ISHS International Society for Horticultural Science

CSIC Consejo Superior de Investigaciones Científicas

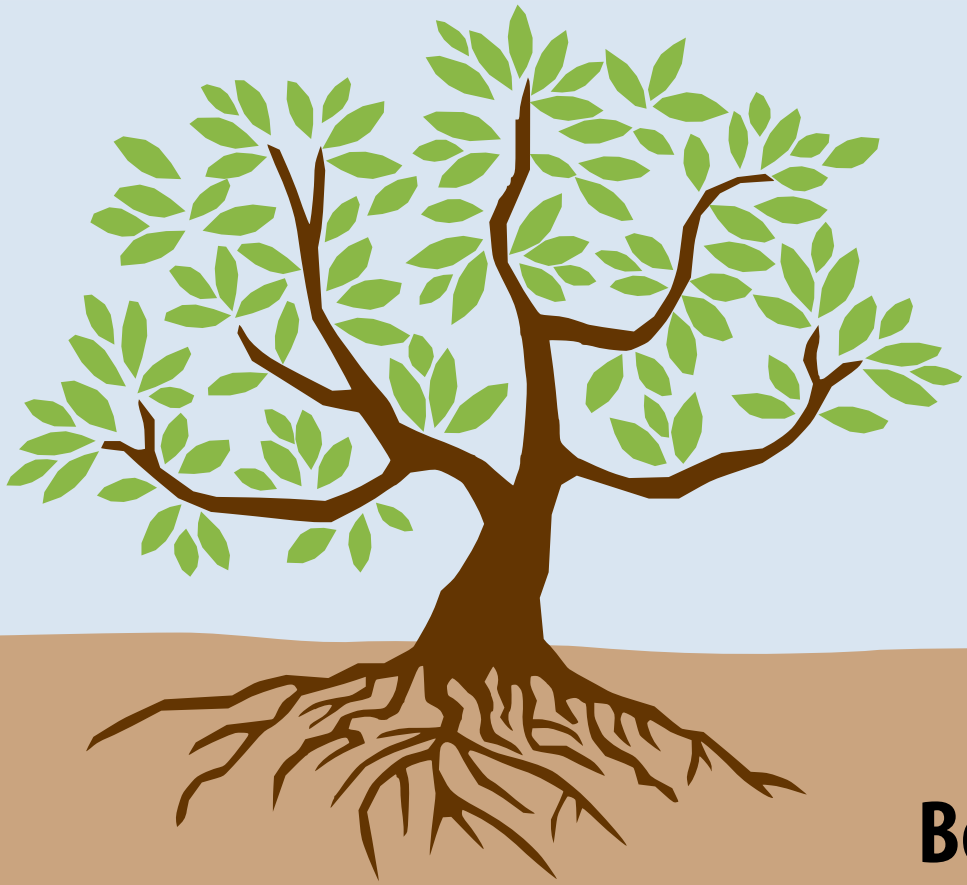
FertiPlus

f SéNeCa(+) Agencia de Ciencia y Tecnología Región de Murcia

III International Symposium on Organic Matter Management and Compost Use in Horticulture

April 20-24th 2015

Murcia, Spain



Program // Book of Abstracts

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Official website of the Symposium: www.compost-for-horticulture.org

FINAL VERSION 29 May 2015

WELCOME

Dear Colleagues,

On behalf of the International Society for Horticultural Sciences (ISHS) and the Spanish National Research Council (CSIC), we are delighted to welcome you to the **III International Symposium on Organic Matter Management and Compost Use in Horticulture** (**Murcia, Spain)**.

The scientific program during the next four days has been designed to gather the main scientific and practical challenges for the sustainable recycling of organic residues in agriculture. The selection of research topics includes nutritional issues (N use efficiency and P recycling) and the implication on global food security, different environmental impacts associated to the use of organic amendments, and also a reflection on novel soil conditioners and future needs to ensure their safe use.

Two key research topics have attracted the attention of researchers and we would like to highlight them here. First, the opportunity of using organic wastes as an alternative source of P for food production, as a means to reduce our dependence on the natural P resources. Another important and hot topic of research is the combination of biochar and compost and their potential synergy during the composting process. A specific session is devoted to the interaction of biochar and organic matter both in soil and during composting, in the framework of the European project FERTIPLUS (www.fertiplus.eu). A round table has been organized to discuss this topic and everybody is invited to actively participate in the discussions.

We would like to thank our colleagues from all around the world for their significant contributions, which allows the consolidation of a growing event initiated back in 2011 in Brisbane (Australia) and which continued in Santiago (Chile) in 2013. This edition has received a positive response from research groups from the five continents with 304 authors and 80 delegates presenting their most updated research in the area. The third edition of this symposium is especially relevant this year, when we are celebrating the 2015 International Year of Soils. The overall topic of the Symposium, combining organic waste management and compost use in horticulture, gathers different key agricultural practices in line with the main goals of this important FAO initiative.

Finally, we have made an effort to encourage the participation of early stage researchers in this event, with special fees for students and three Young Scientist Awardees.

We hope you learn from the many and varied presentations, engage in thrilling scientific discussions, find useful contacts for your network and enjoy meeting old and new colleagues during the next days in Murcia.

Enjoy the conference, we look forward to meeting you!

The Organising Committee

2015 International Year of Soils

CSIC
Consejo Superior de Investigaciones Científicas

Organising Committee

- Dr. Miguel Ángel Sánchez-Monedero (CEBAS-CSIC, Spain)
- Dr. Mariluz Cayuela (CEBAS-CSIC, Spain)
- Dr. José Antonio Alburquerque (CEBAS-CSIC, Spain)
- Dr. Asunción Roig (CEBAS-CSIC, Spain)

Scientific Committee

- Dr. Flora Alonso Vega (Vigo University, Spain)
- Prof. Nanthi Bolan (University of South Australia, Australia)
- Dr. Louise Fletcher (University of Leeds, UK)
- Dr. José María Gómez Palacios (Biomasa del Guadalquivir S.L., Spain)
- Prof. Mohamed Hafidi (Cadi Ayyad University, Morocco)
- Dr. Sabine Houot (INRA, France)
- Dr. Peter Kuikman (Alterra Wageningen UR, The Netherlands)
- Dr. Guadalupe López (TECNOVA, Spain)
- Dr. Maria Mercedes Martinez S. (Universität Bonn-Germany & Universidad Federico Santa Maria-Chile)
- Prof. Patricia L. Millner (USDA, ARS, USA)
- M.Sc. Daniel Meyer-Kohlstock (Bauhaus-Universität Weimar, Germany)
- Dr. Claudio Mondini (Consiglio per la ricerca e la sperimentazione in agricultura, CRA, Italy)
- Dr. Varughese Philip (Agri-Food & Veterinary Authority, Singapore)
- Dr. Andrew Ross (University of Leeds, UK)
- Prof. Sami Sayadi (Center of Biotechnology of Sfax, Tunisia)
- Dr. Bart Vandecasteele (ILVO, Belgium)

PROGRAM

General Program and Oral Communications

Monday 20th

16:00-19:00 Registration and placement of posters.

Tuesday 21st

08:00-10:00 Registration and placement of posters.

09:00-09:15 Opening Ceremony.

09:15-10:00 **Opening lecture**. Past, present and future of compost research.
Prof. Ed Stentiford, University of Leeds (UK)

10:00-10:45 **Opening lecture**. Compost as a tool to suppress plant diseases: Established and putative mechanisms.
Prof. Michael Raviv, Agricultural Research Organization (Israel). ISHS Representative.

10:45-11:15 **Coffee break and poster session.**

SESSION 1. NUTRITIONAL ASPECTS OF THE USE OF COMPOST IN AGRICULTURE. ROLE IN GLOBAL FOOD SECURITY
Chair: Peter Kuikman and Bart Vandecasteele

11:15-12:00 **Keynote lecture.** Phosphorus fractions in organic materials and their effects on soil P levels and crop nutrition.
Prof. Rodrigo Ortega Blu, Universidad Técnica Federico Santa María (Chile).

12:00-12:15 Crop yield and N management in an organic horticultural rotation with compost, commercial organic fertilizer and green manure. *Pinto R, Brito LM and Coutinho J (Portugal)*

12:15-12:30 Nitrogen recovery and nitrogen use efficiency of potatoes in an integrated composts fertilization in an andosol soil. *Nakidakida TG and Hayashi H (Japan)*

12:30-12:45 Lettuce (*Lactuca sativa* cv. Webbs Wonderful) shoot and root growth in different grades of compost and vermicomposted compost. *Duggan T and Jones P (Ireland)*

12:45-13:00 Effects of vermicompost and soil ratios on qualitative properties and minerals element contents of Basil (*Ocimum basilicum* L). *Hosseini Farahi M and Noroozinejad M (Iran).*

13:00-13:15 Developing site-specific fertilizer recommendations in Ethiopia: a quick-scan tool based approach in the CASCAPE project innovation team. *Heesmans H, van Beek CL and Elias E (The Netherlands/Ethiopia)*

13:30-15:00 **Lunch time and poster session.**

SESSION 2. IMPACT OF ORGANIC AMENDMENTS ON SOIL SUSTAINABILITY

Chair: Michael Raviv and Maria M Martínez

15:00-15:45 **Keynote lecture.** The complexity of soil sustainability: linking organic C levels to soil biological properties and soil resilience.
Prof. Maria De Nobili, University of Udine (Italy).

15:45-16:00 Impact of long term compost amendments on soil fertility, soil organic matter distribution and nitrogen mineralization. *De Clercq T, Elsen A, Vandendriessche H and Merckx R (Belgium)*.

16:00-16:15 Multi-criteria indexes to evaluate the effects of repeated organic amendment applications on soil quality. *Obriot F, Stauffer M, Goubard Y, Vieublé-Gonod L, Revallier A and Houot S (France)*

16:15-16:30 Can simple indices derived from soil incubations explain soil and maize response to organic and mineral fertilization in real agroecosystems?. *Fiorentino N, Bertora C, Ventorino V, Fagnano M, Pepe O and Grigniani C (Italy)*

16:30-17:00 **Coffee break and poster session.**

17:00-17:15 The relevance water-, nutrient-, and hormonal homeostasis in the molecular and physiological mechanisms involved in the plant growth promoting action of humic substances. *Olaetxea M, Mora V, Bacaicoa E, Garnica M, San Francisco S, Casanova E, Zamarreño AM, Baigorri R, Erro J, Urrutia O and García-Mina JM (Spain)*

17:15-17:30 Using compost amendments to enhance soil health and replant establishment of tree-fruit and berry crops. *Forge TA, Neilsen D, Zebarth B, Neilsen G, Kenney E, Hashimoto N and Watson T (Canada)*

17:30-17:45 Insights into the suppressiveness of composts against *Phytophthora nicotianae* by omics. *Blaya J, Macías R, Santísima-Trinidad AB, Pascual JA and Ros M (Spain)*

Wednesday 22nd

SESSION 3. RECYCLING OF ORGANIC WASTES IN AGRICULTURE
Chair: Claudia Kammann and Hanneke Heesmans

09:00-09:45 **Keynote lecture.** Carbon accounting for compost - from feedstock to farm.
Dr. Sally Brown, University of Washington (USA).

09:45-10:00 Development of markets for using compost in horticulture- Victoria Australia. *Vujovic S (Australia)*

10:00-10:15 Recycling of organic wastes in Brazil: composting, substrate and fertilizer manufacture. *Silva CA (Brazil)*

10:15-10:30 Characterization of the digestate from microalgae anaerobic digestion and co-digestion with sewage sludge for agricultural use. *Solé M, Folch M, Tàpies J, Matamoros V, Garfí M, García J and Ferrer I (Spain)*

10:30-10:45 Co-composting as a method to produce a nutrient rich compost from olive mill waste to use as a substitute for growing strawberries in the UK. *Mortimer N, Fletcher L and Velis C (UK)*

10:45-11:00 Evaluation of a nitrification inhibitor in nitrogen stabilization, fertility potential and biochemical properties during the composting process of sugar mill residues. *Martinez MM and Ortega Blu R (Chile)*

11:00-11:30 **Coffee break and poster session.**

11:30-11:45 Effect of compost amendment on the growth of ornamental plants in a soilless substrate for green roofs. *Di Bonito R, Biagiotti D, Giagnacovo G, Canditelli M, Campiotti CA (Italy)*

11:45-12:00 Phosphorous availability of seven organic manures in a sandy soil. *Cardoso CE, López F, Orden L, Rodríguez R and Díaz J (Argentina/Colombia)*

SESSION 4. ENVIRONMENTAL IMPACTS AND HEALTH RISKS ASSOCIATED TO THE USE OF COMPOST IN AGRICULTURE
Chair: Ed Stentiford and Asunción Roig

12:30-13:15 **Keynote lecture.** Health risks associated to solid waste composting: From production to use in agriculture.
Prof. Martí Nadal and Jose Luis Domingo, University Rovira i Virgili (Spain).

13:15-13:30 P leaching and effects of long term application of compost versus other fertilizer types. *Vanden Nest T, Vandecasteele B, Ruysschaert G, Cougnon M, Houot S, Reheul D and Merckx R (Belgium/France)*

13:30-15:00 **Lunch time.**

15:00-15:15 Assessment of groundwater vulnerability to pollution in Barrax, Albacete, Spain. *Komnitsas K and Bartzas G (Greece)*

15:30-16:00 **Poster session.**

16:00-17:00 **ISHS meeting.**

Thursday 23rd

SESSION 5. CHALLENGES FOR THE DEVELOPMENT AND TESTING OF NEXT GENERATION ORGANIC AMENDMENTS

Chair: Sally Brown and Mariluz Cayuela

09:00-09:45 **Keynote lecture.** Interaction of compost and biochar. Prof. Claudia Kammann, Hochschule Geisenheim University (Germany).

09:45-10:00 Biomass or Biochar – Which is superior at improving hydraulic properties?. *Spokas KA, Watts D, Jun T, Weis R, Novak J and Feyereisen G (USA/South Korea)*

10:00-10:15 Can biochar reduce nitrogen pollution from chicken manure? Assessing biochar's biogeochemical fate and policy opportunities. *Ryals R, Hastings MG, King D, Tang J (USA)*

10:15-10:30 Combination of biochar and clinoptilolite for nutrient recovery from liquid fraction of digestate. *Kocaturk NP, Bruun S, Zwart K, Brussaard L and Jensen LS (Denmark/The Netherlands)*

10:30-10:45 Addition of clay, biochar and their mixture during composting with earthworms: a strategy to reduce carbon emissions?. *Barthod J, Rumpel C and Dignac M-F (France)*

10:45-11:00 Are biochar and hydrochar adequate materials as substrate constituents? A summary of the research carried-out at UPV. *Fornes F and Belda RM (Spain)*

11:00-11:30 **Coffee break and poster session.**

SESSION 6. NUTRIENT AND ORGANIC MATTER RECYCLING VIA INTEGRATION OF BIOCHAR AND COMPOST. PERSPECTIVES FROM EUROPE'S FP7

Chair: Miguel A. Sánchez-Monedero and Carlos Alberto Silva

11:30-11:50 Investigating the nutrient adsorption capacities of various waste-derived biochars.
Ms. Chibi Takaya. University of Leeds (UK).

11:50-12:10 Potential of biochar in composting: effect on process performance and greenhouse gas emissions.
Dr. Claudio Mondini. CRA (Italy)

12:10-12:30 Interaction of biochar with compost, plant health, yield and soil quality: balancing risks and opportunities!.
Dr. Bart Vandecasteele, ILVO (Belgium).

12:30-12:50 New insights on the interaction between biochar and soil N_2O.
Dr. Mariluz Cayuela. CEBAS-CSIC (Spain).

12:50-13:10 Biochar as a soil amendment in vegetable crops developed under greenhouse conditions in Spain.
Dr. Carolina Martínez, TECNOVA (Spain).

13:30-15:30 **Lunch time and poster session.**

15:30-17:30 **Round Table.** Does biochar qualify for a role in sustainable agriculture and circular economy?.
Chairman: Dr. Peter Kuikman. Alterra (The Netherlands). FERTIPLUS coordinator.
Participants:

- Dr. David Wayne. Member of the IBI Board and Advisory Committee (UK)
- Dr. José María Gómez Palacios. Biomasa del Guadalquivir (Spain). REFERTIL
- Dr. Kurt Spokas. University of Minnesota (USA)
- Prof. Claudia Kammann. Hochschule Geisenheim University (Germany).
- Prof. Maria de Nobili. University of Udine (Italy)

Introductory talk. What might biochar cost?.
Dr. David Wayne. Member of the IBI Board and Advisory Committee (UK).

