in to the soils with different levels of heavy metal contamination. Heavy metal contaminated soils used in the pot trial were collected from arable soils in the surrounding of copper smelter in
SW part of Poland and control from Gardermoen agriculture area in Norway. Texture of all soils was silty clay loam, with pH 7.0-7.6, and average Cu, Zn and Pb concentrations respectively 600, 150 and 200 mg kg-1 in the highly polluted soil.
Significant biochar x heavy metal interaction was observed and biochar application in highly polluted soils caused higher yield and better growing conditions for the barley than in the absence of BC application. Higher yield increases, comparable with unpolluted soils highlight the role of biochar addition in soil in reducing heavy metal bioavailability and toxicity for the plants. The changes promoted by the biochar seem to be in favor of its use on soils impacted by heavy metal pollution to help the establishment of a green cover in a phytostabilization process.

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EFFICIENCY OF BIOCHAR SOIL AMENDMENTS FOR REDUCING COPPER AND ZINC MOBILITY AND UPTAKE BY RED CLOVER (TRIFOLIUM PRETENSE L.)

A pot trial was carried out to investigate the effect of biochar soil amendment in soils for regulating the mobility of copper (Cu) and zinc (Zn) and the uptake of these metals by red clover (Trifolium pretense L.) Biochar produced from wheat straw by pyrolysis, in rate
of 60t ha-1, was mixed with two soils with different levels of Cu and Zn contamination (2500 and 600 mg kg-1 of Cu and 1500 and 180 mg kg-1of Zn), collected from the surroundings of the copper smelter in SW part of Poland. Unpolluted soil was used as a control. All soils had silt clay loam texture and pH from 7.0 to 7.4. Trifolium pretense was grown for 2 months and biomass, total concentration Cu and Zn in plants and bioavailable forms in soils was analyzed
in collected samples.
Biochar application in to the polluted soils caused higher yield and better growing conditions for the red clover than in the absence of biochar application. In highly polluted soils with biochar addition concentration of bioavailable Cu and Zn forms was reduced and also uptake by plants was significantly lower comparing to the treatments without biochar. Binding pollutants effect and providing conditions that promote plant growth is promising for the in situ biochar application to heavy metal contaminated soils during the reclamation processes.

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EVALUATION OF BIOCHAR ENVIRONMENTAL TOXICITY USING ANIMAL BIOASSAY TESTS

Biochar is evaluated as a means to improve soil fertility and to mitigate climate change. However, the knowledge about its effects on the soil biota are still scanty, with the exception of some studies on earthworms. The aim of this study was to evaluate the effects of four biochars derived from wheat, grape marc, poplar and conifer respectively on the survival and reproduction of the well studied collembolan Folsomia candida (Willem, 1902). Biochar was obtained by means of a fixed-bed gasifier producing a fine-grained, highly porous charcoal that may significantly vary in its chemical and physical properties depending on originating material.
Ten juvenile springtails (12 days old) were disposed on each well-broken biochar previously mixed to soil standard (ISO11267:99) at the following concentrations (w/w): 2%, 5%, 7.5%, 10%, 20%, 50% and 100%. Springtails survival and reproduction were evaluated after 28 days of exposition. As a control, the same parameters were evaluated on springtails disposed on the pure standard soil.
The results obtained showed a different response of living organisms (springtails) according to the dose of biochar tested in the soil but also to biochar origins and composition. The highest springtail mortality was observed on the marc, in particular at the highest concentrations tested (50 and 100%) while in biochar from wheat, springtail survival was observed also at 100 % biochar concentration. In conifer and poplar derived biochars intermediate effects were observed. The data obtained will be discussed.

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ROCK PHOSPHATE DISSOLUTION THROUGH SULPHUR ADDITION DURING ON-FARM COMPOSTING

A study was carried out to investigate the effect of rock phosphate (RP) dissolution during composting process of green residues with or without sulphur addition The experiment was arranged in complete randomized factorial design with two factors in triplicate During the start of composting the green residue mixtures were enriched by RP at 0%(RP0), 2 3 %(RP1) and 4 6%(RP2) as a first factor and by elemental sulphur (S) at 0%(S0) and 0 5 %(S1) as second factor The mixture was prepared in a whole windrow and it was divided into six sub-piles, one per each treatment Samples were taken in triplicate from each treatment after 4, 40, 80 and 120 days of composting and analyzed for pH; EC; Organic matter (OM); organic carbon; total nitrogen (TN); C/N; total (TP), inorganic (Pin), organic (Porg) and water soluble phosphorus (WSP) The results showed that Water soluble phosphorus (WSP) and organic phosphorus (Porg) were not influenced by sulphur addition although sulphur and RP significantly increased total phosphorus (TP) and inorganic phosphorus (Pin) besides S1 enrichment significantly lowered the pH However Porg and WSP concentration was significantly influenced by RP enrichment Loss of OM and rise in TN, TP, Pin WSP and pH was evident during composting period Higher Porg level in green waste compost with RP enrichment at final composting period confirms that mineral forms of phosphorous from RP had been dissolved and assimilated by microorganisms It can be concluded composting and sulphur enrichment enhanced rock phosphate solubility and produced compost with

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SHORT-TERM EFFECTS OF DIFFERENT ORGANIC FERTILITY MANAGEMENT ON SOIL CHEMICAL, BIOCHEMICAL AND BIOLOGICAL INDICATORS

The limited availability of animal manure and the high cost of good quality compost lead to difficult soil quality management under organic agriculture. Therefore, it is important to find out alternative organic soil amendments and more flexible strategies to maintain and enhance soil quality.
A three years study conducted in Valenzano (Bari) aimed to investigate the short-term effects of different management strategies on soil quality.
Seven treatments [mineral fertilizers (COV) as control; compost (COM), cow manure (MAN) and green manure (legume, LEG) as common organic amendments; residues of mushroom cultivation (MUS), olive mill wastewater (OMW) and coffee chaff (COF) as alternative organic matrices] were applied to a conventional crop rotation.
Soil quality was assessed on a yearly basis, before and after the treatments, by means of biological (microbial biomass carbon and nitrogen, soil respiration and metabolic quotient), biochemical (soil enzymatic activities: β-glucosidase, alkaline phosphatase (AP), urease, fluorescein diacetate (FDA) hydrolysis) and chemical indicators (pH, soil organic carbon, soil organic matter, total nitrogen, available phosphorous, exchangeable potassium, dissolved organic carbon, total dissolved nitrogen).
Interestingly, biochemical indicators showed the highest significant differences within treatments. β-glucosidase significantly increased in all treatments; AP was at its highest level in the LEG treatment; FDA significantly increased to reach the same level in COF, LEG and OMW; urease considerably increased in OMW. The soil chemical indicators remained unchanged.
Results demonstrated the efficiency, the high sensitivity and a quick response of the biochemical and biological indicators in assessing soil quality changes.

