Soil Waste Water 2013

Olive mill wastes and low quality water in agriculture

Effects and interactions in soil

Landau in der Pfalz, 3rd – 5th April 2013

UNIVERSITÄT KOBLENZ · LANDAU

DBG Deutsche Bodenkundliche Gesellschaft

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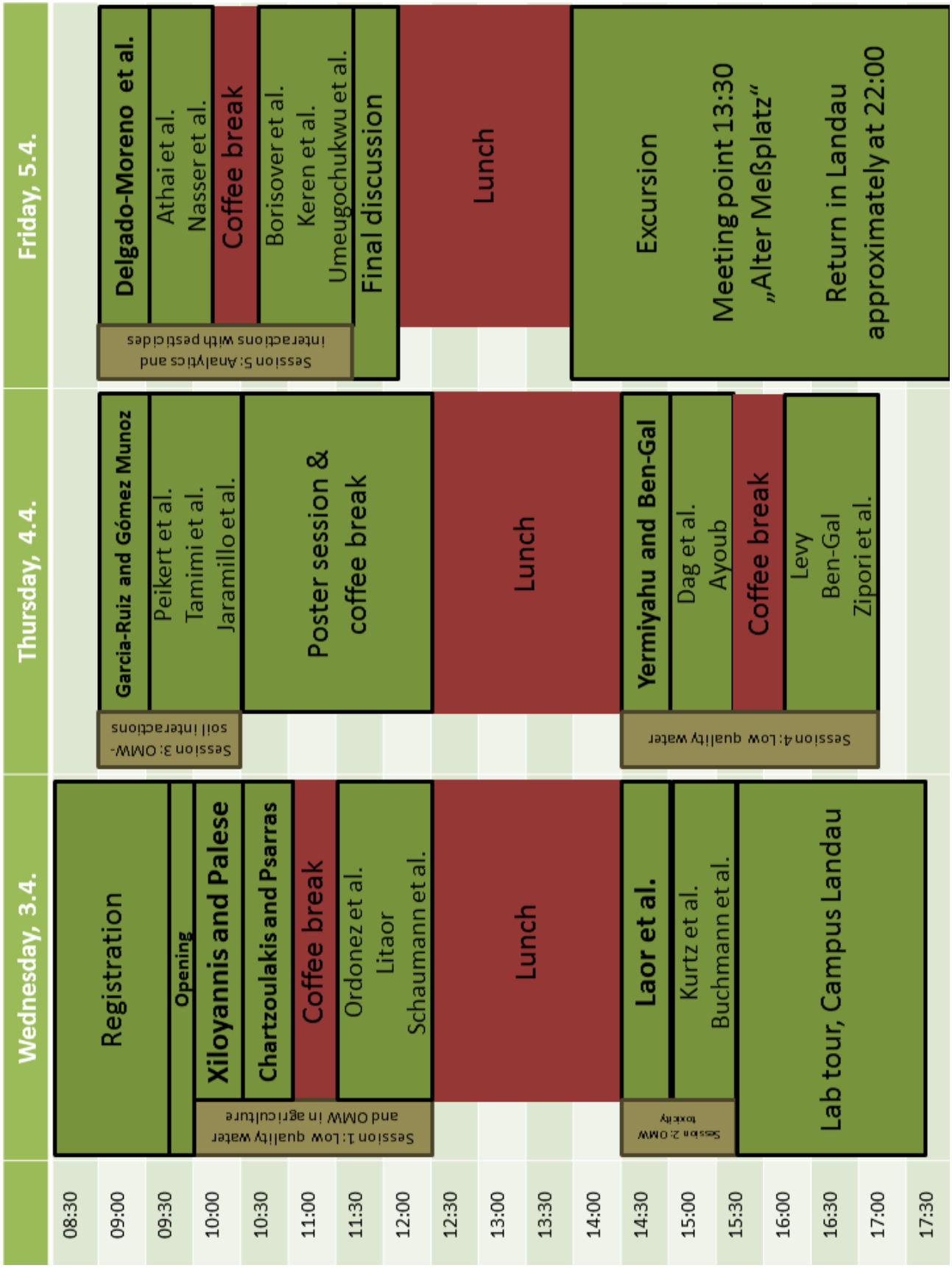
Day by day schedule