17:30-18:00 **Closing session.**

20:00 **Symposium dinner.**

Friday 24th

08:30-19:00 **Technical and cultural visit.**

Posters by session

SESSION 1. NUTRITIONAL ASPECTS OF THE USE OF COMPOST IN AGRICULTURE. ROLE IN GLOBAL FOOD SECURITY

P1-1. Influence of two methods of humic acid application on berry properties of grapevine cv Askari.
Mohamadinea GH and Hosseini Farahi M (Iran)

P1-2. Spent mushroom composts as organic fertilizer: first organic trials.
Gobbi V, Bonato S, Nicoletto C and Zanin G (Italy)

P1-3. Nitrogen mineralization of three organic amendments in two soils with contrasting textures.
Cardoso CE, Laurent G, Rodríguez RA, Miglierina AM and Orden L (Argentina)

P1-4. In-situ mineralization of a sandy soil amended with seven organic fertilizers.
Cardoso CE, Orden L, Rodríguez R, Díaz J and Martins M (Argentina/Colombia/Brazil)

P1-5. Integration of cover cropping and liquid manure application in pear (*Pyrus pyrifolia* cv. Niitaka) orchard.
Lee SE, Park JM, Park YE and Choi DG (Korea)

P1-6. Pear production system innovation: first results.
van der Maas MO and Heijne B (The Netherlands)

P1-7. Using compost to feed the soil community and meet the nutrient requirements of sweet corn.
Hutchinson M, Hutton MG, Handley DT, Britton W and Jackson TL (USA)

P1-8. Effect of compost application rates on high tunnel tomato yield.
Hutton MG, Hutchinson M and Handley DT (USA)

P1-9. Compost as a soil amendment for seed starting.
Stiles J, Hutchinson M and Hutton MG (USA)

P1-13. Evaluation of impact of phosphate-solubilizing microorganisms and humic substance on plant growth.
Giro VB, Vittorazzi C, Jindo K, da Conceição GP, Canellas L and Olivares FL (Brazil)

SESSION 2. IMPACT OF ORGANIC AMENDMENTS ON SOIL SUSTAINABILITY

P2-2. Assessing carbon inputs needs for sustaining organic matter levels and biochemical soil fertility in a baby leaf crop system in Southern Italy.
Pellegrino A, Morra L, Coppola R, Mondini C and Fornasier F (Italy)

P2-3. Humic acids and compost tea from compost for sustainable agriculture management.
Scotti R, D'Agostino N, Pane C and Zaccardelli M (Italy)

P2-4. Restoration of agricultural soil quality by the use of on-farm compost
Scotti R, Pane C, Palese AM, Celano G and Zaccardelli M (Italy)

P2-5. Effect of compost derived from olive mill wastes and natural zeolite on soil properties and nutrient content of open field tomato cultivation.
Kavvadias V, Kardimaki A, Katsaris P, Ioannou Z, Papadopoulou M, Vavoulidou E, Theocharopoulos S and Doula M (Greece)

P2-6. Effect of compost derived from sea grass and natural zeolite on soil properties and nutrient content of open field tomato cultivation.
Kavvadias V, Kardimaki A, Katsaris P, Papadopoulou M, Ioannou Z, Doula M, Vavoulidou E and Theocharopoulos S (Greece)

P2-7. Use of agricultural waste compost to suppress plant diseases.
Pane C, Scotti R, Celano G and Zaccardelli M (Italy)

P2-8. Organic wastes as alternative to inorganic fertilizers for a more sustainable agriculture.
Hernández T, Chocano C, Moreno JL and García C (Spain)

P2-9. The effect of rubber sheet wastewater treated by selected *Rhodopseudomonas palustris* strains secreting 5-aminolevulinic acid (ALA) on soil properties and rice chlorophyll fluorescence under saline stress.
Nunkaew T, Kantachote D and Ritchie RJ (Thailand)

P2-10. Agronomic and environmental evaluation of exhausted grape marc compost addition to an irrigated melon crop under field conditions.
Requejo MI, Cartagena MC, Ribas F, Villena R, Arce A, Cabello MJ and Castellanos MT (Spain)

P2-11. Biocontrol of *Rizoctonia solani* on tomato plants using *Trichoderma harzianum* from garden compost extracts.
Morales-Corts MR, Gómez-Sánchez MA, Pérez-Sánchez R, Suárez-Fernández MB (Spain)

P2-12. Biochemical composition, microbial activity and C/N ratio in composts: combining indicators for assessing product stability.
Vandecasteele B, Viaene J, Nelissen V, Reubens and, Willekens K (Belgium)

P2-14. Effects of the integrated nutrient management on soil properties in table grape var. Crimson seedless during establishment.
Ortega Blu R, Martínez MM, Ospina P (Chile)

P2-15. Organic mulching in high-density olive groves: the use of compost from municipal wastes.
Lodolini EM, Massetani F, Pica F, Orazi C, Polverigiani S and Neri D (Italy)

SESSION 3. RECYCLING OF ORGANIC WASTES IN AGRICULTURE

P3-1. Use of compost to mitigate salt effect of sediment from Taylor Creek in South Florida.
Stoffella PJ and He ZL (USA)

P3-2. The use of alkaline sugar beet lime sludge for composting sludge from food industry.
Hassani OS, Saadaoui N, Rida S, Souraa N, Loqman S and Fares K (Morocco)

P3-3. Sugar beet lime sludge composts as organic fertilizers.
Fares K, Saadaoui N and R'zina Q (Morocco)

P3-4. Co-composting of sludges from wastewater and sugar industry.
Rida S, Saadaoui N, Saadani Hassani O, Souraa N , Loqman S and Fares K (Morocco)

P3-5. Valorization of the organic wastes fraction of the old landfill by its using as an organic amendment.
Bouftila B, Zakri K, Saadaoui N and Fares K (Morocco)

P3-6. Co-composting of poultry manure, municipal organic wastes and sugar beet lime sludge for soil amendment.
R'zina Q, Saadaoui N, Lahrouni M, Almossaid Y, Oufdou K and Fares K (Morocco)

P3-7. Mix of composted urban waste and coir as potting media for basil production.
Pica F, Massetani F, Lodolini EM, Perugini M and Neri D (Italy)

P3-8. Comparing compost from urban waste and digested organic matter as fertilizers for corn production (*Zea mays* L.).
Perugini M, Massetani F, Lodolini EM, Pica F and Santilocchi R (Italy)

P3-10. Spent mushroom composts as organic fertilizer: chemical characterization.
Gobbi V, Bonato S, Zanin G and Sambo P (Italy)

P3-11. Application of agricultural waste compost in greenhouses growing horticultural crops.
Soriano MD, García-España L, García-Mares F and Boluda R (Spain)

P3-12. Isolation and characterization of native microorganisms with hydrolytic enzyme activity from sugarcane compost, for bioaugmentation processes.
Gallo A, Daza ZT, Rincón LM, Parrado DS, Santander MC and Martínez MM (Colombia/Germany).

P3-13. Use of compost co-utilized with rockdust for landscaping and site regeneration.
Szmidt RAK (UK)

P3-18. Impact of peanut shell mixed with peat moss as improved media and its effect on growth characters of petunia.
Shanan NT, Eldardiry EI and El-Hady A (Egypt)

SESSION 4. ENVIRONMENTAL IMPACTS AND HEALTH RISKS ASSOCIATED TO THE USE OF COMPOST IN AGRICULTURE

P4-1. Airborne levels of VOCs and bioaerosols near a composting plant in Catalonia, Spain. Human health risk assessment.
Domingo JL, Vilavert L, Nadal M, Schuhmacher M (Spain)

P4-2. The PO_4^{3-}/NO_3^- ratio of seepage waters as an indicator of macropore contributions to leaching in different agricultural land use.
Yoon DH, Kuecke M and Greef JM (Korea/Germany)

SESSION 5. CHALLENGES FOR THE DEVELOPMENT AND TESTING OF NEXT GENERATION ORGANIC AMENDMENTS

P5-1. Effect of charcoal-blended compost on the plant growth of *Brassica rapa var. peruviridis* for reduction of nitrogen fertilizer use.
Matsumoto K, Sato S, Sudo H, Fujita T, Sánchez-Monedero MA and Jindo K (Japan/Spain)

P5-2. Effect of the addition of sawdust biochar and zeolite on the quality of the compost produced from agricultural wastes.
Zaharaki D, Tinivella F, Medini L, Hernández MT, García C, Moreno JL and Komnitsas K (Greece/Italy/Spain)

P5-3. Co-composting with biochars.
Takaya C, Ross A, Fletcher L and Singh S (UK)

P5-4. Comparison of the levels of polycyclic aromatic hydrocarbons in biochars and hydrochars.
Anyikude K, Ross A, Singh S and Takaya C (UK)

P5-5. *Biochar impact on poultry manure composting.*
Sánchez-García M, Alburquerque JA, Sánchez-Monedero MA, Roig A and Cayuela ML (Spain)

P5-6. Biochar impact on olive mill waste composting.
López-Cano I, Roig A, Cayuela ML, Alburquerque JA and Sánchez-Monedero MA (Spain)

YOUNG SCIENTIST AWARD WINNERS

PhD STUDENT

JOSEFA BLAYA.

Affiliation: Department of Soil and Water Conservation and Organic Waste Management (CEBAS-CSIC, Murcia, Spain).

Title of the communication: Insights into the suppressiveness of composts against *Phytophthora nicotianae* by omics.

CARLOS E. CARDOSO (accessit)

Affiliation: Agronomy Department (Universidad Nacional del Sur, Bahía Blanca, Argentina).

Title of the communication: Phosphorous availability of seven organic manures in a sandy soil.

POSTDOC

REBECCA RYALS

Affiliation: Institute at Brown for the Environment and Society (Brown University, Providence, RI, USA).

Title of the communication: Can biochar reduce nitrogen pollution from chicken manure?. Assessing biochar's biogeochemical fate and policy opportunities.

BEST ORAL COMMUNICATION AWARDS

Most stimulating/challenging talk

TARA MARÍA DUGGAN.

Affiliation: University College Cork (Ireland).

Title of the communication: Lettuce (*Lactuca sativa* cv. Webbs Wonderful) shoot and root growth in different grades of compost and vermicomposted compost.

Best power point presentation

BART VANDECASTEELE .

Affiliation: Institute for Agricultural and Fisheries Research (Belgium).

Title of the communication: P leaching and effects of long term application of compost versus other fertilizer types.

Most innovative topic of research

MARÍA SOLÉ.

Affiliation: Universidad Politécnica de Cataluña (Spain).

Title of the communication: Characterization of the digestate from microalgae anaerobic digestion and co-digestion with sewage sludge for agricultural use.

BEST POSTER AWARD

INÉS LÓPEZ CANO.

Affiliation: CEBAS-CSIC (Spain).

Title of the communication: Biochar impact on olive mill waste composting.

PRACTICAL INFORMATION

All certificates related to your participation (attendance, oral and poster presentation) will be available to be downloaded on the Conference web page (http://www.compost-for-horticulture.org).

CONFERENCE VENUE LOCATION

AULA DE CULTURA DE CAJAMURCIA EDIFICIO GRAN VÍA.

Gran Vía Escultor Salzillo, 23.

SYMPOSIUM DINNER LOCATION (20:00, Thursday 23rd)

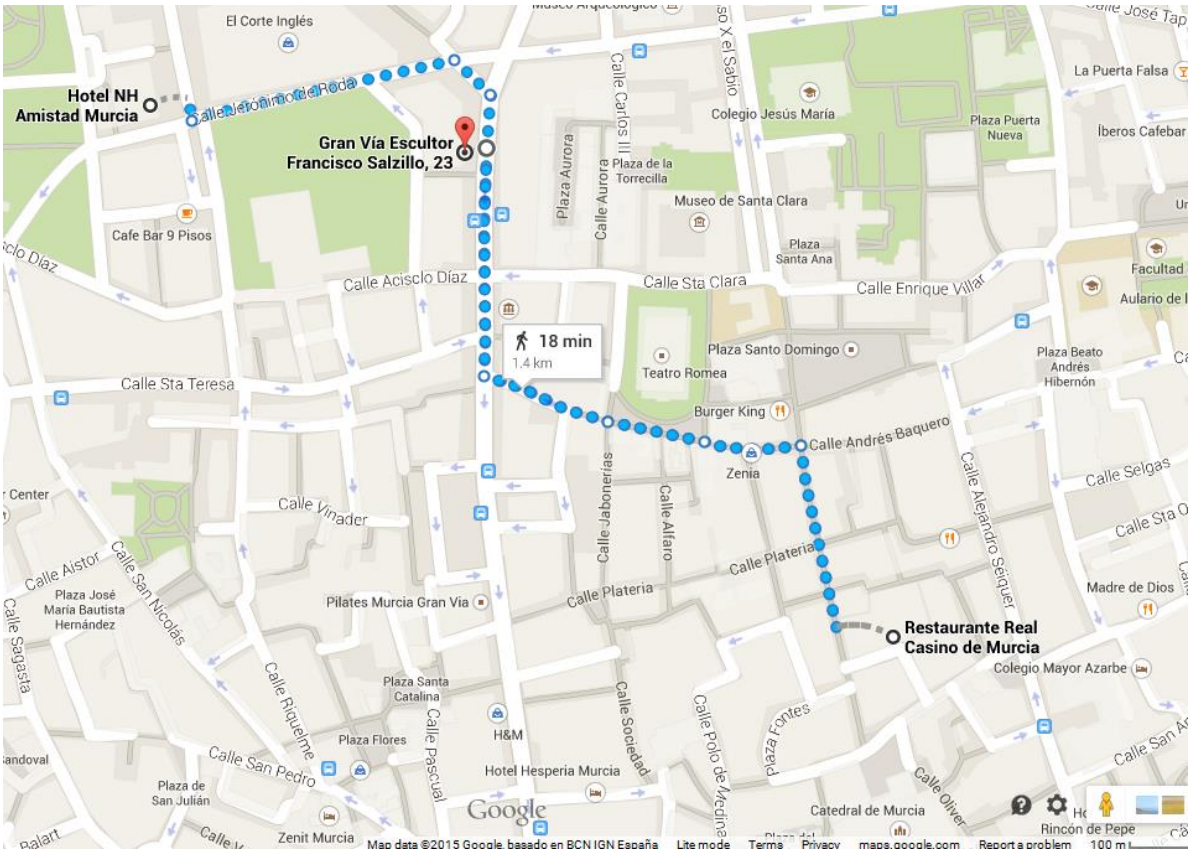
RESTAURANTE REAL CASINO DE MURCIA.

Calle de la Trapería, 18.

TECHNICAL AND CULTURAL VISIT (Friday 24th)

9:00h. The bus will pick us up at NH AMISTAD HOTEL.

Calle Condestable, 1.



OPENING LECTURES

Past, present and future of composting research

E. Stentiford[1], M.A. Sánchez-Monedero[2]

[1] School of Civil Engineering. The University of Leeds, UK
[2] Department of Soil and Water Conservation and Organic Waste Management. CEBAS-CSIC. Murcia. Spain
Email: e.i.stentiford@leeds.ac.uk

Concerns have been raised by some researchers that there is no future in compost research. This paper attempts to take an overview of composting and to set it in a historic context.

Composting represents one of the most widely utilised technologies for organic waste recycling in agriculture which has been used by mankind for many thousands of years: accounts go back to Chinese records from over 5000 years ago. Largely unchanged until early in the 20th century, it is only in the last 50 years or so that effective research has been carried out, both on the composting process and use of the compost product. Much of this research has been driven by the increasing need to find an alternative to landfill for biodegradable wastes, the importance of compost quality, and the implementation of compost quality standards.

Looking through past research it is apparent that some researchers have been better at disseminating the results of their work than others. The importance of dissemination is considered together with the available routes through publications, conferences, networking and outreach.

The future of composting is closely linked to the interests of researchers, governments and other funding agencies. Despite the great deal of research over the past 50 years certain areas are identified where it is considered that work is needed these include: pathogens identification and control, modelling feedstock and process variations, assessing health impacts of compost and the use of modern tools such DNA extraction for pathogen enumeration. Composting will continue to be an important process both on its own, particularly in developing countries, and as a complementary process for systems such as anaerobic digestion in industrialised countries.

In terms of the compost product, researchers are looking at ways of enhancing its value and performance, for example with the use of biochar. In addition there are certain components of the compost, such as phosphate, for which supply options are diminishing and it is important that we recognise the opportunity for compost to supply these needs.

Key words: composting research, compost quality standards, pathogens, health impacts

Compost as a tool to suppress plant diseases: Established and putative mechanisms

M. Raviv

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Well-prepared composts exert numerous beneficial effects on soil physical characteristics and on plant nutrition. Additionally, during the last 3 decades their potential effect on plant health became scientifically evident, but the huge variability among commercial composts placed a question mark regarding the reproducibility and practicality of the use of compost as a suppressive agent against soil-borne diseases (SBD). Only when commercial producers adhered to clear professional recommendation, results of large-scale operations were similar to those of scientific experiments. The main suppressiveness causal agents are consortia of microbial and fungal populations, which colonize the compost mainly during the curing stage. Sterilization largely negates compost suppressiveness, strengthening the notion that biological activity is responsible for most of this phenomenon. Residual non-biological activity is probably related to fungistatic compounds, present in some compost types. Several mechanisms which will be described in the full paper were proposed to explain the suppressive effect of composts on SBDs. Some of these mechanisms, such as competition for nutrients, hyperparasitism, antibiosis, induced systemic resistance and systemic acquired resistance are well documented and proven. The last two mechanisms affect also some above-ground (e.g. foliar) diseases. Several other proposed mechanisms were validated only occasionally. Examples for these mechanisms are induction of futile spore germination, in the absence of host; adsorption of root signals on active surfaces, and their eventual decomposition by soil microorganisms, and others. In some cases a joint activity of two or more mechanisms were suggested, which strengthened the suppressiveness capacity of some composts. Disease suppressiveness was identified against fungal and bacterial diseases, as well as against some nematodes.

***Key words*:** Soil-borne disease, soil microorganisms, suppressiveness

SESSION 1

Nutritional aspects of the use of compost in agriculture. Role in global food security

ORAL CONTRIBUTIONS

Phosphorus fractions in organic materials and their effects on soil P levels and crop nutrition

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Phosphorus is a key element for sustainable agricultural production; there are many soils around the world that still are P-deficient while others, long term-treated with some P-rich organic materials, have an excessive P content, potentially contributing to water contamination and some nutrients imbalances in crop production.

Most P sources used in agriculture are of mineral origin, with world reserves of phosphoric rock being rapidly depleted. The use of organic materials and compost are an excellent alternative to mineral sources; however it is necessary to properly characterize the materials and understand their contribution to soil P fractions and crop nutrition. Most norms on compost and organic materials around the world require characterization of the product only in terms of its total P content; however this analysis does not tell much in terms of its contribution to plant nutrition over time. Other fractions such as organic, water soluble, and labile P should be included to better characterize organic materials.