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MANAGEMENT OF PRUNING FOR ENERGY AND SOIL FERTILITY: A WIN-WIN SOLUTION IN A MEDITERRANEAN OLIVE FARM

This work was financially supported by the national programme PON art 13 and is promoted in the frame of the European 7FP “STAR*AgroEnergy” project A slow pyrolysis-based bioenergy system, ideally implemented at a farm level and fed with olive-grove prunings, was analysed considering the simultaneously production of biochar (for soil fertility management and carbon sequestration) together with syngas (to cover the power and heat requirements of the olive pressing process for oil production) The innovative system was compared with respect to the two singular alternatives: a) the total and direct incorporation of prunings into the soil or b) the utilization of prunings through a complete pyrolysis process and consequent energy generation These scenarios were examined using a life-cycle approach with a specific focus on the determination of the energy balance and the savings in green-house gasses emissions Olive-grove prunings are crop residues and no energy consumption should be accounted for their obtainment, apart the energy used in chopping and harvesting The energy cost of distributing biochar or prunings back in the olive-grove is, however, to be considered The slow-pyrolysis process can be optimized for the recovery of biochar or, alternatively, syngas thus considering different energy return with respect to the energy contained in the feedstock The application of biochar to the soil stabilizes a carbon fraction thus reducing the release of CO2 into the atmosphere As a result, the use of biochar can significantly increase the net energy gains and reduce GHGs emissions showing to be an environmental efficient bioenergy

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NITROGEN BALANCE AND USE EFFICIENCY, VEGETABLE CROP YIELDS IN TWO OUT OF SIX YEARS OF AN OPEN FIELD TRIAL AMENDED WITH MUNICIPAL ORGANIC FRACTION COMPOST

Since 2007, a vegetables crop sequence fertilized by compost has been carrying out in the experimental station of CRA-CAT The objectives of the research were to understand how carbon balance, nitrogen balance and crop productivity are influenced by different fertilization strategies Our present contribution deals with the nitrogen balance, some nitrogen use efficiency indexes and the yields of tomato and onion cropped in the 2011-2012 period The soil treatments were: mineral fertilization with N-P-K doses defined according to crop requirements (MIN), compost amendment with 30 t ha-1 of dry matter (d m) per year in the first three years and 15 t ha-1 (d m) in the other three years (COM), compost amendment with 15 t ha-1 (d m) per year integrated with half dose of mineral nitrogen supplied in mineral fertilization (COM+N), untreated control (CNT) The compost was applied once a year in early spring A simplified N balance (kg N ha-1) was performed with respect to input and output of total N Ninput includes soil mineral N (0-0,30 m) before transplant, mineral N supplied from the fertilizer/compost, soil organic N mineralization during the cropping period, N mineralization from the cropping residues; Noutput includes the crop N uptake at harvest, the soil mineral N at harvest Nitrogen efficiency parameters were the apparent N recovery, the N absorbed utilization efficiency and the N removal coefficient by crop Some indexes and N surplus seem to show a worst use of nitrogen in soil amended with compost, but part

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ENVIRONMENTALLY SOUND USE OF COMPOST WATER EXTRACT

Over the past decade more and more researchers began to study the various possibilities of application of compost water extract. It can be used for nutrient supply and probably has disease suppression effects, especially against soil borne pathogens.
Aqueous extract was prepared by mixing sewage sludge compost and distilled water. The slurry was incubated without agitation for a day and it was enriched with oxygen. Then it was filtered through cheesecloth, and the filtrate allocated into the soil.
The effect of compost water extract was studied on the infection ability of Fusarium solani (F.00715). The field experiment was set with pea varieties (Pisum sativum ‘Avola’ and ‘Lora’) and green pepper (Capsicum annuum ’Fehér özön’). The causative agent was injected into the soil before sowing. The presence of fusarium root rot disease was examined on the test plants in various treatments.
The compost water extract treatments reduced the number of diseased plants compared to the control. The aqueous extract of sewage sludge compost could be recommended as a kind of environmentally sound plant protection product, thus it could contribute to the reduction of the risks caused by the degradation of chemicals used in the agriculture.

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BIOCHAR APPLICATION IN WATER AND SOIL REMEDIATION

The purpose of this work was to evaluate the ability of biochar, produced from forest residues of poplar and conifers, to adsorb a polycyclic aromatic hydrocarbon, phenanthrene (Phe), through model systems in liquid or solid matrix to simulate a real situation of contaminated water or soil. Specific surface and porosity of both the biochars were determined by BET analysis and their FT-IR analysis was performed to characterize their functional groups. By adding biochar to a phenantrene solution at different concentration (5-15 mg l-1) the amount of Fen initially added was completely adsorbed by both biochars already after the 1 day-incubation. The fraction subsequently extracted by n-hexane and ethanol decreased over time especially from conifer biochar. When the remediation system was built confining biochar in selective membranes, several cycles were successfully performed upon repeated immersion in renewed phenantrene solutions. Biochar from conifers showed faster adsorption kinetics than poplar biochar.
Soil artificially spiked with Phe and then amended with biochars from poplar and conifers showed, though it was able itself to mitigate the contamination process, a reduced pollutant availability. In fact the presence of biochar led to a further reduction of the contaminant availability that was grater as higher amount of biochar was added. Nevertheless, the addition of biochar led to a stabilization but it did not assure that the contaminated matrix has been restored, as the contaminant was not removed, but only confined and immobilized on the solid matrix, enriched of biochar.