In this presentation, the different P fractions used to characterize compost and other organic materials and their effects on soil P levels and crop nutrition will be discussed. Emphasis will be put on the different analytical methods to better estimate P availability for plants, in organic materials and soil, respectively.

Key words: organic materials, phosphorus, P fractions, P availability

Crop yield and N management in an organic horticultural rotation with compost, commercial organic fertilizer and green manure

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A three year field crop rotation was set up in a sandy loam soil with an organic C content of 23.4 g kg^{-1} and a total N content of 1.9 g kg^{-1} with rye and vetch as green manure over the autumn/winter followed by potato and lettuce (2012), Swiss chard and navet (2013), and Portuguese cabbage and carrot (2014). N mineralization was determined by field incubation in response to green manure (GM), GM with 20 and 40 t ha^{-1} compost (C20 and C40) and GM with 1 and 2 t ha^{-1} of commercial organic fertilizer (CF1 and CF2). Lettuce, navet and carrot yields increased in the treatment C40 compared to all other treatments because most of the organic fertilizer was mineralized during the previous crop whereas N mineralization in stabilized compost took place during all crop rotation. Potato and Swiss chard yield increased in treatment CF2. However, there were no significant differences between treatment CF2 and C40 in the Portuguese cabbage yield probably due to continuous compost application and the increased amount of green manure biomass in treatment C40. Therefore, the application of 40 t ha^{-1} of farmyard manure compost combined with rye and vetch was found to be the best treatment to increase overall crop yields during this organic horticultural rotation.

Key words: compost, crop yield, field incubation, nitrogen mineralization, organic agriculture

Nitrogen recovery and nitrogen use efficiency of potatoes in an integrated composts fertilization in an andosol soil

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The effects of composts in a potato production system were analysed in terms of growth, yield, nitrogen recovery and nitrogen use efficiencies. Increasing chemical fertilizer (CF) costs have seen farmers applying less than the recommended amounts. Compost has not only been used as a soil amendment, but also as a nitrogen source for potatoes and for constructing a sustainable low chemical fertilizer input production system. Integrated fertilization was evaluated against the sole application of compost or CF. The integrated plots' total, marketable and cumulative tuber yields were equal to or higher than the 100 % chemical fertilizer plot (CF100). Nitrogen recovery efficiencies (REN) of the compost-amended plots were not significantly different from CF100 (18.4 %). Agronomic nitrogen use efficiency (AEN) was not different but the highest was with SM25 (78.9 kg/kg). There were significantly high internal nitrogen use efficiencies (IEN) in almost all of the integrated plots compared to CF100. Partial factor productivity (PFP) was highest in PM25 (223.7 kg/kg). Productivity in the integrated plots was higher than with CF100 considering its reduced CF input. IEN and PFP were indices with significant differences in this study. Composts, specifically PM and its integrations had higher IEN than CF100 and could be candidates for reducing CF input.

***Key words**:* agronomic nitrogen use efficiency, nitrogen recovery efficiency, internal nitrogen use efficiency, partial factor productivity, cumulative tuber yield, continuous cropping

Lettuce (*Lactuca sativa* cv. Webbs Wonderful) shoot and root growth in different grades of compost and vermicomposted compost

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Immature compost can have negative plant and soil effects such as phytotoxicity, soil N immobilisation, and reduced plant growth, especially when used in horticultural applications e.g. as a growing medium. Composting involves three main stages; sanitisation, stabilisation, and maturation. This study investigates the use of vermicomposting as a post-stabilisation method to increase the rate of maturation of composted horse manure. It also compares the effects of three grades (ungraded, >3 mm and <3 mm particle size), and increasing rates (0, 10, 20, 50, and 75% vol/vol in a peat-based growing medium) of the compost and the vermicomposted compost on lettuce shoot and root growth. Compared to composting, vermicomposting reduced the pH, C/N, and increased electrical conductivity and nutrient content. Mean shoot fresh and dry weights were significantly higher in plants grown with vermicompost, compared to compost. The addition of either amendment increased root fresh and dry weight and reduced root water content significantly. Shoot water content responded differently with increasing concentration of vermicompost and compost amendments. The different amendment grades affected shoot dry weight and shoot water content. Vermicomposting increased the rate of maturation, resulting in significantly larger plants, with reduced conductivity stress and root/shoot ratio, especially at higher amendment concentrations.

***Key words*:** composting, vermicomposting, phytotoxicity, growing medium, maturation

Effects of Vermicompost and soil ratios on qualitative properties and minerals element contents of Basil (*Ocimum basilicum* L)

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In order to evaluate different ratios of vermicompost and soil on yield and content of minerals element concentrations of Basil (*Ocimum basilicum* L), a pot experiment based on randomized block design with three replications was conducted in 2014. Ratios of vermicompost (V) and soil (S) were: 0-100, 25-75, 50-50, 75-25, and 100-0. The following parameters were measured: plant height, fresh and dry weights of shoot and root, potassium and nitrogen contents, Chlorophyll index, length of root and number of leaves. Results showed that vermicompost has significant effects on the investigated parameters. The highest length of stem (26.28 cm) was obtained in plants treated with S_{50}-V_{50} and S_{25}-V_{75} as compared to untreated plants (18.58 cm). The most of aerial fresh weight was observed in plants grown with S_{25}-V_{75} and the least was in S_{100}-$V_{0.}$ The most of leaf numbers was obtained in basil planted in S_{50}-$V_{50.}$ The highest nitrogen and potassium content in leaf was observed in soil alone (100-0) as compared to other treatments. Therefore, the use of soil and vermicompost in equal ratio (50-50) in production of basil is suitable.

***Key words*:** nitrogen, potassium, basil, vermicompost

Developing site-specific fertilizer recommendations in Ethiopia: a quick-scan tool based approach in the CASCAPE project innovation team

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Soil fertility has become a major constraint for crop production in Ethiopia. Nutrient mining is widespread, which constrains agricultural growth in the country. In the project CASCAPE the concept of Integrated Soil Fertility Management (ISFM), in which the use of mineral sources of nutrients is integrated with organic sources of nutrients combined with good agronomic practices, is taken as a starting point for improving the productive capacity of the soils. Moreover, it is acknowledged that different interventions are needed at different spatial scales. Therefore, field experiments on improved nutrient management strategies were conducted during the 2011 and 2013 growing seasons to develop a national instrument for soil-crop specific fertilizer recommendations. In this paper, the initial results of fertilizer trials and the suggested soil-crop specific fertilizer recommendations are presented. The results show significant increases in yield levels and agronomic use efficiencies as a result of application of different types of fertilizer. It is concluded that at present unnecessary losses of nutrients occur because of unbalanced fertilization leading to economic losses of about 575 ETB/ha. The national fertilizer recommendation instrument as developed by CASCAPE may be used by the Ministry of Agriculture as part of the formulation of new fertilizer recommendations under the Soil Fertility Roadmap.

***Key words**:* best agricultural practices, fertilization, soil nutrients, agricultural productivity

SESSION 2

Impact of organic amendments on soil sustainability

ORAL CONTRIBUTIONS

The complexity of soil sustainability: linking organic C levels to soil biological properties and soil resilience

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Addition of organic amendments can help to increase organic matter levels and reduce the risks of soil degradation and greenhouse gas emissions. Carbon levels can be successfully restored in soils through practices such as incorporation of crop residues, re-vegetation and application of manures, biosolids and composts. Some amendments, such as olive mill waste compost, promote incorporation of altered lignin structures, N-containing compounds and carbohydrates into humic acids. The mineral bound fraction of humic C also increases, after their addition, and contributes to the build up of the most inert soil C pool.

Additions of organic amendments to soil not only compensate for decreased soil C, but also contribute to energy requirements for conserving biological activity levels. Comparatively few studies have considered the direct nutritional role of soil organic matter and its buffering action against short or long periods of insufficient organic carbon inputs to sustain microbial activity. We observed the metabolic behaviour of soil microbial biomass when it utilised organic matter in soils that received very different organic C inputs over 150 years. The soils of the long term experiments at Rothamsted, UK, offer a unique opportunity to study long-term changes caused by different organic C inputs to the soil without a confounding effect due to other factors. Soils of low organic C content, previously receiving inorganic fertilizer (NPK), showed the greatest decline in biomass C during the first 30 days of incubation. Losses were about two to three times larger than those observed in comparable farm-yard manure treated soils, which

declined on average by only about 14%. The ATP concentration of this rapidly declining microbial biomass did not change during the prolonged incubation period, when the only C sources could have been derived from endocellular reserves, dead microorganisms or soil organic matter. At the same time, its specific respiration rate did not depend upon substrate availability, being larger in soils that had received the lowest C inputs. The qualitative and quantitative changes observed suggest the existence of complex decomposition/re-synthesis equilibria. Humified soil organic matter is probably a much more dynamic component than is normally considered and a utilizable energy reserve for soil microorganisms when C inputs to soil are discontinued.

***Key words**:* organic amendment, soil microbial biomass, humification, carbon inputs

Impact of long term compost amendments on soil fertility, soil organic matter distribution and nitrogen mineralization

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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. 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 less protected SOM fractions. These results were combined with a 400 day long incubation experiment to investigate the influence of long term compost fertilization, causing an altered SOM distribution, on the soil respiration and nitrogen mineralization.

***Key words**:* compost amendments, soil organic matter, organic matter mineralisation, long term effects, aggregate distribution

Multi-criteria indices to evaluate the effects of repeated organic amendment applications on soil quality

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Soil application of organic waste products (OWP) favours the increase of soil organic matter, the biological activity, the recycling of nutrients and crop production, but it may also lead to soil contamination. All these effects may occur simultaneously and must be considered in the evaluation of the practice. Various urban composts and manure have been applied in September every second year in a long term field experiment. A soil sampling assessing the cumulative residual effect of 7 applications was compared to a second sampling assessing the additional effect of a recent application. More than 30 different soil indicators were measured (organic C, N availability, pH, $P_{Olsen,}$ plasticity, microbial biomass, enzymatic activity, heavy metals, etc.) and classified in classes: fertility, microbial activity, biodiversity, physical properties, productivity and contamination. Five soil quality indices (SQI) and one contamination index (CI) were estimated using a weighted additive calculation method described by Velasquez et al. (2007). Repeated application of OWP improved soil fertility and microbial activity index compared to control treatments, but did not significantly affect the SQI dedicated to biodiversity. The largest improvements were observed in treatments that were more efficient at increasing the soil organic matter content. A recent additional application did not impact the biodiversity, microbial activity and fertility SQI. Physical properties, productivity and contamination indices will be presented also. The use of SQI allows the evaluation of specific ecosystem services (soil biodiversity, crop productivity, etc.) and disservices (heavy metal contamination) related to applications of OWP in soil.

Key words: organic waste product, cumulative residual effect, recent application effect, soil quality index, aggregated method

Can simple indices derived from soil incubations explain soil and maize response to organic and mineral fertilization in real agroecosystems?

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A deeper knowledge of the fate of N from organic fertilizers is required to optimize N rates, getting valuable crop performances and minimizing the impacts on the environment. In this work we used data from a 3-year field study and a medium term soil incubation to highlight the connections between field plot and soil laboratory incubation approaches in studying N availability from fertilized soils. Simple chemical and microbiological indices are evaluated to identify a predictor of mineral N for crops easy to use at field scale. N fixing free living bacteria seem to give a good indication about the soil attitude to mineralize native and added organic matter. Moreover, comparing the abundance of different microbial groups involved in nitrification can also give useful indications to plan an adequate fertilization. Mineral N data from soil incubation resulted a good predictor of crop N uptake in real field conditions when incubation length was normalized over the crop growth cycle according to the simplified model of thermal time. According to our results, short-medium term incubation should give consistent information about the soil fertility, if chemical data are coupled with microbial analyses of specific functional groups involved in the N cycle.

Key words: compost, soil incubation, N mineralization, maize, mineral N, N-cycling bacteria

The relevance of water-, nutrient-, and hormonal homeostasis in the molecular and physiological mechanisms involved in the plant growth promoting action of humic substances

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The ability of humic substances (HS) obtained from different sources to affect plant development and mineral nutrition has been reported, well established and supported by experimental findings. On many cases these effects may be explained by HS-mediated improvements in soil texture, microbiota activity and/or nutrient bioavailability. However, in other cases the presence of some type of direct action on root and functionality cannot be ruled out.

A number of studies have reported that the effects of HS on root lateral growth and root architecture seems to be functionally related to IAA-, ethylene- ABA- and NO- dependent metabolic pathways. Likewise, other studies reported that the shoot growth promoting action of HS seems to be related to cytokinin root to shoot translocation and CKs-regulated processes. Furthermore, these HS-effects are also closely related to the activation of genes and enzymes involved in root nutrient uptake and further metabolism, as well as water root uptake and water plant homeostasis. However, the functional relationships integrating the HS growth promoting effects on both shoot and root remain unclear. In this work we try to present a holistic model on the coordinated positive action of HS, extracted from compost and sediments, on both root and shoot. This model tries to stress some of the main questions that remain unclear, which, on the other hand, directly influence our ability to develop more efficient humic-based products for agriculture.

Key words: humic substances; plant growth; hormones; mineral nutrition; water homeostasis

Using compost amendments to enhance soil health and replant establishment of tree-fruit and berry crops

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Young fruit trees or berry crops replanted into soil previously used for the same crops are often stunted. This replant disease syndrome is usually associated with root-lesion nematodes (genus *Pratylenchus*) and/or infection by opportunistic soil-borne fungi. Poor soil physical and chemical properties also contribute to poor replant establishment and may interact with biotic agents. Commercial growers have relied primarily on chemical fumigants to reduce pathogen populations prior to replanting. In order to develop more sustainable alternatives, we studied the effects of manure-based compost amendments on nematode populations, soil properties and replant establishment of raspberry and sweet cherry in British Columbia. Raspberry experiments involved comparing pre-plant amendments of compost, poultry manure, cover crop-green manure, fumigation and an untreated control. The cherry experiment involved comparing pre-plant amendments of compost, fumigation and an untreated control, with and without post-plant application of wood chip mulch. In raspberry, compost and manure treatments suppressed root-lesion nematode populations, improved soil chemical and physical properties, and enhanced plant growth relative to the untreated control. The manure treatment resulted in excessive soil nitrate that would threaten groundwater quality. Fumigation resulted in the greatest plant growth but had deleterious effects on soil physical properties. In cherry, the compost amendment suppressed root-lesion nematode populations and increased first-year shoot growth relative to the untreated control and similar to fumigation. We conclude that because compost amendments provide multiple soil health benefits in addition to improving early plant growth, they are more sustainable options for overcoming replant stress than fumigation.

Key words: replant disease, *Pratylenchus penetrans*, raspberry, cherry, nematode suppression, fumigation alternatives

Insights into the suppressiveness of composts against *Phytophthora nicotianae* by omics

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Phytophthora root rot caused by the soil-borne pathogen *Phytophthora nicotianae* is an economically important disease in pepper plants. Nowadays, there are not effective treatments for its control, being the use of compost a promising alternative. The use of composts in growing media to suppress several soil-borne pathogens has been widely studied. However, inconsistent results limit its practical use. We have investigated the suppress capability of four composts-peat mixtures against *P. nicotianae* in pepper plants. Different parameters were measured to try to predict the suppressive effect of composts, including the enzymatic activity dehydrogenase, chemical features (pH, electrical conductivity, total carbon, total nitrogen) and organic fractions composition (by SP-MAS ^{13}C-NMR spectroscopy). In addition, omic approaches such as metagenomic and metabolomic were performed. We have observed that the control of *P. nicotianae* seems to be related to the activity of a consortium of microorganisms, which is associated with the ability of materials to sustain sufficient microbial activity over time. We found that dehydrogenase activity was highly correlated with disease suppression as well as the principal component analysis of the metabolome of composts separated them according to their suppressiveness. It seems that the study of metabolome of composts may be a good tool to predict the suppressiveness against this oomycete. We conclude that the integration of different parameters may be a useful approach to improve the disease suppression prediction of compost.

Key words: suppressiveness, compost, *Phytophthora nicotianae*, dehydrogenase activity, metabolomic, metagenomic

SESSION 3

Recycling of organic wastes in agriculture

ORAL CONTRIBUTIONS

Carbon accounting for compost from feedstock to farm

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The primary benefits for waste diversion to composting derive from fugitive gas avoidance associated with landfilling. Quantifying these benefits involves estimating the rate of decay, total methane generation potential, and methane capture efficiency within a landfill for different feedstocks. If material is composted, there is also a concern that fugitive gasses will be emitted during the composting process. The US EPA has recently re-evaluated their WARM (Waste Reduction Model) model and has values for food scraps that appear to be more reflective of the actual benefits for landfill diversion. The WARM calculations for green waste still indicate that landfilling is a preferred option. The assumptions behind these calculations are questionable. A second consideration that is referenced in the new WARM model but not fully quantified are the benefits associated with compost use. These include soil carbon sequestration, fertilizer avoidance, and increased resilience for soils and crops. As our climate changes, this increased resilience is likely to be a critical factor.

Key words: methane, composting, landfill avoidance, nitrous oxide, fugitive emissions, resilience

Development of markets for using compost in Horticulture- Victoria Australia

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Compost Victoria is the peak industry body for the Organics Recycling Industry in Victoria, Australia. We currently collect around 350,000 ton/annum of organic wastes (including household and commercial landscaping green waste), which are diverted from landfill and converted into a compost product for use in a variety of markets. Current models predict this to grow to 1.3 million ton/annum by 2025. Compost Victoria works with the industry to promote high standards of production and product quality management in order to serve the current market and develop new. Most compost products are currently sold into the urban amenity market (landscaping and soil yards) with smaller but increasing amounts going to the agricultural sector.

A key element of Compost Victoria market strategy is to work with the horticultural industry leaders and their respective associations to do limited applied research trials in order to build an understanding of the markets, including the effectiveness and viability of products within markets. The aim of this collaboration is to build evidence in product effectiveness (benefits to the end user) specific to the end user commodity and geographical area, and focus on identifying barriers that may prevent growers becoming regular compost customers. At the moment Compost Victoria is trialling compost products with horticulture in strawberry, berries (Blackberry, Raspberry and Blueberry), grapes and vegetable industries.

We believe that establishing compost demonstrational trials with leading growers and working with their industries will lead to on farm practice changes with the increased use of Recycle organic compost products.

Key words: Compost Victoria, organics recycling, compost, practice change, horticulture

Recycling of organic wastes in Brazil: composting, substrate and fertilizer manufacture

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High amounts of wastes are produced in Brazil. Since most organic wastes produced in Brazil are not disposed adequately, compost end-products are an economic and environmental way to recycle nutrients. When mixed appropriately, organic wastes also generate rich nutrient composts that could be used to produce substrates and fertilizers.

Waste inventory and factors regulating the composting process are discussed in this manuscript by covering the following issues:

1. The waste inventory includes manures, plant residues, industrial and agro industrial wastes and postharvest residues of coffee, sugarcane and eucalyptus.
2. The best mixing of wastes in order to control pH, C/N ratio, N levels and other biological, chemical and physical factors that regulate composting process.
3. Changes in the composition and in the main characteristics of composts are discussed in order to optimize the manufacture of substrates and high agronomic value fertilizers.
4. The use of renewable wastes in substitution to peat, vermiculite and pine bark in substrate production.
5. Factors controlling the production of high agronomic value organic and organo-mineral fertilizers, mainly those associated to pH, amounts and forms of N, P and K fertilizers and raw materials mixed in industrial plants with different humified organic matrices.

Recycling of substantial amounts of organic wastes produced in Brazil could have important benefits for crops, environment and Brazilian economy.

Key words: composting, organic matter, waste inventory, humic substances, organic fertilizers

Characterization of the digestate from microalgae anaerobic digestion and co-digestion with sewage sludge for agricultural use

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Microalgae-based wastewater treatment systems have drawn attention to combine wastewater treatment and bioenergy production. The most straightforward process is anaerobic digestion, which produces biogas along with a digestate that may be used in agriculture. However, the suitability of this digestate for agricultural use has yet to be determined. The aim of this study was to characterize the digestate from anaerobic digestion and co-digestion with primary sludge in terms of nutrients, pathogens, emerging contaminants, heavy metals and dewaterability. According to the results, microalgae digestion and co-digestion digestates presented high organic matter content and macronutrients, especially organic and ammonia nitrogen, available for agricultural reuse as organic fertilizer. However, pathogen removal under mesophilic conditions was poor and ought to be improved with advanced treatments. Only some emerging contaminants could be removed during anaerobic digestion. Dewatering properties were significantly improved after co-digestion, which appears as a promising alternative to improve microalgae digestion and digestate management for its subsequent use in agriculture.

***Key words**:* microalgae digestate, co-digestion, anaerobic digestion, agricultural reuse, emerging contaminants removal, organic matter mineralisation

Co-composting as a method to produce a nutrient rich compost from olive mill waste to use as a substitute for growing strawberries in the UK

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A compost was produced by co-composting olive mill wastewater (OMW) and chicken manure (CM), with greenwaste as a bulking agent. Two different variants of OMW compost were used in growth trials during the 2014 season in the UK, one twice composted and one that was composted three times. The composting was on a pilot scale in windrows. During the first composting procedure these windrows were turned 14 times. For the second composting CM and OMW were added to the compost from the first stage used as the bulking agent; this was turned 8 times. This compost was used as a bulking agent for the third composting, with CM and OMW added. Amounts of this product in ratios of 10, 25, and 50% were combined with substrate to create a medium suitable for strawberry (*Fragaria ananassa).* Fruits were assessed for quality by measuring sugar content and flesh firmness using a refractometer and penetrometer respectively. The compost combinations compared similarly to standard peat-free compost for yield when comparing both the number of and weight of fruit produced. The control with 100% peat free compost yielded the firmest fruits and the treatment combinations with 25% and 50% of three times composted OMW produced the sweetest fruits.

The extent of these trials was not enough to get an understanding of any consistent differences in the production of strawberries when grown in different substrates. Trials in 2015 will have greater scope to clarify if this substrate has an impact on marketable crop quality.

Key words: olive mill waste, manure, composting, substrate, yield, strawberries

Evaluation of a nitrification inhibitor in nitrogen stabilization, fertility potential and biochemical properties during the composting process of sugar mill residues

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In order to evaluate the effects of a nitrification inhibitor (NI) in a commercial sugar mill composting process, 5 ton of the residues (bagasse, filter cake “cachaza”, leaves, and ash) were piled up under greenhouse and turned mechanically, keeping 60% moisture content. The NI corresponded to 3.5 DMPP (dimethylpyrazole phosphate), formulated as Summit Ready^{TM} (15% 3.5 DMPP w/v; Sumitomo corporation). Four NI rates were evaluated (0, 0.4, 0.8 and 1.6 L of commercial product/ton). Samples were collected at 0, 7, 17, 28, 37, 49, 58 and 69 days after application (DAA) to evaluate pH, electrical conductivity (EC), organic carbon (OC), organic nitrogen (ON), total N, cation exchange capacity (CEC), extractable nutrients (P, K, Ca, Mg, Na, S, Fe, Mn), and enzymatic activities: urease and ammoniamonooxygenase (AMO). Data were processed through analysis of variance, regression, and correlation analyses using SAS software. Results indicated that pH value, OC, ON, NO_3-N, NH_4-N/NO_3-N ratio, C/N ratio and Mg content, resulted significantly affected by the rate of NI, while all chemical properties were also affected by DAA. A significant interaction between rate of NI and DAA was observed for OC (OM), NO_3-N, and NH_4-N/NO_3-N, meaning that the effect of the NI rate depended on the time (days after application-DAA) and vice versa. This result is very important, considering that time in composting processes is very variable; sometimes, just few days are available to stabilize the material, some processes continue until starting maturity time, and others reach maturity or complete maturity. The final levels of OC and ON were higher for the piles receiving NI than for the control. Regarding to AMO activity, until 17 DAA, AMO activity was low probably because of the NI effect, increasing linearly from there on.

Key words: compost, nitrification inhibitors, sugar mill residues

Effect of compost amendment for the growth of ornamental plants in a soilless substrate for green roofs

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The substrates used for the installation of green roofs on urban buildings are soilless mixes of inorganic and organic materials able to support the plant growth in a thin layer. In this work we have evaluated the effect of amendment with compost obtained from food waste on soilless mixes for the growth of ornamental and aromatic species from Mediterranean regions. In the first experiment the compost was added to commercial soilless substrates containing a mix of perlite, lapil, pumice and peat (5% and 10% Vol/Vol) used for the growth of the species *Sedum acre* and *Sedum reflexum* in pots. A significant increase of the biomass (fresh and dry weight) was observed in both species. In the second experiment compost amendment (10% Vol/Vol) was performed on containers filled with soilless substrates of 18 cm and 8 cm depth, respectively, simulating mid-extensive and extensive green roofs, planted with species of Lamiaceae and Crassulaceae. The observations taken during four seasons detected an increase of the plant canopy for *Rosmarinus officinalis prostratus, Salvia officinalis, and Thymus citriodorus* and on the surface coverage of *Sedum sp., Sempervivum sp.*, and *Rhodiola sp.* characterized by vegetative propagation and prostrate growth. The results indicated a potential positive effect of compost as component of substrates, not only for green roof installations, but also in nursery and greenhouse production of ornamental plants in soilless mixes characterized by low organic matter.

***Key words**:* compost amendment, soilless substrate, green roof, Crassulaceae, Lamiaceae

Phosphorous availability of seven organic manures in a sandy soil

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Nitrogen (N) is the main limiting factor of plant production in the lower valley of the Rio Colorado, Argentina (VIRC). However, organic fertilizers applications based on N requirements often results in unbalances of other nutrients, such as phosphorus (P), which can result in contamination problems. Therefore it is necessary to know the amount of P provided by the organic amendments and its availability to establish management strategies that minimize the environmental impact. A field mineralization assay was performed during the spring-summer period 2013/14 in the VIRC. The used amendments were: Bioorganutsa (B, commercial amendment) vermicompost of municipal solid waste (VC), composted poultry (CPM), horse (HM), poultry (PM), cattle (CM) and sheep (SM) manures. The amount of each amendment was adjusted to 350 kg N/ha. Each treatment was sampled at 0, 3, 21, 35, 49 and 83 days. The extractable P (Pe) was determined for each sample by Bray and Kurtz technique. Linear regression and curve comparison analysis were used in order to evaluate Pe dynamics during incubations. All the evaluated amendments provided more P than the crop requirements. However, two different behaviors were observed in the P availability along the incubations ($p < 0.05$). B, PM and SM showed an initial contribution of Pe which remained similar quantities for the evaluated period while PMC, HM, CM and VC showed an initial contribution and a progressive increase of P along incubation ($p > 0.25$).

Key words: organic amendments, extractable phosphorous, in-situ mineralization

SESSION 4

Environmental impacts and health risks associated to the use of compost in agriculture

ORAL CONTRIBUTIONS

Health risks associated to solid waste composting: From production to use in agriculture

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The recycling of organic wastes in agriculture means an enhancement of some useful soil properties. However, this practice may be also related to important environmental problems, such as groundwater pollution due to N and P leaching as well as metal accumulation in soil and plants. This investigation was aimed at studying the effects of long-term, controlled, systematic fertilization of agricultural soil with organic and mineral products. The study was conducted in experimental fields of wheat, which were treated with organic and mineral fertilizers for 13 years. A number of soil parameters were evaluated, including chemical properties, accumulation of potentially toxic elements (As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb and Zn) in soil and plants, effects on C and N mineralization, enzymatic activities, phytotoxicity, and grain production. Moreover, the human health risks associated to this agriculture practice were also evaluated. Organic amendments added to soil, increased the organic matter content, soil nitrogen and microbial activity, enhanced mineralization processes of C and N, as well as some enzymatic functions in soil. Total concentrations of metals were found to be below the maximum values for agricultural soils according to the Spanish legislation, regardless of the fertilization treatment. Furthermore, human health risks due to the direct ingestion of wheat, the consumption of milk from cows fed with straw, and the dermal contact and inhalation of soil, were found to be very low.

***Key words**:* C and N cycle, heavy metals, compost, pig manure, health risk assessment

P leaching and effects of long term application of compost versus other fertilizer types

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Many agricultural soils in NW Europe contain an amount of phosphorus (P) that not only exceeds the crop needs, but is also an important source of diffusive P losses to the environment. The restriction of P fertilization (as required by the nitrates and water framework directives) implicates also a restricted application of organic fertilizers and soil improvers as source of carbon. Our objective was to compare organic fertilizers in their ability to increase the soil organic carbon level, and their influence on P leaching. In this research project, we sampled 5 long term field trials where fertilization with compost, farmyard manure, digestates, cattle slurry and mineral fertilizers were compared, to determine the effect on soil P and soil organic carbon level. A leaching experiment with samples of the tillage layer (0-30cm) in controlled unsaturated conditions revealed differences in susceptibility to leach P between the fertilizer types. Indicators for P-capacity seem to be useful to divide agricultural soils in categories of susceptibility to P leaching. However, within one field or within a group of fields with comparable P-capacity, the P leaching seems to be determined by the fertilizer category. We observed that compost based on plant materials is a better option than cattle farmyard manure to increase the soil organic carbon levels, without further increasing the P losses in soils with highly elevated P capacity. Although farmyard manure has a potential to increase the soil organic carbon levels comparable to compost, the use of farmyard manure increases soil P availability and P leaching.

Key words: animal manure, compost, exogenous organic matter application, soil P availability, P leaching and soil organic carbon

Assessment of groundwater vulnerability to pollution in Barrax, Albacete, Spain

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The assessment of groundwater vulnerability to pollution through GIS-based risk mapping is a relatively new scientific approach for facilitating planning and decision making in order to protect this valuable resource. In this study, the vulnerability of groundwater to pollution in the municipality of Barrax, province of Albacete, Spain, was assessed using Drastic, the most sophisticated among the GIS-based index methods, and employing both Generic and Agricultural models. Seven parameters, namely Depth to water, net Recharge, Aquifer media, Soil media, Topography, Impact of vadose zone media, and hydraulic Conductivity of the aquifer have been considered as weighted layers to enable an accurate groundwater risk mapping. The calculated vulnerability indices, as derived from both models, indicate that Barrax is characterized by “low” to “medium” risk for groundwater pollution, especially in areas with bedrock limestone formations having medium uniform distribution of hydraulic conductivity. The results of the Drastic-Agricultural model have been validated using actual groundwater quality data. It is important to mention that there is strong relationship between the DRASTIC Index and the concentration of nitrates in groundwater. The aquifer vulnerability maps created in this study are an effective tool that can be used for future environmental planning and groundwater management from local and regional authorities. They may also assess any potential risk for groundwater pollution as a result of the use of compost in agriculture.

Key words: groundwater vulnerability, risk mapping, GIS, Drastic index method, nitrate pollution, agriculture

SESSION 5

Challenges for the development and testing of next generation organic amendments

ORAL CONTRIBUTIONS

Interaction of biochar and compost

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Biochar is a recently carved term used for the recalcitrant charred product of biomass pyrolysis, when the pyrolysis product is intended for (beneficial) soil use. Since biochar is degradation-resistant carbon previously concentrated from atmospheric CO_2 by photosynthesis + pyrolysis (p^2), it sequesters (atmospheric) carbon when applied to soils, or used elsewhere as long as it is not burned (e.g. as a paper filler, or as a replacement of sand in concrete). Moreover, biochar amendments to soil can reduce the emissions of nitrous oxide (N2O), as shown by a recent meta-analysis. Since a range of highly fertile dark soils (Mollisols in the US, chernozems in Europe, or Amazonian dark earths) are enriched in pyrogenic carbon the idea emerged to apply (pure) biochar to soils to increase their fertility.

However, the first decade of intensified research on (pure) biochar use in soils revealed, unsurprisingly, that it did on average have only moderately positive effects on yields particularly when the soils were already fertile; that the effects were highly heterogeneous (from negative to very positive) depending on the biochar-soil-crop combination, but mostly unpredictable. In the black-carbon rich soils, however, biochar has been in contact to organics for decades or centuries; and the ADE soils even suggest that composting litter piles may have played a central role. Hence we concentrated our research efforts on compost-biochar interactions.

Our results obtained during recent years suggest a surprisingly strong role of organically treated biochar in retaining mineral nitrogen, mostly in the form of nitrate, rather than ammonium (as could be expected). In field studies we observed significant nitrate retention in the top soil (0-15cm) where the biochar had been incorporated, while the subsoil nitrate concentrations (30–60 and 60–90cm) were significantly reduced. Biochar particles extracted by forceps were considerably enriched with nitrate. However, only a fraction was extractable with

conventional standard methods. The co-composted biochar strongly improved plant growth particularly at nutrient-limited conditions while the pure biochar did rather reduce plant growth. However, the most beneficial combination was to use biochar-compost. In a macrocosm (container) leaching study with *Vitis vinifera* (cf. Riesling) pure biochar reduced nitrate leaching by 60% compared to pure sandy control soil. T the biochar-compost combination however was much more effective, despite lower amounts of biochar in the applied product, reducing nitrate leaching to virtually zero. The same amounts of pure compost without biochar increased the nitrate leaching, due to nitrate release by mineralized compost.

Subsequently ^{15}N labelling-tracing studies revealed that the untreated and even more the aged (co-composted) biochar both strongly sorbed mineral N, particularly nitrate. In a soil mixture of with 2% (wt/wt) biochar, up to 60% of the labelled nitrate-^{15}N was retrieved with the (washed) biochar particles roughly 50 hours after ^{15}N application. The co-composted biochar was even more effective than the untreated biochar in sorbing nitrate, despite the fact that it was already preloaded with nitrate (5300 mg N/kg biochar); surprisingly, this nitrate-loaded composted biochar still reduced N_2O emissions significantly, although it carried dissolved organic carbon and nitrate as prerequisites for denitrification. Our results encourage further research into combining nutrient-rich agricultural waste streams with biochar post-treatment (i) to bring marginal soils into production, (ii) to actively reduce nitrate groundwater pollution, and (iii) to design and develop beneficial peat-free horticultural planting substrates amended with biochar. When biochar-substrates (often termed "Terra preta" substrates by emerging producers) would replace peat, their horticultural use may significantly improve the CO_2 footprint of horticultural products.

Key words: biochar, peat replacement, compost additive, biochar-compost, horticulture, nitrate leaching, N_2O emissions

Biomass or Biochar – Which is superior at improving hydraulic properties?