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PS3b. SUSTAINABLE USES, APPLICATIONS AND ENVIRONMENTAL IMPACT OF BIOCHARS, COMPOSTS AND DIGESTATES

19 October, h. 08:00 – 20:00

PS3b.01 **Agronomical and microbiological effects of olive mill waste compost used as a potting substrate for ornamental plants**

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AGRONOMICAL AND MICROBIOLOGICAL EFFECTS OF OLIVE MILL WASTE COMPOST USED AS A POTTING SUBSTRATE FOR ORNAMENTAL PLANTS

In the frame of the SAN-SOIL project, a high-quality compost obtained from olive mill waste (OMW) using a static procedure was tested as a peat surrogate for nursery cultivation of potted plants. A farm-scale trial was implemented using three ornamental tree species, namely Viburnum lucidum, Prunus laurocerasus and Cupressus sempervirens, and substituting peat with 33%, 66% and 100% of OMW compost with or without chemical fertilization.
The potting substrates containing the OMW compost showed higher pH and electrical conductivity than those containing only peat. Interestingly, after 6 months of cultivation, the growth (assessed as fresh weight) of plants potted with 33% and 66% of OMW compost, especially in the presence of chemical fertilization, was much higher than those potted in the traditional peat-based substrate.
The effects of OMW compost on the structure and abundance of microbial communities of both the potting substrates and the plant roots were assessed using culture-independent molecular methods such as denaturing gradient gel electrophoresis (DGGE) profiling and qPCR analysis of ribosomal (rRNA) genes. While qPCR analysis indicted that replacing peat with OMW compost did not inhibit bacterial growth, DGGE profiling clearly showed that these substrates profoundly modified bacterial diversity.
Taken together these results clearly indicate that OMW compost can represent a valuable alternative to peat for nursery cultivation of potted ornamental trees and suggest that the modulation of soil and endophytic microbial communities may mediate the observed beneficial effects on plant growth.

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EVALUATION OF SOIL FERTILITY IN CONTINUOUS RICE CROPPING SYSTEMS AMENDED WITH LIVESTOCK AND WASTE-DERIVED ORGANIC MATERIALS.

Disappearance of livestock production and prevailing of monoculture conditions in the Italian rice-cropping area have compromised the return of organic matter (OM) to soil with important implications on soil fertility and indigenous N supply For this reason, off-farm OM input may have a positive effect on the soil physico-chemical characteristics and rice paddy fertility The aim of the study was to evaluate the effect of different OM applications on grain yields, yield components, and N use efficiency The research was carried out in 2012 within an experimental platform situated in the Rice Research Centre The experimental design consisted of 7 treatments: cow manure, solid separated pig slurry, dry digestate, solid separated digestate, sewage sludge and compost, and an unamended control Each treatment had both fertilized (170 kg N ha-1) and non-fertilized plots and was cultivated to rice Application of solid separated pig slurry, sewage sludge and solid separated digestate resulted in highest grain yields and N-use efficiency These materials also showed a lower degree of humification and a higher humification index with respect to the other materials, indicating the presence of easily mineralizable organic N forms The production components used as indicators of N availability, show that solid separated pig slurry improved N nutrition in the second part of the crop cycle, resulting in the highest number of spikelets per panicle and weight per 1000 seeds This result was also confirmed by SPAD values that were significantly higher in the solid separated pig slurry treatment from the stage of panicle

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EFFECTS OF BIOCHAR APPLICATION ON SOIL MICROBIAL ACTIVITY AND CROP YIELD IN A SANDY SILT IN NORTHERN GERMANY

Biochar produced from pine wood chips in a pyrolysis process at 550-600°C was applied at a rate of 5 t ha-1 in a field experiment to test the effects on microbial activity and crop yield. The biochar was applied manually in spring 2009 prior to sowing a maize crop. Two tillage systems, conventional and conservation were tested in the field experiment. Soil samples (0-30 cm) for microbiological analysis were taken at nine days, two months (BBCH 32) and five months (BBCH 99) after this biochar application. Yield data were recorded each year between 2009 and 2012 in a maize, maize, winter wheat and lupine crop rotation. Effects of biochar application were observed on protease, dehydrogenase activity, alkaline phosphatase activity, and cellulose activity under both tillage systems in 2009. Under conservation tillage the following effects were observed. The CO2 respiration was significantly reduced nine days after the biochar application but increased significantly two months after the biochar application, then decreased back to the control level after five months. Only minor effects on crop yields were recorded between 2009 and 2012 under both tillage systems.

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EFFECTS OF SOFTWOOD BIOCHAR ON CROP NUTRIENT UPTAKE IN TWO BOREAL SOILS

Biochar effects in soils of the northern climates remains largely unknown due to the paucity of field studies in this area We investigated whether and how biochar affects the biomass nutrient concentration and crop uptake in two experiments carried on Southern Finland The first one included wheat (Triticum aestivum L), horse bean (Vicia faba L) and turnip rape (Brassica rapa L) and was conducted on fertile sandy clay loam in 2010–2011 Biochar was applied at 0 and 10 t ha-1 combined with 30% and 100% NPK fertilization In the second experiment biochar was applied at 0, 10 and 30 t ha-1, with and without NPK fertilization to a nutrient deficient loamy sand In both experiments, plant biomass samples at full flowering were analysed for their elemental composition using ICP-OES Biochar addition decreased wheat uptake of Cu and Zn in 2010 ($p < 0\ 1$) and increased the uptake of Mn in 2011 ($p = 0\ 04$) In horse bean, biochar addition increased the K uptake ($p = 0\ 04$) in 2010 and decreased the uptake of Fe in 2011 ($p = 0\ 01$) No significant effects were found in the second experiment or in case of turnip rape in the first experiment We suggest that biochar fertilization efficacy depends both on the native soil fertility as well as on its content of easily soluble nutrients It could be that more pronounced effects will be seen by interaction of soil biota, plant roots and biochar in longer term