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Different physical and chemical properties of biochar, which is made out of a variety of biomass materials, can impact hydraulic properties. The objective of this research was to evaluate the impacts of raw biomass compared to biochar additions of the same feedstock and their impact on hydraulic properties in soil mixtures. Both raw biomass (pine chips) and a corresponding pine chip biochar (slow pyrolysis; 2 hr; 500 ^{o}C) from the same feedstock were added to soil at four incremental particle size fractions (1-2 mm; 0.5 to 1 mm; 0.2 to 0.5 mm; and <0.2 mm). Furthermore, three other biochars were added to four different textured soils (coarse sand, fine sand, loam, and clay texture) to assess potential biochar specific effects. In addition, inert materials (glass and plastic beads) were also utilized to assess if the alterations in the hydraulic properties were due to the alteration in soil particle packing (tortuosity) or the addition of the intra-particle pore structure. The results showed that the K_{sat} of the biochar amended soils were significantly influenced by the rate, particle size, and type of biochar. In addition, these correlations were dependent on the original particle size of soil. The K_{sat} decreased when biochar was added to coarse and fine sands, as a function of the biochar rate. Biochar with larger particles sizes (60%; >1 mm) also decreased K_{sat} to a larger degree than the smaller particle size biochar (60%; <1 mm) in the two sandy textured soils. Biochar additions universally reduced the bulk density ($P<0.05$) and simultaneously reduced K_{sat} for sandy soils ($P<0.05$). On the other hand, for the clay loam 1% and 2% biochar additions universally increased the K_{sat} with higher biochar amounts (up to 5%) providing no further alterations. The increasing tortuosity in the amended sandy soil could explain this behavior, and was supported by the similar behavior observed with the inert solid materials. Therefore, the immediate alterations in the hydraulic properties of the

amended soil are primarily a function of the particle size of the material, versus the type of material. However, to increase water holding capacity, materials with pore sizes between 0.3 and 15 µm should be targeted.

***Key words**:* saturated hydraulic conductivity, composting, biochar, water holding capacity, soil moisture

Can biochar reduce nitrogen pollution from chicken manure? Assessing biochar's biogeochemical fate and policy opportunities

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Intensification of animal agriculture has profound impacts on the global and local biogeochemistry of nitrogen, resulting in consequences to environmental and human health. Chicken production is rapidly intensifying around the world. Manure from confined chicken feeding operations is typically applied in its raw form to nearby crop fields. The nitrogen from the manure that is not taken up by crops is lost to the environment, contributing to local air pollution, contamination of water bodies, and climate change. We conducted a two-year field study replicated on two soil types (sandy and silty-loam) to identify manure management strategies that minimize nitrogen losses. Field treatments included three types of manure (raw manure, compost, and biochar), urea, and an unfertilized control. Biochar significantly reduced losses of nitrogen as nitrous oxide (N_2O), nitrogen oxides (NO_x), and nitrate (NO_3^-) leaching, while increasing crop yields and stabilizing nitrogen in recalcitrant soil organic matter pools. Our policy assessment identifies important opportunities and barriers to their widespread adoption of manure-derived biochars. Our findings suggest that transforming raw chicken manure into biochar can be an effective strategy for reducing nitrogen pollution while increasing crop yields.

Key words: biochar, compost, poultry manure, reactive nitrogen, nitrous oxide, environmental policy

Combination of biochar and clinoptilolite for nutrient recovery from liquid fraction of digestate

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The liquid fraction of digestate contains nutrients, particularly nitrogen and potassium, predominantly in ionic forms. Ion exchange and adsorption technologies can potentially be applied to recover and concentrate these valuable nutrients.

In a number of publications, ion exchange with clinoptilolite has been shown to be very effective for the removal of ammonium from domestic wastewater. Furthermore, more than 90% removal efficiencies for both ammonium and potassium from source-separated human urine have been reported in the literature. Biochar has recently been suggested as bio-sorbent material for removing various types of contaminants from wastewaters. Combination of clinoptilolite and biochar could be an alternative solution for the concentration of nutrients from the liquid fraction of digestate.

We found that the combination of clinoptilolite as an efficient cation exchanger and biochar as an easily available and cheap adsorbent result in efficient ammonium, potassium and phosphate removal.

***Key words**:* liquid fraction of digestate, biochar, clinoptilolite, nutrient recovery, adsorption and ion exchange

Addition of clay, biochar and their mixture during composting with earthworms: a strategy to reduce carbon emissions?

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Composting and vermicomposting are two biological processes which enhance the degradation and stabilization of the organic matter. However, these methods of waste recycling emit greenhouse gases, including CO_2. The aim of the study was to reduce these emissions by the use of substrate addition during the composting process. We chose clay as well as biochars, which have both been recognized to be able to sequester organic carbon in soils. We hypothesized that interactions between these substrates and the composting organic matter may lead to their stabilisation and that the formation of such interactions may be enhanced by the presence of earthworms. Our experimental approach consisted of addition of different proportions of clay and biochar with and without earthworms to green wastes. We monitored C mineralization of these mixtures during composting and after their application to soil. Our results indicated lowest mineralization during composting in presence of 50 % of clay. Interactions between earthworms and added substrates were also observed. The amount of clay enhances C sequestration through earthworm activity during composting, but not over of 25% of clay. Besides, addition of biochars only reduced carbon emissions during composting without earthworms. The reduction of CO_2 emissions through clay persisted after addition of the final vermicompost to soil, where it still had positive effects on plant growth. These findings show that addition of mineral substrates may be an important strategy to limit carbon emissions during the production of soil ameliorating substrates used for horticulture.

***Key words**:* composting, earthworms, carbon dioxide, clay, biochar, organic matter mineralisation

Are biochar and hydrochar adequate materials as substrate constituents? A summary of the research carried-out at UPV

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Biochar and hydrochar are produced by charring organic matter through pyrolysis and hydrothermal carbonization. Biochar has been extensively tested in agricultural soils. Nevertheless, both materials have been scarcely tested as soilless growth media constituents. We have conducted studies on the properties and behaviour of biochar (forest waste [BCH-FW]; milled olive stone [BCH-OMW]) and hydrochar (forest waste [HYD-FW]) as growth media constituents in different culture conditions. We have grown ornamental, forest and vegetable species. We have conducted assays on seed germination, cutting rooting and plantlet growth in nursery conditions, and tomato growth in commercial conditions. The materials proved useful for growth media formulation. However, they were not good performers as sole constituents because they posed specific problems depending on the material. BCH-FW was alkaline, nutritionally poor, and non-phytotoxic. Its major problem was the large particle size that caused low retention of water and nutrients leading to low plant performance. Nevertheless, good results for seed germination, cutting rooting and plant survival were obtained. BCH-OMW was nutrient-rich, alkaline and highly saline, resulting phytotoxic to plants. This was a drawback for seed germination and young plant growth but not for adult and saline tolerant species such as tomato. Due to its characteristics, this material retains water and traps CO_2, which represents an environmental benefit. HYD-FW was highly hygroscopic and showed high microbial activity. It emitted large amounts of CO_2, although no N immobilization was detected. In these conditions, the low O_2 pressure in the rhizosphere led to a decrease in plant performance.

***Key words**:* biochar, CO_2 trap, hydrochar, microbial respiration, N immobilization, soilless growth media

SESSION 6

Nutrient and organic matter recycling via integration of biochar and compost. Perspectives from Europe's FP7

ORAL CONTRIBUTIONS

Investigating the nutrient adsorption capacities of various waste-derived biochars

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To investigate the phosphate and ammonium adsorption capacities of biochars and hydrochars derived from various waste biomass feedstocks, key physicochemical properties such as surface area, CEC, ash and mineral content were compared. Biochars produced from treated organic fractions of municipal solid waste, greenhouse and greenwaste at varying thermochemical conditions were compared with oak-derived biochars. Results showed that the biochars were capable of adsorbing ammonium and to an extent, phosphates, and compared favourably with some adsorbent materials used in other studies. After ammonium and phosphate adsorption, however, biochars in this study did not easily release adsorbed ions. These findings provide more information for the waste management and energy production sector, as awareness of these factors will guide feedstock selection and production techniques for biochar generation on both small and large scale.

Key words: biochar, ammonia, phosphate, adsorption, CEC

Potential of biochar in composting: effect on process performance and greenhouse gas emissions

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The addition of biochar to the feedstock mixture as a mean to improve the performance of the composting process and the quality of the end product was investigated in a full scale composting process. Biochar from oak wood (74.2% C, 0.7% N) was added in a 10% proportion (on a dry weight basis) to a mixture of green waste and the organic fraction of MSW (50:50 w:w; 36.6% C, 1.8% N) before processing in a full-scale composting plant. Normal composting operation involves a bioxidative phase of about 30 days carried out in mechanically turned lanes and a maturation phase of 60 days performed in windrows. During the process GHG emissions were measured (10 times) and solid samples (5 times) were taken for physico-chemical analyses. Results showed that biochar addition caused an enhanced rate of organic matter (OM) decomposition during the bio-oxidative phase (OM loss of 21% and 11% for feedstocks mixed or not with biochar, respectively), without affecting the total OM loss at the end of the process. Addition of biochar resulted also in a significant reduction of N losses (0.4 and 36.4 kg corresponding to 3 and 22% of initial N for compost with or without biochar, respectively) and higher easily available (water extractable) P concentrations (17.4 vs 14.9 mg l^{-1}). Biochar caused a reduction or no effect on GHG emissions depending on gas and specific conditions of the composting process. It can be concluded that adding biochar to the feedstock mixture before composting represent an effective improvement to the traditional composting system as it may reduce the process costs without affecting the quality of the end product.

***Key words**:* biochar, composting, methane, nitrous oxide, organic matter decomposition, N losses, P availability

Interaction of biochar with compost, plant health, yield and soil quality: balancing risks and opportunities!

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Biochar can be applied as a pure soil amendment, but can also be processed with other biomass before being added to the soil. We tested the effect of adding biochar during or after composting or ensiling. This was tested for compost based on the organic fraction of MSW mixed with green waste, and for silages of vegetable crop residues and maize straw. Besides assessing the effect on the process and on the product quality, these products were also tested as soil amendments in bioassays and field trials, allowing to study the effects on plant and soil quality as well. Bioassays with lettuce were executed to quantify the effects of biochar, compost and biochar-blended compost on different agronomical aspects related to plant and soil health. We observed a product-specific response on disease suppression and microbial life. We assessed the effect of compost, biochar and their mixture on soil organic C content, chemical, physical and biological soil quality in field trials, and compared this with the effect of other soil and crop management practices. In the field trial in Belgium, the effect of biochar is compared with compost and biochar-blended compost at a rate of 10.9 t C ha^{-1}, in a crop rotation with cereals, leek and ryegrass. Three field trials in vineyards in Italy include biochar, biochar-blended compost and compost added at the same rate as in Belgium. The field trial in Spain includes treatments with biochar, olive mill waste compost and a mixture of biochar and compost, added to an olive orchard at a rate of 20 t ha^{-1}. We tackled the question whether the effects on soil quality are generic or rather depending on climatic conditions, soil type, type of compost applied and crop rotation.

***Key words**:* biochar-blended compost, soil quality, disease suppression, silage

New insights on the interaction between biochar and N_2O emissions from soil

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One of the most intriguing aspects of using biochar as soil amendment is its potential to mitigate N_2O emissions. More than 60 peer-reviewed scientific articles have been published on this topic in the last five years and a recent meta-analysis has found an average 50% reduction in soil N_2O emissions after biochar application. However, the reasons behind this reduction remain incompletely understood. Contradictory results have been reported, with some studies showing no differences or even increased N_2O emissions after biochar application. In order to propose efficient N_2O mitigation strategies, an in-depth understanding of the mechanisms involved will be necessary. The research developed by our group during the last years provides some knowledge on how and when biochar might be interacting with N_2O formation processes in soil. For instance, we found that an application rate of 15-20 tons/ha is necessary to perceive significant effects and also that biochars should have a C/N higher than 30 to be effective. Regarding mechanisms, we have demonstrated that the N_2O reductions are not associated to the content of polycyclic aromatic hydrocarbons in biochars. A recent study suggests that biochar is generally effective during denitrifying conditions, but might increase emissions when N_2O is produced by nitrification-mediated pathways. Finally, an ongoing field experiment under the FERTIPLUS EU project analyses the impact of compost, biochar and a blend compost/biochar on soil N dynamics and N_2O emissions in an olive orchard.

***Key words**:* charcoal, nitrous oxide, N fertilisers, greenhouse gases

Biochar as a soil amendment in vegetable crops developed under greenhouse conditions in Spain

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The production of vegetables under greenhouse conditions in south-east of Spain is associated with contamination of soils and water bodies by nitrates. Most of these nitrates are leached after the application of soil amendments using high amounts of semi-dried manure. Four different soil amendments have been evaluated during one tomato crop developed under greenhouse conditions in Almeria, using different combinations of semi-dried sheep manure and biochar produced from oak trees. Two different irrigation and fertilization strategies have been applied during this crop. The chemical composition of the soil and the nitrates concentration of the soil solution in the root zone have been evaluated. Different crop parameters (nutritional status, biomass production, yield and quality parameters of commercial fruits) have been characterized. The use of biochar as a substitute of a proportion of manure applied to the soil as a soil amendment could be an interesting solution to reduce the contamination by nitrates in this intensive production system.

***Key words**:* biochar, vegetable, soil amendment, greenhouse

SESSION 1

Nutritional aspects of the use of compost in agriculture. Role in global food security

POSTERS

Influence of two methods of Humic acid application on berry properties of grapevine cv Askari

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In this study the effect of two methods of humic acid application on quantity and quality of grape cv. Askari, was evaluated. The experiment was conducted in a randomized complete block design with seven treatments and three replications in a vineyard adjacent to Sisakht, Iran. Treatments included control, soil and foliar application of humic acid in 2.5, 5 and 7.5 g/l from Green hum source (13% humic acid). Parameters such as total soluble solids (TSS), titrable acidity (TA), pH, TSS/TA, weight of single cluster, yield per plant, length and width of berry, berry volume, chlorophyll content (SPAD) and berry firmness were measured. Results showed that application of humic acid in soil increased the quality and quantity of grape. The highest yield and firmest berry, was obtained in soil application of 2.5 g/l humic acid. Therefore, application of humic acid in higher concentration is not recommended in grape.

Key words: grape, humic acid, yield, berry firmness

Spent mushroom composts as organic fertilizer: first organic trials

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The fast dynamics of the vegetable production sector, characterized by rapid cropping successions, species with very different cultural needs, intensity of soil cultivation and scarcity of manure, leads to a progressive depletion of the soil, which implies a reduction of the overall fertility.

The effects of different nitrogen sources on the lettuce and leek crops production was evaluated in this experiment. The requested nitrogen mineral fertilizer for each crop was partially or completely replaced by spent mushroom compost (SMC). A factorial combination of 4 nitrogen treatments and 3 different types of SMC were arranged in a completely randomized block design. The 4 treatments were: unfertilized control (T0), mineral control (TMIN) in which 100% of the crop nitrogen requirement was supplied by mineral fertilizer, T50 in which 50% of the crop nitrogen requirement was supplied by mineral fertilizer and the remaining needs with SMC, T100 in which 100% of the nitrogen requirements of the crop were supplied by SMC. The 3 types of SMC were straw + manure (PL), straw + poultry manure (PP), straw + poultry manure + manure (PPL).

Plants were harvested at marketable size, and samplings were carried out in order to evaluate morphological and dimensional characteristics specific for both the crops considered. Nitrogen concentration, anion and cation content were also considered.

No statically significant differences were recorded among treatments for marketable yields. A little increase in salt content when mineral fertilizers were used has also been recorded. In general SMC demonstrate to be suitable as replacement of mineral fertilizers.

***Key words*:** organic matrix, macronutrient, lettuce, leek

Nitrogen mineralization of three organic amendments in two soils with contrasting textures

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N mineralization measured during incubation in the laboratory allows studying the factors that affect the release of nutrients in ideal situations and their mechanisms. Soil texture affects mineralization of nitrogen (N) because the clay might complex the organic matter and fix ammonium. For this assay an aerobic incubation was performed at 25^{o}C for 112 days in two soils of contrasting textures. Each soil was evaluated with a control and three organic amendments: vermicompost municipal solid waste (V), composted cattle manure (CCM) and BioOrganutsa, a commercial organic fertilizer (BioO), all in triplicate glass jars. The manures were added at equivalent of 350 kg N/ha. Samples were taken at 0, 3, 7, 14, 21, 35, 49 and 83 days of incubation and inorganic nitrogen was analyzed (NH_4^+ and NO_3^-) for each treatment. The N availability presented different dynamics between treatments ($p < 0.05$). The BioO was the most labile of evaluated manures featuring high initial ammonium, rapid nitrification (<12 days) and a similar mineralization in the two soils. The V was the most recalcitrant of the three treatments, with lower contents of available N and similarly in the two soils. The CCM had an intermediate content of N mineralized and a different dynamic between soils ($p < 0.05$). A first order kinetics function was used to describe the mineralized N; mineralization rates and mineralization potential were estimated. The mineralization of organic amendments occurs differently in contrasting texture soils.

***Key words*:** organic amendments, clay soil, potentially mineralizable nitrogen

In-situ mineralization of a sandy soil amended with seven organic fertilizers

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The mineralization of organic amendments should be studied in detail to propose strategies to maximize their use. This requires experiments adjusted to local soil and climatic conditions, for that reason an essay of in-situ mineralization was developed in the area of the lower valley of the Rio Colorado, Argentina. The experiment was conducted in the spring-summer season (2013/14) with soil (0-20 cm) fertilized with seven organic amendment: BioOrganutsa (B, commercial organic fertilizer), vermicompost of solid municipal waste (VC) composted poultry (PMC) and horse (HM) poultry (PM), cattle (CM) and sheep (SM) manures, were added at the rate of 350 kg N / ha. Periodic samples were taken at 0, 3, 7, 14, 21, 35, 49 and 83 days and the concentration of NO_3^- and NH_4^+ was analyzed. Different dynamics of mineralization-immobilization were found ($p<0.001$). The treatments with high contents of NH_4^+ had rapid nitrification after incorporation. Regressions were adjusted to the mineralization curves as function of time and the growing degree days (0^oC based temperature). The best fit was found in the curves of growing degree days. Mineralization rates and potentially mineralized nitrogen of each treatment were determined. The dynamics of mineralization of the amendments are very different and it is necessary to establish various strategies that maximize their use.