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EFFECTS OF BIOCHAR APPLIED AS A SINGLE AMENDMENT OR COMBINED WITH MINERAL FERTILIZER, MUNICIPAL SOLID WASTE COMPOST, AND SEWAGE SLUDGE ON SOIL RESPIRATION

We conducted an incubation experiment to investigate the effects of biochar applied alone or mixed with mineral and organic fertilizers on soil CO2 emissions for 120 days. The treatments examined were biochar added as a single amendment at rates of 0, 20, 40, and 60 t ha-1; mineral fertilizer, municipal solid waste compost, or sewage sludge at rates equivalent to 0, 75, 150, and 225 t ha-1; and biochar added at a rate of 20 t ha-1 combined with either mineral fertilizer, municipal solid waste compost, or sewage sludge at rates equivalent to 0, 75, 150, and 225 t potentially available N ha-1. The addition of biochar as a single amendment did not affect significantly soil respiration. Cumulative soil CO2 emissions increased with increasing the rate of municipal solid waste compost and sewage sludge and decreased with increasing the rate of mineral fertilizer. The addition of biochar did not change significantly the observed effects of mineral and organic fertilization on soil respiration.

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ORGANIC FORMS OF PHOSPHORUS IN SOIL AS AFFECTED BY LONG-TERM APPLICATION OF ORGANIC WASTE

Organic fertilizers as compost and manure are important sources of phosphorus (P) in agriculture. P forms in soils are influenced by environment and management practices. A better understanding of the P turnover and P forms in soil is necessary in order to increase the utilization of P and to avoid P losses. Organic P compounds in soil can be characterised by the addition of hydrolytic enzymes with different substrate specificities to classify enzyme-labile P into simple monoesters (monoester-likeP), diesters (DNA-like P) and inositol hexakisphosphate (Ins6P-like P). This technique requires relatively little lab equipment and low costs compared to other techniques like 31P-NMR spectroscopy. The objective of this study was to investigate the concentration of organic P forms (hydrolysable and non-hydrolysable) in soil after 12 years of different P fertilizer management in a field experiment. The organic fertilizers (cattle manure and biowaste compost) were applied at a rate of 30 t per ha every three years beginning in 1998. The inorganic fertilizer (TSP) was applied once per year. The amount of P applied with inorganic and organic fertilizers was about 22 kg per ha and year. Soil samples (0-30 cm) were taken in autumn 2012 and hydrolysable organic P was estimated by enzyme additions to alkaline soil extracts. The total organic P concentration was highest in the treatments with organic fertilizers. The major form of hydrolysable organic P was Ins6P-like P (about 70 % of total hydrolysable P). Between the compost and the manure treatments no differences were found.

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COMPOST ON-FARM AS A TOOL TO PRESERVE BIOLOGICAL SOIL QUALITY IN AGRICULTURE

One of the most worrying aspects of intensive agriculture, is the gradual loss of soil quality due to organic matter (OM) decrease. The improvement or maintenance of OM content in the soil, can be achieved through the use of different types of organic amendments. Application of organic amendments is a reliable tool to improve soil health and to support sustainable agriculture systems.
Aim of this work was to study the recovery of soil quality in an agricultural soils under greenhouse condition, by compost produced on-farm. The adoption of a composting system "on farm" would be very beneficial for farms, which produce large quantities of green wastes resulting from the cultivation and processing of vegetables, which are not disposed of but rather accumulated in the farms.
Two different compost, the first one a commercial compost from municipal solid wastes, the second one a compost from green wastes produced on farm, were supplied to soil. After addition of organic amendments, soil fertility was monitored, for eighteen months, for main biological and biochemical properties.
Results showed, generally, positive effects of organic amendments on soil biological and biochemical properties, in particular in term of biodiversity, as well as in enzymatic activities. Our results demonstrated that the supply of compost produced on farm, can enhance soil biological and biochemical properties over time, thus representing a promising alternative to commercial compost and an important way to reuse wastes produced by cultivation and processing of vegetables.

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IMPLICATIONS OF COMPOST AND COMPOST TEAS IN PLANT BIOSTIMULATION

Plant biostimulation can be defined as the molecular-induced enhancement of crop's physiological processes leading to a more efficient resources utilization and to improve vigour and yields. There are a lot of experiences about the positive effects of compost and their derived teas on the plants through biostimulating effects, as well as direct and/or indirect plant nutrition implications, hormone-like activities, improvements of photosynthesis effectiveness, supplying of useful microorganisms, such as PGPR, and enhancement of general plant status, that reflect on several morphological, physiological and productive characters of the crops. Our works on this subject revealed the great potential of agricultural waste composts and compost teas, in the development of natural plant improvers. In particular, the bioactivity of these organic matters was revealed by plant assays, carried out at laboratory scale, showing the induction of root and shoot development of seedling and nursery plants, and by open field trials to evaluate the effects of both compost and compost teas applications. Actually, our findings about organic amendments indicated that composts can be surrogate mineral fertilization to assure the same levels of yields. Moreover, compost incorporation in the soil increased the vegetative development of the plants. Similarly, compost teas also showed their beneficial effects in the field. In particular, foliar applications of dilute organic formulate improve productivity of several horticultural systems, such as tomato, pepper, savoy cabbage and lettuce. Results are encouraging for the individuation of innovative tools for a sustainable and smart agriculture.

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PRELIMINARY STUDY ON GROWING MEDIA ALTERNATIVE TO PEAT IN HORTICULTURE

In horticulture, peat is the most used growing media, but the laws related to its use are becoming more restrictive, due to environmental implications associated with this substrate. In the last years, a lot of researches were focused about identification of new low-cost media alternative to peat. The aim of this study was to identify a substrate that could replace, completely or in part, the peat evaluating, at the same time, costs and reuse of industrial waste materials.
In particular, digestate (from anaerobic digestion), different composts (from green waste), and coir fiber (new substrate used for soilless) were used as growing media alternative to peat. The phytotoxicity was evaluated for each growing media and, then, they were mixed in different ratios between them or adding peat from 0% to 75%.
The obtained mixtures were tested for the capacity to retain moisture and for the influence on germination of cress seeds (Lepidium sativum) in containers used in horticultural systems. All mixtures showed a lower water retention compared to peat, although with a different behavior. The germination test with digestate/compost from cauliflower and coir fiber produced promising results, with germination percentage higher than peat. Results indicate a good alternative use of these media respect to peat, but their useful use in horticulture requires further investigations.
Additional observations are ongoing about the use of biochar and zeolite in horticultural nursery.

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USE OF COMPOST AND COMPOST TEAS TO SUPPRESS PLANT DISEASES

Composting is a biological process where biodegradable organic compounds are transformed in compost. Moreover, in the last years, it is also increasing in agriculture the use of new products derived from compost, such as compost tea (CT). In particular, this last is a compost-derived liquid formulate produced by extraction and/or fermentation process, conducted in liquid phase, for a period of time from few hours to two weeks, with or without active aeration and with or without the addition of nutrients. Both products may show positive effects on the plants trough suppressiveness against several plant pathogens, with subsequent interesting improvement of quantity and quality of crop yields. Soluble organic molecules, such as humic substances, and useful microorganisms, such as antagonistic bacteria, fungi, protozoa and nematodes, have a crucial role in plant protection. Our researches are focussed on Agricultural waste compost and teas to understand the main mechanism(s) leading the compost-mediated plant pathogen suppression. Since this action could be explicated through both biotic and abiotic mechanisms, microbiological, biochemical and chemical analysis were applied. Microbial communities, characterized at metabolic and global levels by Biolog system, microbial counting, CO2-release and FDA hydrolysis rate, play a major role in biological control. The complete biotic inactivation by autoclaving composts, has, in fact, reduced or eliminated their ability in pathogen suppression. Moreover, the researches revealed the ecological implication of nutritional microniches in compost that may have profound effects on the community functions, including those linked to the suppressiveness.

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THE BIOCHAR UTILIZATION FOR IMMOBILIZATION OR ACCUMULATION OF HEAVY METALS BY SORGHUM PLANTS

Heavy metal pollution of soil is usually related to human activities. Sites near mining activities or heavy industry are often highly contaminated with toxic metals. Such polluted soil is hardly usable for agricultural purposes because the pollution can be transferred to a food chain. To avoid the spread of contaminants it is possible to use phytoremediation techniques which can immobilize or decrease the pollution. For phytoremediation purpose it is essential to select an appropriate plant species which should be metal tolerant with high biomass production and known agronomic techniques. The above mentioned conditions met woody plants, grasses, and crop plants. The primarily interest concerning biomass crops now is focused on energy crop i.e. Miscanthus giganteus, Salix sp., Populus sp., Zea mays, and Sorghum sp. Sorghum bicolor is C4 grass widely used as a forage crop. It is the fifth most important cereal in the world. The use of charcoal to improve soil properties is increasingly studied. The work focuses primarily on the potential benefit of carbon sequestration in soil, soil improvement, increase crop yield, reduce nutrient leaching, and removal of organic contaminants.
The aim of this work was to expand knowledge about protection mechanisms of sorghum plants under Cd, Cu and Zn stress in presence of biochar. The metals accumulations in roots and shoots of hydroponically grown S. bicolor plants were studied.

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USING OF ORGANIC WASTES FOR REGULAR NUTRIENT SUPPLY

To satisfy the food requirements of the growing human population, more and more food needs to be produced. Beside the new plant species, the fertility of the soils and plant nutrient supply are also important. Several industrial and agricultural by-products with high organic matter content (e.g. different sludges, by-products of canning industry and agriculture) are handled as wastes. The by-products with appropriate quality could be reused after different treatments.
On the other hand, some materials contain other, unwanted elements and molecules. These biowastes could cause environmental pollution. Some wastes or by-products contain toxic elements which are either taken up by plants or transported in drainage waters.
The utilization of organic wastes and by-products is important because the 1999/31 EC directive on landfills prescribes the reduction of the biodegradable organic matter fraction of landfilled municipal solid waste by the middle of 2016 to 35% of the values of 1995 as a base year.
In our presentation we give a summary of the agricultural utilization of different biowastes, especially the sewage sludges, in Hungary. We review the utilized quantity and quality of biowastes, and we compare the effects of sewage sludge composts on the soil and plant quality.

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BIOCHAR APPLICATION FOR PINUS TAEDA PLANTATION IN SOUTHERN BRAZIL

This study aimed to evaluate the effect of biochar incorporated into the soil on the initial growth of Pinus taeda. Biochar was produced using biomass chips from residuals of Pinus taeda harvesting operations. The biochar chip sizes distribution was 14% 0-2 mm, 10% 2-5 mm, 41% 5-15 mm, 20% 15-25 mm, 15% >25 mm and they had a dry bulk density of 0,21 gcm-3. The chips were pyrolysed in a handmade reactor with a cylindrical tank measuring approximately 2.4 m long and 1.0 m diameter. The biochar was incorporated into the soil in holes of 0.4 x 0.4 x 0.4 m^3, where Pinus taeda seedlings were planted. Treatments consisted in increasing biochar amounts applied in the hole: 0, 2, 4, 6, 8 and 10 t/ha. The control consisted in an incorporation of 100 g of NPK (2-18-18). The experiment was arranged in a randomized blocks with 5 replications and 30 plants per plot. One year after planted, it was observed significant differences between treatments for height ($p<0.001$) and collar diameter ($p<0.001$). The treatments with 8 and 10 t/ha and with NPK showed largest diameter (23.4; 24.2; 25.8 mm; respectively) and heigth (115.6; 120.3; 126.2 cm, respectively), when compared with other treatments (Tukey test, $p<0.5$). Incorporation of biochar in the soil is promising for Pinus taeda plantation. However, more years of evaluation is necessary for final conclusion.