***Key words*:** growing degree days, potentially mineralizable nitrogen

Integration of cover cropping and liquid manure application in pear (*Pyrus pyrifolia* cv. Niitaka) orchard

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Cover cropping and liquid manure application are considered as effective ways to replace the use of chemical fertilizer in orchard. This study was conducted to investigate the effect of cover crop species and liquid manure application rate on green manure production, leaf mineral content, fruit quality, and soil chemical properties in pear orchard. The treatments include rye and hairy vetch as cover crops, two liquid manure application levels based on N and K_2O requirement on each cover crop species, and chemical fertilizer as control. Green manure production was higher in hairy vetch than in rye. K content of pear leaves and soil exchangeable K content increased in N requirement-based liquid manure application treatments. The yield was higher in rye + liquid manure and fertilizer treatments, and fruit quality was not different between the treatments. Taking all of this into account, rye + K_2O requirement-based liquid manure application is recommended in pear orchard for not only sufficient nutrient supply but also prevention of any problem related with soil K_2O accumulation in pear orchard in long-term perspective.

Key words: rye, hairy vetch, pig slurry, orchard, soil management

Pear production system innovation: first results

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An innovative approach of pear cultivation focusing on fertilisation and soil biodiversity was tested in commercial orchards in the Netherlands from 2013 and onwards. Fertilisation was carried out by combining soil applied fertilizer with compost and foliar fertilization. The pesticide schedule was adapted by omitting those harmful for soil organisms. We determined numbers of earthworms as an example of soil life. The number of earthworm individuals varied substantially between locations and in time, from 16 to 263 / m^2. Also the number of earthworm species varied, from 1 to 9 species per orchard. Notably, the number of earthworms and the number of species was similar in organic orchards compared to conventional ones.

Timing of compost application affected earthworm populations within months after treatment in the first halve of the season, especially with more juveniles, while the effects at the end of the season were not significant.

Foliar phosphorus fertilisation appeared to be very efficient in increasing the phosphorus leaf content for pear grown on the calcium-carbonate containing soil. It also resulted in increased firmness of the pear fruits after 8 months of storage under low oxygen-conditions. It was postulated that low phosphorus containing compost for enhancing soil biodiversity in combination with foliar phosphorus fertilisation for increasing fruit quality improves the pear production system on calcium-carbonate containing soils in situations where phosphorus input is limited for environmental reasons.

***Key words**:* soil organic matter, pear, production system innovation, phosphorus, soil biodiversity, earthworm

Using compost to feed the soil community and meet the nutrient requirements of sweet corn

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This study evaluated two composts, leaf and yard waste (LY) and biosolids (BS) as soil amendments at three application rates on sweet corn production over two years 2010 and 2011. In 2010, 36.29 kg of P_2O_5 was broadcasted as recommended by soil tests. No additional fertilizer was added in either year. BC 0805 sweet corn (82 days) was planted on 86 cm rows with a plant population of approximately 69,160 plants per hectare. Composts were hand applied in three replicated plots and incorporated at the rates of 0, 22.4, 44.8, and 89.6 $Mgha^{-1}$. In 2011, each plot was split in half. One half received the same treatment as in 2010. The second half did not receive any additional compost or fertilizer.

In 2010, marketable yields were greater in plots receiving compost compared to the control. BS application rates of 44.8, and 89.6 $Mgha^{-1}$ produced acceptable yields, 2640 and 3120 dozen per hectare, respectfully. Yields from LY treated plots were lower then acceptable yield levels of 2470 dozen per hectare.

All compost treatment yields were significantly higher in 2011 than in 2010 while control plots were similar in both years. BS yields were greater than LY yields though both produced acceptable yields. Yield increased with multiple compost applications indicating an accumulative effect of compost in soils. This indicates that the effects of compost last for at least two years and supports the idea that compost has a residual effect on the soil and crop productivity.

Key words: sweet corn, biosolids, leaf and yard waste, compost

Effect of compost application rates on high tunnel tomato yield

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Compost application has become a cornerstone of soil health and soil improvement practices on many farms in the Northeast United States, particularly in high tunnels. A lack of researched-based information on compost application rates has led to excessive applications of compost and resultant accumulations of phosphorus and salts in the soil.

The objective of this experiment was to develop baseline data for recommendations regarding compost application within high tunnels. The 2013 study employed five compost application rates: control, 18.9, 37.8, 94.4, 170 m^3/Ha. 'Big Beef' tomato seedlings were transplanted at 38 cm spacing. Yield (number and weight of fruit graded as marketable and cull) was measured from the center three plants of each plot. In 2014, the same plots were evenly divided allowing for ± compost treatment. The zero compost treatment plots received a pre-plant application of 27.22 Kg of actual N. The compost treated plots had compost applied at the same rate as in 2013.

The number of marketable fruit harvested in compost-amended plots in 2013 and 2014 were significantly lower in the 18.9 m^3/Ha compost treatment compared to the 94.4 m^3 treatment. However, fruit number and weight were lower in the 170 m^3 treatment compared to the 37.8 or 94.4 m^3 treatments, suggesting an over-application of compost. There were no significant yield differences among plots not receiving compost in 2014. These data indicate that compost application rates greater than 94.4 m^3 have no additional beneficial effect on yield.

Key words: compost application rate, high tunnel, tomato

Compost as a soil amendment for seed starting

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This study evaluated the fitness of local farm manure based compost for use in seed germination and seedling growth. Different rates of compost were used to germinate lettuce and broccoli seeds in 96 cell trays. The media included 0, 10, 20, 30, 50 and 100% compost mixed with a standard seed starting mix Fafard #3 and keep in a greenhouse at constant temperature. Water was provided as needed. Germination was significantly reduced with 100% compost, but was statistically equal for all other proportions of compost. Seedlings were grown four weeks to identify potential differences in seedling growth among the treatments. Seedlings grown in 0 and 10% of compost had a greater number of true leaves and highest score for visual health rating; followed in size by those grown in 20 and 30% compost. Seedlings grown in 50 and 100% compost were significantly reduced in size and rated lower for plant health. Based on these findings, seedlings will germinate in up to 50% compost. However seedling growth was better in mixtures not exceeding 30% compost.

Key words: compost, seed germination, seedling growth

Rock phosphate combined with phosphate-solubilizing microorganism and humic substance for reduction of plant P-demands as single superphosphate

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The aim in our work was to evaluate: i) combined application rates of single superphosphate (SSP) and natural rock phosphate of Araxá (RP) on the growth of maize (*Zea mays* L.); and ii) use of phosphate-solubilizing microorganisms (PSM) and humic substance (HS) as RP bioreactor for partial replacement of SSP application. Two pot experiments were designed under greenhouse condition. First, combined proportions of SSP and RP were arranged in the following six treatments (T1:0-100%, T2:20-80%, T3:40-60%, T4:60-40%, T5:80-20% and T6:100-0%) and two different P-placement methods (broadcast and deep placement). In the result, deep placement of the P-fertilizer application produced better plant response in all P treatments. Concerning the different SSP-RP ratio, the treatment of 40%SS+60%RP had shown no significant statistical difference for root dry weight and root volume related to the result of 100%SSP-0%RP application, meanwhile the shoot dry weight of this treatment did not reach the same level as the 100%SSP-0%RP application. Based on the selected proportion of SSP-RP, minimizing the use of SPP, a second assays were performed using selected mixed strains of bacteria and fungi (PSM previous selected for RP solubilization) combined with humic acid (HA). We had shown that PSM+HA treatment positively stimulated root and shoot weight compared to non-inoculated plants at 17% and 22 %, respectively. Despite of this biomass increase, no difference was observed in P concentration. Overall, our findings suggest that both application of PSM and humic substance with RP may be suited for reduction of P-fertilizers soluble sources demands compromising yields.

Key words: humic acid, biofertilizer, organic farming, P deficiency, Acrisol

SESSION 2

Impact of organic amendments on soil sustainability

POSTERS

Assessing carbon inputs needs for sustaining organic matter levels and biochemical soil fertility in a baby leaf crop system in Southern Italy

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Intensive horticulture causes a high soil organic matter (SOM) mineralization which must be balanced by a sufficient organic input to maintain soil fertility. A trial involving soil amendment was initiated on April 2013 in tunnels cropped with rocket (*Diplotaxis tenuifolia* DC.) and basil (*Ocimum basilicum* L.) on a soil with sandy-clay texture and SOM content of 0.9%. The organic amendments were: biowaste compost (C/N = 16), olive pomace compost (C/N = 30), olive pomace compost (C/N = 11) and manure (C/N = 15). Every organic amendment was annually distributed in two doses: 15 and 30 ton ha^{-1} fresh matter. Organic matter content, microbial biomass (as dsDNA) and 8 enzyme activities involved in C, N, P and S cycles (utilising a high-throughput fluorimetric assay) were performed 4 months after the second amendment occurred on June 2014. The results of the first sampling showed no increase of organic matter, but a significant enhancement of microbial biomass and enzyme activities in plots amended with all types of amendments, with the unexpected exception of manure.
These preliminary results indicate that the amount of compost added to soil is effective in improving short term microbial activity, but it is likely to be inadequate to increase the original organic matter level in a crop system with intensive soil tillage under tunnel.

Key words: fluorimetric assays, biowaste compost, olive pomace compost, manure

Humic acids and compost tea from compost for sustainable agriculture management

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In order to counteract soil degradation, it is important to convert conventional agricultural practices to environmentally sustainable management. To this end, the application of bio-stimulants could be considered as a good strategy. Compost, produced by composting of biodegradable organic compounds, is a source of natural bio-stimulants, such as humic acids (HAs), naturally occurring organic compounds that arise from the decomposition and transformation of organic residues, and compost-tea (CT), a compost-derived liquid formulate produced by a compost water-phase extraction. The aim of this work is to evaluate the bio-stimulant activity of HAs and CT, obtained from different composts, on tomato plants through RNA-seq experiments, aiming at the description of the molecular mechanisms underpinning tomato plant response to bio-stimulation. Preliminarily, different HAs and CT were tested on two tomato varieties, cv Crovarese and Auspicio, in hydroponic and spray treatments, for radical and foliar treatments, respectively. Tests *in vitro* showed an effect of the radical treatments mainly on the development of secondary roots. Afterwards, tomato plants grown in hydroponic culture were treated with HAs and CT and the roots sampled 24, 48 and 72 h after bio-stimulation, to proceed with the RNA-seq. Directional single-end sequencing has been performed on an Illumina HiSeq1500 device. Ongoing bioinformatics analysis includes: i) read quality checking and adapter trimming; ii) read alignments to the tomato reference genome; iii) summarization, namely aggregation of sequence reads over gene loci as biological units; iv) intra- and inter-sample normalization; v) identification of differentially expressed genes.

Key words: humic acid, plant biostimulation, next generation sequencing, sustainable agriculture, tomato

Restoration of agricultural soil quality by the use of on-farm compost

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Intensive agriculture determines a gradual loss of soil quality, mainly due to a decrease of soil organic matter (SOM) content. The improvement of SOM can be achieved through the use of organic amendments. Application of organic amendments is a reliable tool to improve soil health and to support sustainable agricultural systems. The aim of this work was to study the recovery of soil quality in an agricultural soil under greenhouse condition, by adding 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.

Two different composts, the first one a commercial compost from municipal solid wastes, the second one a compost from green wastes produced on farm, were applied to soil. After addition of organic amendments, soil fertility was monitored, for eighteen months, for main chemical, biological and biochemical properties.

Results showed, generally, positive effects of the on-farm compost, respect to the commercial compost, on soil chemical properties, especially in terms of organic matter recovery and electrical conductivity decrease. Moreover, biological and biochemical properties were positively affected, in particular in terms of biodiversity, as well as in enzymatic activities. Our results demonstrated that the addition 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.

Key words: compost on farm, organic carbon, biodiversity, enzymatic activities

Effect of compost derived from olive mill wastes and natural zeolite on soil properties and nutrient content of open field tomato cultivation

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The objective of this study was to investigate the effect of natural zeolite-clinoptilolith and the compost derived from olive mill wastes (COMW) on tomato crop in the open field. The experiment was conducted in the premises of the Department of olive and horticultural crops of Kalamata, located in Peloponnisos, South Greece, during the spring and summer of 2013. The experimental design was a factorial, completely randomized design, with 12 treatments. Two levels of chemical fertilization (zero and conventional NPK fertilization), two rates of compost (0 % and 15 % v/v) and three rates of natural zeolite-clinoptilolith (0%, 2% and 4% w/w) were combined in a factorial design. Measurements of growth parameters, tomato weight, and leaves were taken from the middle of June until the beginning of August every week. In addition, soil samples were collected at the end of the cultivation period at soil depth of 0-30 cm. Treatment effects were evaluated by measuring plant biomass, soil and plant nutrient status. The highest yield (117 t/ha) was achieved in treatment with the chemical fertilization, 4 % zeolite and 15% compost. Zeolite and compost played an important role, even in unfertilized plants. Compost provided nutrients to plants and the addition of zeolite contributed to additional biomass. The positive effect of zeolite-clinoptilolith on biomass and nutrient status of plant and soils appears when it is mainly combined with compost or fertilizer treatments. Zeolite (2% and 4% w/w) improved yields, provided it was applied with compost and/with chemical fertilizer. The possible mechanism is probably by improving the soil cation exchange capacity.

Key words: olive mill wastes, tomato, soil, zeolite

Effect of compost derived from sea grass and natural zeolite on soil properties and nutrient content of open field tomato cultivation

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The objective of this study was to investigate the effect of natural zeolite-clinoptilolith and the compost derived from sea grass (CSG) on tomato crop in the open field. The experiment was conducted in the premises of the Department of olive and horticultural crops of Kalamata, located in South Peloponnisos, Greece, during the spring and summer of 2013. The experimental design was a factorial, completely randomized design with 12 treatments. Two levels of chemical fertilization (zero and conventional NPK fertilization), two rates of compost (0 % and 15 % v/v) and three rates of natural zeolite-clinoptilolith (0%, 2% and 4% w/w) were combined in a factorial design. Measurement of growth parameters, tomato weight, and leaves were being taken every week, from the middle of June until the beginning of August. In addition, soil samples were collected at the end of the cultivation period at soil depth of 0-30 cm. Treatment effects were evaluated by measuring plant biomass, soil and plant nutrient status. Zeolite and compost played an important role, even in unfertilized plants. The highest yield (91 t/ha) was achieved in treatments without compost and 4 % zeolite. The results attributed to the increase of soil electrical conductivity, mainly due to the presence of Na. Both zeolite and sea grass had high content of Na. The positive effect of zeolite-clinoptilolith on biomass and on nutrient status of plant and soils appears when it is mainly combined with fertilizer treatments. The possible mechanism is probably by improving the soil cation exchange capacity.

***Key words*:** zeolite, compost, sea grass, tomato

Use of agricultural waste compost to suppress plant diseases

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Composting is a biological process where biodegradable organic compounds are transformed in compost. Compost may show suppressiveness against several plant pathogens, especially fungi, with a subsequent interesting improvement of quantity and quality of crop yields. Soluble organic molecules, such as humic substances, and useful antagonistic bacteria and fungi have a crucial role in plant protection. Our researches are focussed on agricultural waste compost to understand the main mechanisms 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, CO_2-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. Nevertheless, some composts derived from vegetable residues containing a high quantity of aromatic compounds, such as artichoke and aromatic/medicinal plants, showed suppressive activity also after autoclaving, demonstrating that some chemical molecules are active to inhibit phytopathogenic fungi.

Key words: compost, pathogen suppression, phytopathogenic fungi, sustainable agriculture

Organic wastes as alternative to inorganic fertilizers for a more sustainable agriculture

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Organic wastes (OW) can be a suitable alternative to mineral fertilization (MF) since apart from providing nutrients to plants trough organic matter mineralization, they improve soil physical, chemical and microbiological properties contributing to maintain soil fertility. However, due to the slow mineralization of the OW organic matter, the amount of nutrients provided by OW does not always meet plant nutrient requirements in a given time. The addition of combined fertilization (organic and mineral) is more advisable. In this work, the effect of OW, MF and combined organic and mineral fertilization on barley and wheat crops was evaluated under field conditions. The fertilizer treatments assayed consisted of: i) OW (2 composts at 2 different rates), ii) MF, iii) combined inorganic and organic fertilization. Parameters such as total grain and vegetal biomass production, average grain weight, specific grain weight, grain yield and harvest index were determined. Results showed that both, compost addition and the combined use of compost and MF lead to similar yields and grain quality than the conventional MF whilst leading to better soil microbiological quality.

Key words: organic wastes, inorganic fertilization, barley crop, soft wheat crop, soil microbiological quality

The effect of rubber sheet wastewater treated by selected *Rhodopseudomonas palustris* strains secreting 5-aminolevulinic acid on soil properties and rice chlorophyll fluorescence under saline stress

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5-aminolevulinic acid (ALA) is an essential biosynthetic precursor of tetrapyrrole compounds such as heme and chlorophyll. It has been suggested that ALA is a potential plant growth regulator in saline stress. Phototrophic purple nonsulfur bacteria (PNSB) are one group of ALA-producing bacteria that are widely distributed in paddy fields. This study aimed to ameliorate the effects of soil salinity with the use of rubber sheet wastewater (RSW) treated with *Rhodopseudomonas palustris* TN114, PP803 and their mixed culture (1:1) for stimulating rice growth; and it was assessed by determining the chlorophyll fluorescence in rice using a Pulse Amplitude Modulation fluorometer. As the RSW sets used had ALA content in a range of 89.61-130.84 µM and 8.1-8.6 log CFU mL^{-1} PNSB; and thus they were diluted 50X for watering rice grown in two intermediate saline soil series (Bangkok and Ranot). The results showed a remarkable increase in chlorophyll fluorescence; i.e. Fv/Fm, ΦPSII, ETR, but there was a huge decrease in the level of non-photochemical quenching (NPQ). Hence, 50X diluted RSW treated by either single cultures, particularly PP803 or mixed culture, protected rice seedlings from high NPQ under salinity stress. In addition, a mixed culture had also been related to Na^+ decrease in the tested soil; and this was the main reason for facilitating the rice growth. It can be concluded that the treated RSW by selected *R. palustris* strains was a cheap source of ALA for stimulating rice growth in saline soils. Hence, overall results suggested that PNSB may represent an important biotechnological approach to decrease the impact of salinity in paddy fields.