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BIOCHAR AS SUBSTRATE FOR ROOTING OF PINUS TAEDA

This study aimed to evaluate the influence of the utilization of biochar on the rooting of Pinus taeda. The treatments consisted of using biochar associated with commercial forestry substrate in different ratios (v:v): 0:100, 20:80, 40:60, 60:40, 80:20 e 100:0. The experiment was conducted in randomized blocks design, with six treatments, with seven replications, containing 12 minicuttings per replication. Biochar was produced using biomass from Pinus taeda sawdust from residuals of a sawmill. The sawdust was pyrolysed in a handmade reactor with a cylindrical tank measuring approximately 2.4 m long and 1.0 m diameter. The mini-cuttings were collected from apical coppicing of young seedlings, with 120 days after sowing. The experiment was conducted in the forestry nursery, at Federal University of Paraná, in Southern Brazil. Rootings were evaluated after 60, 90 and 150 days. Sixty days after vegetative propagation, it was not observed significant differences between treatments for rooting, with rootings between 12.6 to 23.3%. After 90 days, the treatment with 100% biochar achieved 36.9% of rooting and it was significantly lower (Tukey test, $p<0.5$) than the others treatments (65.2 to 78.1%). The treatment with 20% biochar attained the highest average with 96.4% of rooting, but statistically similar to the treatments with 40% biochar (92.1%) and without biochar (91.4%). The lower average of rooting was observed in the treatment only with biochar (77.9%). Adding biochar in commercial substrate may be viable for rooting of Pinus taeda.

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PREDICTING THERMAL CONDUCTIVITY OF BIOCHAR AND SOIL USING PHYSICAL-SATISTICAL MODEL

Organo-mineral interactions between biochar and soil provide a means of modifying properties of soils beyond that which can be achieved by organic matter alone. The biochar may sustainably sequester carbon and at the same time improve soil structure and conductive functions including thermal conductivity. Thermal conductivity has a significant effect on the soil surface energy partitioning and resulting temperature distribution. There is currently a lack of data concerning the effects of biochar application the soil thermal conductivity. The aim of this study was to compare measured and predicted thermal conductivity (using statistical-physical model of Usowicz et al., 2006) of biochar, mineral soil and soil with addition of biochar at various water content and bulk density. The model operates statistically by probability of occurrence of contacts between particular fractional compounds. It combines physical properties, specific to particular compounds, into one apparent conductance specific to the mixture. The results showed that the mineral soil displayed the highest thermal conductivity that successively decreased in soil with addition of biochar and pure biochar. The least and the most decline in thermal conductivity with decreasing water content was found for pure biochar and mineral soil, respectively. Shapes of relationships between thermal conductivity and water content were modified by bulk density of the studied media.

Usowicz B. et al., 2006. Thermal conductivity modelling of terrestrial soil media - A comparative study. Planetary and Space Science 54, 1086-1095.

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BIOCHAR AFFECTS THE STRUCTURE OF MICROBIAL COMMUNITIES IN TEMPERATE SOILS RATHER THAN TOTAL MICROBIAL BIOMASS

Biochar application is a promising strategy for sequestering carbon in agricultural soils and for improving degraded soils; however, there are still contradictory and unsettled issues involved This study seeks to investigate whether biochar has effects on the biomass and community structure of microorganisms Further on, this investigation aims at testing the effects of different biochar types on microbial communities and possible changes over time after application To this end, a greenhouse experiment and a field experiment have been set up In the former, we added four types of biochar (wood biochar, straw biochar, vineyard pruning biochar, all pyrolyzed at 525°C, and vineyard pruning biochar pyrolyzed at 400°C) to three different soils In the latter, we applied a mixed woodchip biochar on two different soils To examine the effect of biochar on the soil microbial communities, we used phospholipid fatty acid (PLFA) analysis Our results indicated only little significant evidence for a positive effect of biochar on the total microbial biomass, this was found in the treatment with the vineyard pruning pyrolysed at low temperature (400°C) Nevertheless biochar's reaction in the soil changed prevailing physical and chemical properties, e g the C/N ration of the soil and thus affects microorganism structure indirectly Discriminant analysis showed significant separation of treatments and clarified shifts within the microorganism community The grouping of treatments was not driven by a certain PLFA or a distinct microbial group In summary the most influencing factors in our study on microbial PLFAs were, in the order of diminishing importance:

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AGRICULTURAL WASTE AVAILABILITY FOR BIOCHAR PRODUCTION: SCENARIOS TO 2100.

The potential viability of biochar systems will depend on a number of factors, not least the sustainable availability of suitable biomass. The potential types of biomass for biochar production are varied, and spatially and temporally dependent. In order to design biochar systems which can effectively remove large amounts of carbon dioxide from the atmosphere and store it in soils, assessment is needed on the future availability of these biomasses.

The Representative Concentration Pathways (RCPs) are future scenarios of emissions and land-use change which represent four different future pathways of climate and socio-economics. They are the most recent scenarios developed by the climate modelling and integrated assessment modelling communities and are used in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. The scenarios span the range of future climate change within literature, from a scenario of extreme mitigation, to a scenario of extreme climate change.

The RCPs are used in this study to determine availability of agricultural wastes under four future scenarios. Each scenario has a pathway of future land use which has been used to determine the quantity of agricultural waste, by crop type, available globally from 2005 to 2100. Experimental data and literature has then been used to determine biochar yields from the available agricultural waste resources, after accounting for competition sources for the wastes.

Global biochar availability, from agricultural wastes, for the four RCP scenarios will be presented.

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RESEARCH OF THE EFFECTIVENESS OF VERMICOMPOST AND OTHER MELIORANTS FOR SOIL FORMATION OF LOESS DEPOSITS

From 1991 to 2012 studied the effect on the efficiency of nude loess soil formation following meliorants: vermicompost, manure, straw and mineral fertilizers. As phitomeliorants selected alfalfa blue, control variant is loess where barley is grown. The experiments were carried out pre-fill the soil stationary loess extracted from the depths of 3-3.5 m soil stationary built in 1971, situated within the zone of Mollic Kastanozems in the south-east of Kazakhstan, 18 km east of Almaty city at an altitude of about 1000 meters above sea level. 20 years of studying meliorants studied by different effect on the rate of soil formation, the number of above-ground biomass and species composition phytocenosis phytocenosis.

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EVALUATION OF BIOCHAR AS TOOL FOR THE CONTROL OF STORED-PRODUCT INSECT PESTS

Biochar (BC) is believed to be a recalcitrant carbonaceous compound able to stock carbon (C). The application of BC to soil is proposed as a novel approach to establish a significant, long-term C sink, in order to genuinely contribute to the climate change mitigation. Anyway, results are often contradicting.
In the present work, a new, possible application of BC was tested, i.e., its utilization as substrate for the control of Sitophilus granarius (L.) (Coleoptera, Curculionidae), a major pest of stored cereals worldwide.
The BC was characterized by elemental analysis (CHNS-O), XRF spectroscopy, Ft-IR spectroscopy, and molecular fluorescence; cation exchange capacity, pH and EC were also determined.
In order to test the bioactivity of BC against S. granarius, groups of adult insects (n = 25) were exposed to 100 g of wheat grains (WG) treated with increasing concentrations of BC (1, 5, 10, 15, and 20 mg BC / g of WG).
Results did not show a significant effectiveness of BC as a physical control mean against S. granarius. At the same time, its intrinsic features (e.g., high CSC, porosity and specific surface) seem to suggest a possible utilization of this compound as carrier material of volatile organic molecules with fumigant toxicity against stored-product pests.
Further researches are in progress on this topic.

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PS4. CERTIFICATION, REGULATION AND MARKETING OF BIOCHARS, COMPOSTS AND DIGESTATES

19 October, h. 08:00 – 20:00

PS4.01 **An integrated action plan for municipalities and farmers: public awareness campaigns and composting of separately collected bio-waste linked to local production of certified vegetables**

Contin Marco, *University of Udine - Udine, Italy*
Baca Maria Teresa, Lorente Pilar, Peña Alberto, Perales Manuela, *Alhendín Council - Alhendín, Spain*

PS4.02 **Evaluating the economic feasibility of the chain of compost enriched with biochar**

Michele Donati, Alessio Malcevschi, *University of Parma - Parma, Italy*

PS4.03 **Effect of sewage sludge on Zea Mays L. metabolism**

Ertani Andrea, *University of Padova - Legnaro (PD), Italy*
Francioso Ornella, *University of Bologna, Alma Mater Studiorum - Bologna, Italy*
Nardi Serenella, *University of Padova - Legnaro (PD), Italy*

PS4.04 **Economic assessment of carbon accumulation/sequestration strategies in agricultural soils**

Prosperi Maurizio, Calitri Francesca, Zaccone Claudio, *University of Foggia - Foggia, Italy*

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AN INTEGRATED ACTION PLAN FOR MUNICIPALITIES AND FARMERS: PUBLIC AWARENESS CAMPAIGNS AND COMPOSTING OF SEPARATELY COLLECTED BIO-WASTE LINKED TO LOCAL PRODUCTION OF CERTIFIED VEGETABLES

A biannual project is being implemented in one of the neighbourhoods of Alhendin village, in Andalusia, Spain.The project features a 0 km strategy: the separate collection of biowaste at source (biowaste sorting in households) and the valorisation of crops manured with the compost produced with this biowaste.
The active involvement of high school students has revealed itself essential. They carry out regular surveys, increasing the awareness of the population towards the need of C recycling and encouraging a behavioural change.
The biowaste collection process is performed separately and the compost is generated in a plant located within the municipality. This compost has been used as manure for the production of selected seasonal crops such as tomatoes, peppers, courgettes, etc., in 11 farms which joined the project.
The village has registered its own brand of products that match set quality standards and environmental requirements: this makes easier the differentiation of products grown under this scheme. The brand is already commercially available to consumers in and out of the municipality, through short distribution channels.
The soils are analyzed annually, in order to monitor increments in macro- and micro-nutrients and in organic matter content. The aim is to increase the organic carbon of soils, making them act as carbon sink while enhancing their fertility, closing in this way the bio-waste cycle in a sustainable way.

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EVALUATING THE ECONOMIC FEASIBILITY OF THE CHAIN OF COMPOST ENRICHED WITH BIOCHAR

There is evidence that biochar, produced as solid waste from pyrolysis/gasification plants, could provide society with a double dividend when it is properly used. The first positive effect concerns the capacity of biochar, when mixed to soil , to improve soil fertility taking advantage of its peculiar chemical-physical structure. The second effect, which can be viewed as a positive externality, consists in the jointed effect on the long-run carbon sink, when it is used as soil amendment. Despite these relevant agronomic and environmental properties, biochar nowadays still faces difficulties in being used for agricultural purposes, mainly due to the possible presence in it of pollutants, such as PAH and heavy metals, produced during the pyrolysis process which might engender toxic effects on the environment. However, this problem can be mitigated if biochar is obtained through a process characterized by the combined use of controlled raw materials, tuning of pyrolysis temperature and its use as amendment in combination with other biomass based fertilizers like compost. The present study focuses its attention to the evaluation of the economic potential in Italy of an organic fertilizers based chain consisting of compost enriched with biochar. The market of compost will be investigated in order to estimate the economic feasibility of a chain based on biochar use in agricultural fertilizers. The study intends also to identify the agricultural sectors (e.g. horticulture, arable crops, permanent crops) most interested to the compost-biochar application and to analyse similar experiences in Europe.

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EFFECT OF SEWAGE SLUDGE ON ZEA MAYS L. METABOLISM

For several years agricultural research has aimed at improving crop yields, while placing little attention on the quality of the products or environmental protection. One way for stimulating plant productivity and at the same time to reduce the environmental pollution could be the use of organic residues from agro-industrial processes as bioactive products. The present study was focused on the effects of sewage sludge (SES) derived from an agro-livestock farm, which uses an anaerobic digestion, to produce biogas, on plants metabolism in a pot experiment. The product was chemically characterized and then supplied to maize (Zea mays L.) plants grown for 12 d in a nutrient solution in the absence (control) or in the presence of SES applied at two rates (0.1 and 1mL L–1). The product increased root and leaf biomass, chlorophyll, glucose and fructose content. The treatments also increased the activity and gene expression of phenylalanine ammonia-lyase, a key enzyme of the phenylpropanoid pathway. From our results it can be assumed that residues from agro-industry may be successfully used as bioactive products in agriculture to increase plant yield.