Key words: 5-aminolevulinic acid (ALA), chlorophyll fluorescence, rubber sheet wastewater*, Rhodopseudomonas palustris*, rice, salinity

Agronomic and environmental evaluation of exhausted grape marc compost addition to an irrigated melon crop under field conditions

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The importance of the winery industry in Mediterranean regions is accompanied by the generation of big amounts of wastes from the wineries and distilleries. The agricultural use of exhausted grape marc after composting is evaluated in this study under field conditions, considering both yield and environmental aspects. A field experiment was carried out in Ciudad Real (central Spain) where melon crop was grown under drip irrigation. This area was designated “vulnerable zone” by the Nitrates Directive 91/676/CEE. Melon crop has been traditionally cultivated in this area under drip irrigation with high inputs of water and fertilizers, but no antecedents of application of winery and distillery wastes are known. In a randomized complete block design, four treatments were established: three compost doses consisted of 7, 13 and 20 t compost ha^{-1} and a control without compost addition. Drainage and nitrate concentration in the soil solution were measured weekly in the plots to determine N leached during the crop period. Crop yield was also followed by harvesting plots when a significant number of fruits were fully matured. The addition of exhausted grape marc compost showed an increase in crop yield with a low environmental risk.

Key words: winery and distillery wastes, composting, melon crop, irrigation, yield, groundwater quality

Biocontrol of *Rizoctonia solani* on tomato plants using *Trichoderma harzianum* from garden compost extracts

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Rhizoctonia solani is one of the most important soil-borne fungal pathogens which causes disease on many economically important crops throughout the world. Fungi from *Trichoderma genus* are among the common biological control agents of *Rhizoctonia solani*. Isolation of *Trichoderma* was carried out from garden compost tea. A phylogenetic analysis was made by DNA extraction and sequencing of isolated *Thrichoderma* fungi. The potential biocontrol against *Rhizoctonia solani* was evaluated in vitro through dual cultures in PDA Petri dish measuring growth diameter of the pathogen compared with control. Nine replications were analysed and Student test was performed at $p<0.05$. In vivo essays were established using tomato plants pre-inoculated with *Rhizoctonia* solani. Ten treatments applying compost extracts and various concentrations of *Trichoderma harzianum* were carried out in order to evaluate seedling growth and pathogen suppressor effect. Nine plants per treatment were evaluated. Data were analyzed using ANOVA and Duncan Multiple test. Results confirm that *Trichoderma harzianum* isolated from garden compost extracts presents a high level of biocontrol against *Rhizoctonia solani* due to antagonism and parasitism effects. The in vivo essays showed the high interest of garden compost tea application in tomato seedlings production, which could reduce the use of chemical fertilizers and pesticides.

Key words: green and pruning wastes, compost tea, antagonism effect, parasitism effect, bio-efficiency

Biochemical composition, microbial activity and C/N ratio in composts: combining indicators for assessing product stability

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We combined three indicators for assessing compost stability, *i.e.,* microbial activity measured as oxygen uptake rate, biodegradation potential based on the holocellulose/lignin ratio, and C/N ratio. We assessed the relationships between biochemical composition, microbial activity and C/N ratio for a dataset with (a) 27 green waste composts, (b) 8 composts based on vegetable crop residues, (c) 9 chicken manure based composts, (d) 14 composts from small-scale composting and (e) 7 composts based either on farm yard manure or the solid fraction of separated cattle slurry. The characteristics of feedstock mixtures were specific for each type of compost. The biodegradation potential was used in this study as an indicator for the decomposition potential of the feedstock mixture on one hand, and to assess the stability of the composts at the end of the process on the other. During composting the holocellulose/lignin ratio decreased for all compost types. The studied composts had C/N ratios between 5 and 28. The holocellulose/lignin ratio at the end of the composting process was significantly positively correlated with the C/N ratio, which indicates an effect of N content of the feedstock mixture on biochemical decomposition. N shortage might limit further biodegradation or the microbial community involved in the decomposition might be affected by the N concentration. No relation was found between microbial activity and the holocellulose/lignin ratio or the C/N ratio. We conclude that knowledge on the biochemical composition improves the compost quality assessment when combined with other stability indicators.

Key words: nutrient cycling; lignocellulosic; cell wall components; crude fiber analysis; oxygen uptake rate

Effects of the integrated nutrient management on soil properties in table grape var. Crimson seedless during establishment

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Table grape is one of the main items of export fruit in Chile. Its production has increased over the past 20 years, becoming a leading exporter of fresh fruit in the southern hemisphere (49.9% of exports). The fertilization of grapes, mainly require nutrients such as N, P, K, Ca, Mg, Fe, Zn, Cu, Mo and Cl, which play essential roles on growth of plants. However, conventional production systems, specifically, fertilization management practices, has generated an excessive use of chemicals to sustain high yields. Integrated nutrient management is the combined use of available technologies and tools to design and apply the "best" possible plant nutrition programs, such us, use of diagnostic and follow up tools, proper estimation of nutrient rates, use of fertilizers of high efficiency, application of organic matter and inoculants and precision agriculture (site-specific management). To evaluate the effect of the addition of different types of organic matter and soil inoculant, as a complement to conventional fertilization, on soil quality, agronomic variables, yield, and fruit quality in table grape at establishment, a completely randomized block experiment was accomplished, using grape compost, humic extract and a microbial consortium along with NPK chemical fertilization on 100 L pots using table grape var. Crimson seedless as model and alluvial soil as support.

At the end of the productive season, the soil showed statistically significant differences ($p=0.0001$) between treatments in the β-glucosidase activity. The treatment with the highest activity was the one with the lowest doses of C applied as compost and the microbial consortium.

Key words: soil quality indicator, integrated nutrient management, compost, humic substances

Organic mulching in high-density olive groves: the use of compost from municipal wastes

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A green cover is pivotal to prevent soil erosion, but the competition for water and nutrients should be avoided between weeds and trees during the early stages after planting. This study compared seven mulching materials applied along the row of a young high-density olive orchard (1,250 trees/ha) in order to evaluate effects on weed growth, temperature and humidity of the soil and olive vegetative growth. Tested organic by-products were chipped pruning residues, coir fibre carpet, coir film, compost from municipal wastes and a combination of compost and coir fibre carpet. Synthetic materials were green anti-algae and black polyethylene films. Tillage and chemical weeding treatments were used as control. Compost was not able to contain weed development, showing similar values to the control. Synthetic materials showed the best weed control, while chipped pruning residues, coir fibre carpet and compost+coir fibre carpet had an intermediate behaviour. Black polyethylene film and compost+coir fibre carpet maintained the highest mean temperature of the soil, while chipped pruning residues the lowest. Moreover, all the tested materials showed higher below-mulching soil humidity compared to control, except polyethylene film and compost. Compost significantly stimulated olive vegetative growth, whereas no differences were registered between the other mulching treatments. In conclusion, organic materials showed good mulching characteristics and higher environmental/economical sustainability since no further removal/disposal was necessary as contrarily required for synthetic ones. The combination of compost and coir fibre carpet resulted in a very interesting option because stimulated the olive growth and properly controlled the weed development.

***Key words*:** weed control, vegetative growth, coir fibre, *Olea europaea*, organic by-products, recycling

SESSION 3

Recycling of organic wastes in agriculture

POSTERS

Use of compost to mitigate salt effect of sediment from Taylor Creek in South Florida

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Disposal of a large quantity of sediment dredged from Indian River Lagoon and tributaries remains a great challenge in south Florida. The sediment from Taylor creek contained relatively low organic matter (total C <5%) and nutrients (0.3% total N), but a large amount of salts (>2%). Therefore, the sediment cannot be directly used as soil amendment due to adverse salt effects on seed germination and subsequent plant growth. Addition of compost (of biosolids and yard waste) substantially increased organic matter and nutrient contents as well as moisture-holding capacity and reduced soil pH and diluted salt concentration. Plant test indicated that even 20% of sediment in the sediment-compost mixture resulted in <20% germination of Japanese millet (*Echinochloa frumentaceae*). However, seed germination significantly improved by placing a thin layer of compost (1-2 cm) on the top of the mixtures, with the germination rate > 70% in the mixtures with 80% or less sediment. At 100% sediment, no plant survived, but plant growth as measured by plant height and biomass yield increased with increasing proportion of compost. Plant analysis did not indicate deficiency of nutrients at the high proportions of sediment, but revealed very high Na concentration in the plant shoot. A significant negative correlation occurred between shoot dry matter yield and plant Na concentration. The results from column leaching study indicate that it may take six months of rainfall in the Indian River area (approximately 700 mm) to reduce salt concentration in the sediment to below critical levels for plant growth.

Therefore, for the beneficial re-use of this sediment for plant/crop growth, it is essential to overcome the high salt constraint by amending the sediment with compost and/or leaching out of the excessive salts.

Key words: column leaching, environmental risk, greenhouse experiments, plant growth, salt effect, sediment-compost mixtures

The use of alkaline sugar beet lime sludge for composting sludge from food industry

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Industrial activity in Morocco generates about 88,000 tons of sludge per year. By 2030, 118 000 tons of sludge will be produced. Furthermore, in Morocco, the sugar industry produces annually about 270,000 tons of lime sludge from the purification of beet juice and sugar cane, which are not valorised. The present work has for objective to show that an agronomic valorisation of a big part of this sludge is possible by co-composting with sugar beet lime sludge and green wastes as structuring agents.

The sludge was sampled from a food factory producing oil. Three windrows (C1, C2, C3) were prepared: C1 (compost control) was prepared without lime sludge, whereas the quantity of sludge was fixed at 20Kg and the sugar beet lime sludge was added for C2 and C3 in a proportion allowing to reach a pH of 7 and 8, respectively. The proportion of green wastes was fixed to 8.5% of the total mass of each mixture. The temperature, humidity, pH, nitrogen and organic matter concentrations were followed during 103 days of composting process. Heavy metals and nutrients were determined during and at the end of composting. Both germination and agronomic tests on the radish were also performed to evaluate the quality of the composts produced.

The results showed that co-composting of industrial and lime sludge produces mature composts, which could be used to amend the soil with organic matter to overcome the dramatic decline of organic matter in the Moroccan soils and to increase the fertility and contribute to the sustainable development.

Key words: sludge, compost, sugar beet lime sludge, industry, agriculture

Sugar beet lime sludge composts as organic fertilizers

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The sugar industry in Morocco produces in the purification step a large amount of lime sludge, which is not properly valorized. Furthermore, this lime sludge cannot be directly used for pH correction of soils as in Europe, since the pH is already high in most regions. The aim of this work was to study the valorization of the sugar beet lime sludge (LS) as an organic fertilizer after co-composting with different kind of wastes: olive mill wastewater (OMWW), household wastes (HW) and green wastes (GW).

Two composts were studied in our research: C1 prepared with LS plus HS and GW, while C2 was prepared with the same composition plus OMWW. The monitoring of the physicochemical parameters during the composting process showed that the produced composts are stable and mature. Furthermore, the assessment of the agronomic value of compost C1 was performed in two field trials on sugar beet crop, using 6 t/ha of compost. The results obtained showed no phytotoxicity on plant biomass and root development, which reflects the quality of the compost used. The produced beets showed a good yield, despite the 30% reduction in the use of a chemical fertilization (NPK) and the same quality as the control. The agronomic test was also conducted on radish for the compost C2. Both lime sludge composts could constitute a sustainable solution in order to reduce the harmful effects of the chemical fertilizers.

Key words: compost, sugar beet lime sludge, olive mill waste water, household wastes, chemical fertilizers, organic fertilizers

Co-composting of sludges from wastewater and sugar industry

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The development of human activities, the acceleration of economic growth and the extensive programme of wastewater treatment plant (WWTP) construction in Morocco, lead to a considerable increase in the amount of sludge. This sludge is piled next to the WWTP, either stored on site or mixed with the household waste in landfills without any treatment. Furthermore, the sugar industry produces annually about 270,000 tons of sugar beet lime sludge. The objective of this study is to determine the feasibility of co-composting wastewater and sugar beet lime sludges using green wastes as a bulking agent. Three composts were made from wastewater sludge, green wastes and different amounts of sugar beet lime sludge (0%, 20% and 30%) in order to achieve a pH equal to 7, 7.5 and 8, respectively. The windrows were followed for 100 days and temperature, water content, pH, nitrogen and organic matter concentrations were determined during the composting process. Microbial biodiversity was also studied by analyzing mesophilic aerobic bacteria, fecal coliforms, *Staphylococcus aureus*, *Enterobacteriaceae*, *E. coli*, *Salmonella,* yeasts and molds. A germination test was done on radish and turnip seeds in order to determine the quality of the composts. The results showed that the addition of sugar beet lime sludge allows a high quality compost to be obtained in a short time; the micro-organisms present in high levels in the untreated sludge decreased significantly after the aerobic composting process. The results obtained suggest that co-composting can be considered as a suitable option for the valorization of wastewater sludges.

***Key words*:** Compost, Sludge, Wastewater, Sugar beet lime, Organic fertilizer

Valorization of the organic wastes fraction of the old landfill by its using as an organic amendment

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Seven million tons of solid household wastes are produced annually in Morocco. Through the National Program Management Household and Similar Wastes (PNDM), Morocco has recently undertaken a vast controlled landfill construction program and rehabilitation of old dumps. This rehabilitation is based mainly on the landfilling with the construction of green spaces without any recycling or valorization of the organic part of the landfill wastes, which constitutes almost 65%. The present work aims to determine the physicochemical and microbiological characteristics of organic substrates in the old landfill in order to use it as an organic amendment. Three samples of 100 kg each were taken from the landfill of Sidi Bennour, sieved and the organic substrates fraction (OSF) chemically and microbiologically analyzed. The results showed that the OSF represents 65 % in weight. This OSF was stable and hygienic, especially when sugar beet lime sludge (SBLS) was added: the pH value was reduced to 8.4, the C/N ratio to 12 and no microorganism pathogen was detected. The heavy metal content was lower than the limit values recommended. The germination test using aqueous extracts of the OSF showed no phytotoxicity for all plants tested. Based on these findings, the addition of sugar beet lime sludge to the OSF and the reuse of this organic substrate as amendment could be considered a sustainable solution. An agronomic trial will be conducted for further research.

Key words: old landfill, organic fraction substrates, sugar beet lime sludge, organic amendment

Co-composting of poultry manure, municipal organic wastes and sugar beet lime sludge for soil amendment

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Poultry manure is a known source of bacterial pathogens, which decreases its direct application as an amendment of agricultural land. The composting of this waste is proposed as a suitable option with economic and environmental profits. This process eliminates or reduces the risk of spreading of pathogens, leads to a stabilized end product and reduces the high nitrogen concentration of the original waste.

This work has a twofold aims: i) to study the evolution of physicochemical and microbiological parameters describing the composting of a mixture of poultry manure (PM), municipal solid wastes (MSW) and lime sludge of sugar beet industry (LS), and ii) to assess the possibility of using the composts produced for soil amendment. The experiments were carried out with three different windrows: C1 prepared without LS (only MSW were composted with PM), C2 prepared from MSW plus PM and 10% LS; and the last one C3 from MSW plus PM and 20% LS. The results showed a good evolution of organic matter and C/N ratio, mainly for composts produced with LS. The monitoring of the microbial population during the composting process showed that the composts are mature and hygienic. In addition, the germination test using aqueous extracts of composts showed no phytotoxicity. Based on these findings, the composting of poultry manure with LS and MSW could be considered as a good opportunity for soil amendment in the context of sustainable development.

Key words: soil amendment, poultry manure, composting, municipal solid wastes, sugar beet lime sludge

Mix of composted urban waste and coir as potting media for basil production

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Composts from urban organic wastes and agro-industrial by-products represent a potential source for growing media preparation in nursery productions. Unfortunately, qualitative characteristics of the compost do not always meet the requirements for plant growth. The effect of an industrial compost (pH: 8.8 and Electrical Conductivity: 2.7 mS cm^{-1}) was evaluated for basil (*Ocimum basilicum* L.) production. Under controlled conditions in a completely randomized design, Composted municipal waste mixed with coir at different percentages (0%, 25%, 50%, 75% and 100% v:v) was used as growing media under controlled conditions in a completely randomized design. Basil was seeded and the percentage of germination was recorded during the first week; seedling performance was evaluated, after one month, measuring biometric parameters (canopy fresh and dry weights, stem total length, basal diameter and leaves number). The percentage of germinated seeds (76.6% to 90.6%) did not show significant differences between treatments. Canopy fresh and dry weights and stem length decreased with increasing the compost percentage. Basal diameter and leaf number decreased using 50% or higher compost percentages, probably because of the high values of electrical conductivity observed in the compost. Low plant growth suggested a phytotoxic effect of compost, also detected using the cress bioassay. Compost represents an opportunity for nursery production alone or mixed with other materials like coir, according to the requirements of growing media.

***Key words*:** germination, growing media, *Ocimum basilicum*, organic by-products, recycling, substrate

Comparing compost from urban waste and digested organic matter as fertilizers for corn production (*Zea mays* L.)