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ECONOMIC ASSESSMENT OF CARBON ACCUMULATION/SEQUESTRATION STRATEGIES IN AGRICULTURAL SOILS

The term carbon “sequestration” is commonly used to describe any increase in soil organic carbon (SOC) content caused by a change in land management, with the implication that increased soil C storage mitigates climate change But this is true only if the management practice causes additional net transfer of C from atmosphere to land For example, removing land from annual cropping and converting to forest, grassland or perennial crops will remove C from the atmosphere and contribute to climate change mitigation, whereas adding organic materials (e g , manures, composts) to soil generally does not constitute an additional transfer of C from atmosphere to land In general, any increase in SOC content in agricultural soils will be beneficial for their quality, whether or not there is a benefit for climate change; more effective measures should be undertook, including governmental actions to minimise C losses from land (e g , limiting deforestation) and more sustainable agricultural practices In this study, we will show results of an interdisciplinary research carried out in Apulia (Italy), where we compared different soil management practices (i e , utilization of biochar or digestate) in order to estimate the economic value of SOC accumulation/sequestration The valuation of SOC, currently based on C market quotations, could be also measured with the opportunity cost method (i e , comparing the cost of implementing the best policy measure aimed at achieving the same effect) The implication of the study is to support decision makers promoting the adoption of best farming

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K

Kachinskiy Vladimir	S4.2.05
Kloss Stefanie	S3.4.02
Knicker Heike	S2.1.02 - S3.6b.01
Krümmelbein Julia	PS3a.35
Kumar Jaiswal Amit	S3.8.02

L

Le Son	W.3.01 - W.3.05
Leal Otávio	PS3a.36
Ledda Claudio	S1.1.04
Leinweber Peter	S3.3.04
Leita Liviana	PS3a.37
Libutti Angela	PS3a.38
Lipiec Jerzy	S3.3.03
Lobo Deyanira	PS3a.15
Loffredo Elisabetta	PS3a.39 - PS3a.40
Lourenzi Cledimar Rogério	PS3a.41

M

Macci Cristina	PS3a.42
Maestrini Bernardo	S3.7.05
Makádi Marianna	PS3a.43
Malerba Anna Daniela	PS2.10
Manariotis Ioannis	S3.4.03
Manfredi Paolo	PS3a.44 - PS3a.45
Mantovi Paolo	S3.5.06
Manya Joan J.	PS2.11
Marañon Elena	W.3.02

Marchetti Rosa	PS3a.46
Marsala Valentina	PS2.12
Matchavariani Lia	S3.2.06
Medina Jorge	PS2.13 - PS2.14 - PS2.15
Medynska-Juraszek Agnieszka	PS3a.47 - PS3a.48
Menta Cristina	PS3a.49
Mihretehab Habte T.	PS3a.50
Miniotti Eleonora	PS3b.02
Mondelli Donato	PS3a.51
Monteleone Massimo	PS3a.52
Morra Luigi	PS3a.53
Mounier Stéphane	S2.2.05
Mukherjee Santanu	S3.4.06
Mumme Jan	S1.1.07

N

Ng Ee Ling	S3.1.04

O

Obia Alfred	S3.8.03
Olk Dan	S4.1.02
Orosz Viktória	PS3a.54

P

Pagano Marcela	PS2.16
Panten Kerstin	PS3b.03
Parillo Rita	PS2.17
Pawlett Mark	W.3.07
Peter Leinweber	PS2.18
Pituello Chiara	PS3b.04
Placentino Claudia Marcella	PS1.04
Plaza César	PS3b.05
Prosperi Maurizio	PS4.04 - S4.2.01
Provenzano Maria Rosaria	PS2.19 - PS2.20 - PS2.21 - PS2.22

Q

Quayle Wendy	S2.3.03

R

Rao Maria A.	SP3a.55
Rees Frédéric	S3.4.04
Reibe Katharina	PS3a.34
Requejo Maria	PS3b.06
Réthási Gabriella	PS2.23
Richard Lamar	S4.1.02
Romani Marco	S3.2.01

S

Sabiene Nomeda	S3.4.05
Saghir Muhammad	S2.2.06
Sakrabani Ruben	W.3.06
Schnug Ewald	S3.5.01
Sciubba Luigi	S3.2.07
Scotti Riccardo	PS3b.07 - PS3b.08 - PS3b.09 - PS3b.10
Senesi Giorgio	PS2.24
Shepherd Jessica	S3.8.04
Singla Ankit	S3.8.05
Slijepcevic Ana	S3.8.06
Smebye Andreas L.	S2.1.03
Smith Jo	S3.6b.02 - S3.6b.03
Soudek Petr	PS3b.11

T

Taupe Natalie	PS2.25
Tomócsik Attila	PS3b.12
Trazzi Paulo André	PS3b.13 - PS3b.14
Trejo-Lizama Wilbert	S2.3.04
Tsunoda Mayumi	S3.7.01
Tumwesige Vianney	S3.6b.04

U

Usowicz Boguslaw	PS3b.15

V

Ventrella Domenico	S3.5.02
Vernile Pasqua	S1.1.05
Voelkner Amrei	S3.3.05

W

Watzinger Andrea	PS3b.16
Wilske Burkhard	S1.1.06
Windeatt Jayne	PS3b.17

X

Xing Baoshan	S3.8.07
Xu Jianming	S3.3.06

Y

Yelikbayev Bakhytzhan	PS3b.18

Z

Zaccone Claudio	PS3b.19
Zhao Xu	S3.6a.05
Zwart Kor	S2.1.04
Zyngier Romy L.	S3.3.07