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The use of compost from urban waste can represent a sustainable way to replace mineral fertilizers for corn (*Zea mays* L.) cultivation. A one-year experiment was conducted in an irrigated low-land farm in a NVZ (Nitrogen Vulnerable Zone) of Marche Region (central Italy). The aim of the research was to compare the effect of compost from urban waste, mineral fertilizer and digested organic matter (from corn through solid-state anaerobic digestion) on corn production, soil fertility and quality. A completely randomized block design with three replicates was used and 100 kg ha^{-1} of N for each treatment were provided during sowing. Yield components at harvest were measured. Nutrient and heavy metal contents in the soil were analyzed before and after the experiment. Compost had positive effects on corn yield: significant differences between compost and digested organic matter were highlighted in the production (in terms of grain and biomass) whereas similar production was obtained in comparison to mineral fertilization. Furthermore, both compost and digested organic matter supplied macro- and micro-nutrients to the soil and did not increase heavy metal content. In conclusion, compost from urban waste represents an alternative fertilization method in agriculture, comparable to mineral nutrition, but with higher sustainability. Further perennial experimentations are required to study the use of anaerobic digested organic matter and the accumulation of organic matter and heavy metals in the soil.

***Key words*:** recycling, nitrogen, yield, soil fertility, heavy metals content

Spent mushroom composts as organic fertilizer: chemical characterization

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The Veneto Region (North-East Italy) is the largest mushrooms productive area of the country. The mushroom cultivation has become a real productive activity since the 50s and in the following years has undergone various processes of evolution due to the introduction of more advanced technologies. Nowadays the Veneto Region produces about 50% of the national mushroom production. Spent mushroom compost (SMC), obtained after a crop cycle, was initially reused by mushroom growers, but nowadays it is legally considered a soil conditioner (D. Lgs. n. 75/2010). SMC is becoming available in increasing quantities with the Italian mushroom cultivation industry producing an estimated 200.000 ton of SMC per year, a fact that poses a great environmental challenge in terms of its effective management. The present work investigates the potential of SMC as an organic fertilizer in vegetable production, by means of appropriate laboratory analysis of the chemical characteristics of 3 different types of SMC collected in the Veneto Region. The 3 kinds of composts were formed by different mixtures made of poultry manure + horse manure (PL), straw + poultry manure (PP), straw + poultry manure + horse manure (PPL) in different proportions. The selected parameters measured include dry matter, organic matter, total N, P and K, C/N ratio, pH, EC, anions and cations. All composts showed good potential in terms of some nutrients content (organic N, Ca, S) with an acid pH. The only possible problem could be connected with the salinity, which was around 7 dS m^{-1} for all the 3 kinds of composts and probably is not appropriate for compost utilization as growing media. Very low contents of heavy metals were also detected.

Key words: organic matrix, macronutrient, sustainability

Application of agricultural waste compost in greenhouses growing horticultural crops

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The feasibility of growing lettuce on compost obtained from agricultural plant waste and rabbit manure in greenhouses was studied. Compost was used as a single fertilising source for horticultural crops, and a reference with no fertilisation type was used as a control. The objective of this experiment was to compare production parameters of a traditional lettuce variety, the Batavia-type. The experiment was done in 2-litre PVC pots. Twelve containers were filled with 100 g of vermicompost made from rabbit manure. Three waste compounds were added per mixture: lettuce (L), corn (C) and peat (P) as follows: Peat P, Lettuce L, Lettuce + Corn LC, Corn+Lettuce+Peat C+L+P. Then one lettuce was planted in each pot. For approximately 20 days, lettuces grew in their corresponding pots and were drip-irrigated in the greenhouse. Then pots were taken to the laboratory where the aerial and root parts were separated. Each part was weighed, and leaves were counted and measured. The results were analysed by ANOVA. Vegetal production was determined for total aerial biomass, dry weight and dry matter. The content of nutrient elements (N, P, K, Ca, Mg, Fe, Cu, Mn, and Zn) was analysed. In the composts and vermicomposts, several physic-chemical (pH, electric conductivity), chemical (organic and inorganic nitrogen, organic carbon) and biological (edaphic respiration) properties were analysed. The results obtained for production indicated that the composts used in the different mixtures showed differences in total aerial biomass compared to the control. However given the low mineralisation rate of these composts, the combined direct use of this organic amendment and other materials with greater fertilising power is recommended in horticultural crops.

Key words: agricultural waste, vermicomposting, vegetal development

Isolation and characterization of native microorganisms with hydrolytic enzyme activity from sugarcane compost, for bioaugmentation processes

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The production of sugar, ethanol and electricity from sugarcane, generates byproducts such as leaf, bagasse, rum, ash and vinasse, which are transformed through composting processes where the enzymatic activity of microorganisms, promotes the mineralization of organic materials. The activity of those microorganisms can be biotechnologically enhanced for the biodegradation of the organic matter. The present research aimed to isolate and select microorganisms from compost piles and to produce a bio-inoculant with hydrolytic activity. Six bacterial strains were selected by enzymatic activity tests, and characterized using BIOLOG®. Amylolytic, cellulolytic and proteolytic enzymatic activities were evaluated and performed in chemically defined media, incubated at 150 rpm/ 37 and 55 ° C, 48 h. The activity was quantified by 3,5-dinitrosalicylic acid (DNS) and trichloroacetic acid (TCA) techniques. Finally, for the production test of microbial culture, a no commercial medium with vinasse and molasses was used in a BioFlo® 110 bioreactor. The results showed that microorganisms produced amylases, cellulases, lipases and proteases as hydrolytic enzymes both at mesophilic and thermophilic conditions with higher expression at 24 h of incubation (p-value = 0.025). The P1C strain, identified as *Bacillus racemilacticus*, presented significantly higher enzyme activities with UA 457.20 / min.L, 81.95 UC / min.L and 282.39 UP $min^{-1}.L^{-1}$ respectively (α = 0.05). In mixed culture, the microbial growth followed a Gaussian model where the higher amylolytic activity was expressed in 15 hour with 365 AU / min and maximum biomass of $1x10^{10}$CFU mL^{-1}.

Key words: compost, hydrolytic enzymes, *Bacillus* sp. bioaugmentation

Use of compost co-utilized with rockdust for landscaping and site regeneration

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Research examined use of compost with or without additional recycled minerals (rockdust) for landscaping and land restoration. Rockdusts are mineral fines recovered from quarrying of primary rocks, often regarded as waste. Use of rockdusts as soil improvers is also referred to as soil remineralization. Two contrasting sites were used: an exposed quarry undergoing restoration and peripheral land at a restored landfill. Trials were carried out over a five year period from 2009 with plots each in a randomised statistical design. Effects of treatments on soil analytical properties and a range of both native and ornamental landscape plant species were measured. Environmental impacts of the use of recycled materials were also determined, including biodiversity and sward quality. Economic sensitivity of using compost and rockdust was then modelled. Plant growth benefited principally from the use of compost. Autumn growing period was extended and, overall, resulted in better plant growth and performance. There were highly significant differences between compost treatments. Initially there were also significant growth differences between rockdust treatments. In terms of overall site development and naturalisation there were dramatic advantages to the use of compost. Treated plots generated significantly more biomass with improved key performance indicators. Trends in biodiversity suggest that this is optimised in a balanced use of compost and rockdust. Blends performed better towards the end of the trial period. There were differences in performance between rockdust types. Plant losses were greatest in untreated controls compared to those treated with compost and / or rockdust.

***Key words*:** compost, rockdust, landfill, restoration, remineralisation, remineralization

Impact of peanut shell mixed with peat moss as improved media and its effect on growth characters of petunia

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Pot experiment was carried out at the nursery of the Ornamental Horticultural Department, Agricultural Faculty, Cairo University, Egypt throughout the two successive seasons of 2008/09 and 2009/10. Peanut shell mixed with peat moss was evaluated as growth media at different concentrations; 0, 30, 50 and 70%. The results showed that increasing the percentage of peanut shell in the pot media above 50% has a noticeable effect on most of the studied properties. The highest values of pH and electrical conductivity in the pot media were obtained with 70% peanut shell. Increased peanut shell was associated with a progressive increasing in available water. Fresh and dry plant weights reached their maximum values with a peanut shell addition at 50%. There were highly significant positive correlations between N, P and K contents in plant and the easily available water and water retained capacity. The highest flower number was recorded at 50% peanut shell in both seasons. These numbers exceeded those of peat moss by 44%.

The application of peanut shell in association with peat moss rather than their individual use is found to be a viable option for providing better aeration, and water availability to plants as well as water buffering capacity of the media which has long been a challenge for pot culture.

Key words: *Petunia*, pot media, peanut shell, media physical properties, flower waves

SESSION 4

Environmental impacts and health risks associated to the use of compost in agriculture

POSTERS

Airborne levels of VOCs and bioaerosols near a composting plant in Catalonia, Spain. Human health risk assessment

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Despite the composting of the municipal solid waste organic fraction is an extended activity, adverse health effects related to this practice are not yet well known. During this process, a wide range of microbiological and chemical agents, such as volatile organic compounds (VOCs), may be generated and released. Furthermore, VOCs are sources of odour nuisance. In the summer of 2014, we carried out a sampling campaign to determine air levels of 19 VOCs and a number of microbiological pollutants in four sampling points located near a composting plant located in Torrelles de Llobregat (Catalonia, Spain). Fungi grown at 25 ºC were the microbial agents presenting the highest levels, ranging between 530 and 2020 colony-forming units per cubic meter (CFU/m^3). In contrast, *Aspergillus fumigatus* was not detected in any sample, while the levels of gram negative bacteria showed the lowest concentrations (<detection limit-30 CFU/m^3). Total bacteria presented a mean value of 561 CFU/m^3, while fungi grown at 37ºC ranged from 60 to 1030 CFU/m^3. With respect to chemical pollution, BTEX (benzene, toluene, ethylbenzene, *m,p*-xylene and *o*-xylene) were the only VOCs detected in all the samples, being also the most abundant compounds. Individually, toluene was the compound showing the highest concentration, while 1,3-butadiene and *p*-isopropyltoluene were undetected in all the sampling sites. The current human exposure to the VOCs here evaluated is not likely to mean additional health risks for the population living nearby.

***Key words**:* municipal solid waste management, composting, air, volatile organic compounds (VOCs), bioaerosols

The PO_4^{3-}/NO_3^- ratio of seepage waters as an indicator of macropore contributions to leaching in different agricultural land use

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The leaching of mineral and organic nitrogen and phosphorus was studied under different agricultural land uses such as grassland and arable land. Passive capillary samplers (PCAPS) were used to collect seepage water. The highest concentrations of mineral N (NO_3^-, NH_4^+) were detected in the late winter, and mineral P concentrations were highest in late summer. The average proportion of ammonium N out of the total N was 15 % higher in the seepage waters from the arable land after long-term organic fertilisation and 6 % was found after long-term mineral fertilisation. The organic N concentrations in seepage waters from the experimental sites noticeably decreased in most cases when the organic P concentrations increased, and vice versa. From this observation, it was concluded that organic N compounds are leached separately from organic P compounds. In most cases, a decrease in the drainage nitrate concentration was parallel to that observed with an increase in the PO_4^{3-} concentration. In these situations, a higher contribution of macropore/preferential flow to leaching is assumed. From these results, it was concluded that the PO_4/NO_3 ratio can be used to indicate macropore and/or preferential flow.

Key words: seepage water, macropore, tillage, PO_4^{3-}/NO_3^- ratio, PCAPS

SESSION 5

Challenges for the development and testing of next generation organic amendments

POSTERS

Effect of charcoal-blended compost on the plant growth of *Brassica rapa var. peruviridis* for reduction of nitrogen fertilizer use

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Agricultural use of biochar has recently been paid attention as an alternative strategy for mitigating GHG emissions as well as a useful tool for enhancement of soil fertility. Our study was focused on effect of compost with biochar on plant growth and soil property to obtain acknowledgement in regard to a question; how much application of poultry manure compost with/without biochar (PM, PM+B) can be alternative for replacement of chemical nitrogen fertilizer. A treatment of sole chemical fertilizer was set up as control in plant growth experiment of Komatsuna (*Brassica rapa* var. peruviridis). Based on calculation of same nitrogen content to control (0% organic fertilizer), four different doses (12.5%, 25%, 50%, and 100%) of compost application with/without biochar (PM, PM+B) were set up for replacement of chemical N fertilizer (urea). After the experiment, morphological measurements, nutrient content in leaf, and soil physico-chemical properties were analyzed. Root fresh weight and root activity in the treatment of PM+B (25% and 50%) was much higher than control (100% of chemical nitrogen fertilizer), although no difference was observed in shoot weight and plant height. Vitamin C content in leaf was higher in the application of PM and PM+B than control. Concerning soil characteristics, the combination between chemical fertilizer and PM+B (25% and 50%) increased total carbon content as well as carbon water-soluble carbon fraction. Synergic effect of chemical and organic fertilizer application performed favorable results in providing more equilibrate volume of nutrient components in leafy vegetable and mitigating the environmental risk in soil.

Key words: manure, compost, biochar, organic farming, organic fertilizer

Effect of the addition of sawdust biochar and zeolite on the quality of the compost produced from agricultural wastes

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In the present experimental study, biochar and zeolite were mixed with compost, to improve its quality and beneficial properties as soil amendment for the crop cultivation in the Mediterranean region. The compost was produced from agricultural wastes (AWs) such as olive mill waste, sheep and goat manure. Commercial zeolite and clinoptilolite were obtained/produced in Spain and Italy, respectively. Biochar was produced after slow pyrolysis at 350 ^{o}C of sawdust obtained from a carpentry workshop in the region of Chania, Crete, Greece. Biochar and zeolite to compost ratios used were 1 and 5% w/w. After maturing for one and three weeks, phytotoxicity tests were carried out in the mixtures to assess compost quality in terms of reduction of contaminants leaching and mobility, increase of nutrient availability and mitigation of any potential adverse effects on humans and the environment.

Key words: agricultural waste, biochar, compost, zeolite

Co-composting with biochars

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Organic waste composting is often used to improve soil characteristics, resulting in products with low moisture content, minimised odour and pathogens compared to raw bio-waste. However, nitrogen loss in form of ammonia volatilisation typically occurs during composting, thus a number of compost amendments have been considered to minimise such emissions, amongst which are biochars, carbon-based solid products formed from the thermochemical treatment of biological matter. In this study, the ammonia adsorption capacities of oak-based biochars produced at low and high temperatures (450°C and 650°C respectively) were compared, and potential mechanisms governing ammonia adsorption were considered. In accordance with previous findings, it was found that co-composting with the former biochars resulted in lower ammonia emissions. Possible influencing factors were identified as pH, adsorption capacity or presence of surface acid groups.

Key words: biochar, composting, ammonia, functionality

Comparison of the levels of polycyclic aromatic hydrocarbons in biochars and hydrochars

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To investigate the pollutants formed during the production of biochars and hydrochars derived from various waste biomass feedstocks, levels of polycyclic aromatic hydrocarbons were compared. Biochars and hydrochars produced from treated organic fractions of municipal solid waste, greenhouse and greenwaste at varying thermochemical conditions were compared with oak-derived biochars. Results showed Levels of PAH in the chars are comparable although the levels of extractable oxygenated hydrocarbons are higher in the hydrochars. These findings provide more insight into the levels of contaminants in biochars and hydrochars before they are used as soil amendments.

Key words: biochar, hydrochars, PAH, oxygenates

Biochar impact on poultry manure composting

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Poultry manure is a N-rich residue with important management challenges. Composting is considered a viable option for its safe use in agricultural soils. However, manure composting involves N losses, which leads to a decrease in its agronomical value and negative environmental impacts due to greenhouse gas (GHG) release and bad odours. Biochar is a C-rich material that contributes to the reduction of GHG losses in several environments. However, its performance as a composting co-substrate is largely unknown and even less its impact on gaseous emissions.

The objective of this study was to evaluate the impact of biochar on composting performance, gas release, and end-product quality. Two treatments: (i) control (78% poultry manure + 22% barley straw, dry weight basis) and (ii) the same mixture treated with biochar (3%, dry weight basis), were composted per duplicate and monitored during 19 weeks.

Biochar addition prevented the formation of big clumps (> 2.5 cm) during the process, which resulted in an improved aeration conditions. It promoted C mineralisation, ammonification and nitrification processes, maintaining the rates of GHG release and N losses. Overall, it is estimated that the higher process efficiency induced by biochar addition could reduce the composting time in 4 weeks.

Key words: charcoal, gas emissions, compost quality, nitrification, methane, nitrous oxide

Biochar impact on olive mill waste composting

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The olive mill waste composting process has been extensively studied and it is characterised by an excessively long composting time due to its high lignocellulosic content, which slows down its microbial degradation. Nowadays, the main challenge is to reduce the current problems associated to the management of the olive mill waste composting process and to raise the agronomical quality of the compost produced, minimising environmental impacts. Biochar is a carbonaceous by-product obtained by pyrolysis of organic materials, which could be a powerful tool for retention and release of nutrients when used as a soil amendment. In addition, biochar may act as a slow release N pool for plants preventing the risk of NO_3^--N lixiviation to groundwater. The aim of this study was to study the biochar effect on N transformations during the composting process by analysing: total N losses, nitrification rates and N_2O fluxes. Two treatments: (i) control (olive mill waste 46% + sheep manure 54%, dry weight basis) and (ii) the same mixture treated with biochar (4%, dry weight basis), were composted using the windrow turning aeration system and monitored during 31 weeks. The results indicate that the incorporation of a small amount of biochar (4% dry weight basis) increased the nitrification rate and the amount of NO_3^--N content, which is an indicator of a higher activity of nitrifying bacteria, and reduced the total N losses by 15% without affecting significantly the amount of N_2O released during the process. From an agricultural point of view, the biochar could improve the availability of N in the compost obtained from N-limited composting mixtures.

Key words: olive mill waste, biochar, manure, composting, nitrous oxide, nitrification, organic matter mineralisation

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MY NOTES