Platforms, Wednesday, 3rd April 2013

Session	Low quality Water and OMW in agriculture
10:00	Xiloyannis and Palese - Use of treated wastewater as alternative source for olive irrigation
10:30	Chartzoulakis and Psarras - Application of olive mill wastewater on olive orchards: an environmentally acceptable and cost effective management method
11:00	Coffee break
11:30	Ordonez et al. - Anaerobic co-digestion of wastes from the production of olive oil in various European Mediterranean countries
11:50	Litaor - Vertical Flow Constructed Wetland for Treatment of Olive Mill Wastwater (OMW)
12:10	Schaumann et al. - Wastewater from Olive Oil Mills in Israel and Palestine: Interactions with Soil, Organic Contaminants and Soil Organic Matter- a Trilateral Project
12:30	Lunch
Session	**OMW toxicity**
14:30	Laor et al. - Phytotoxicity of raw and soil-applied olive mill wastewater: causes and bioassay methodology
15:00	Kurtz et al. - Effects of Olive Mill Wastewater on Soil Arthropods in Two Different Cultivation Scenarios in Israel and Palestine
15:20	Short-term effects of Olive mill wastewater application on degradation of polyphenols, ecotoxicology and carbon isotope ratio of a Mediterranean soil
15:40	Lab tour, Campus Landau

Platforms, Thursday, 4th April 2013

Session	OMW-soil interactions
09:00	Garcia-Ruiz and Gómez-Muñoz - Composting olive mill pomace: converting a waste into a resource. Environmental benefits of its application in olive oil groves
09:30	Peikert et al. - Application of olive oil mill wastewater in summer? A laboratory incubation study
09:50	Tamimi et al. - Effect of olive mill wastewater spreading on soil under different climatic condition in a semi humid area: A field study in Bait Reema – West Bank – Palestine.
10:10	Jaramillo et al. - Effect of olive mill waste compost on the physical fertility of a calcareous soil
10:30	Poster session and coffee break
12:30	Lunch
Session	**Low quality water**
14:30	Yermiyahu and Ben-Gal - Using treated wastewater in agriculture: the influence of combined excess boron and high salinity on crops
15:00	Dag et al. - Irrigation olive with recycled water – the effect on oil production and quality
15:20	Ayoub - Effect of Irrigation with Reclaimed Wastewater on Soil Properties, Olive Tree Yield and Oil Quality
15:40	Coffee break
16:10	Levy - Long term irrigation with treated wastewater (TWW) – how sustainable is it?
16:30	Ben-Gal - Irrigation of olives with brackish water: an overview and Israeli perspective
16:50	Zipori et al. - The effect of irrigation of olive orchard with reclaimed wastewater on soil properties.

Platforms, Friday, 5th April 2013

Session	Analytics and interactions with pesticides
09:00	Delgado-Moreno et al. - Use of products derived from the olive oil industry to reduce the impact of pesticides in soil and waters.
09:30	Athai et al. - Review of antifungal potential of natural polyphenols extract from olive pomace against pathogens of fruit and viticulture
09:50	Nasser et al. - Physico-Chemical Characterization of Olive Oil Mill Effluents
10:10	Coffee break
10:40	Borisover et al. - The impact of olive oil mill wastewater on organic compound – soil interactions: the survey
11:00	Keren et al. - Herbicide interactions with soils affected by olive oil mill wastewater: sorption isotherms, possible change of the mechanism and irreversibility.
11:20	Umeugochukwu et al. - Understanding soil and ground water pollution caused by on-land disposal of waste water generated by small scale palm oil mill farmers in southeastern Nigeria
11:40	Final discussion
12:10	Lunch
13:30	Excursion, meeting point “Alter Meßplatz”, Return in Landau approximately at 22:00

Workshop

Get together

Get-together buffet: 2nd April 18:00 in the workshop location "Rote Kaserne". There we will offer "Tarte flambée" and drinks for all participants.

Excursion

Excursion on the 5th April after lunch to the "Dienstleistungszentrum Ländlicher Raum" (Service Center Rural Areas) to visit their facilities related to horticulture, irrigation and wine. After that we will visit and dinner in Gimmeldingen, near Neustadt/Weinstraße in Netts Restaurant. Anticipated return to Landau: 22:00h. The excursion is for free, just lunch and diner have to be paid by the participants.

Menu 1

Tatar and carpaccio from Irish beef on endive aple mash with goat cream cheese
Fried guinea fowl breast with wild garlic ricotta filling on creamy pea risotto and chorizo-peperonatafumé
Trilogy of homemade sorbet with marinated strawberrys
38€ per person

Menu 2

Spring herbage soup with tempura shrimp and papaya chutney
Filet from Ahrenshorster white Edelwaller (fish) on stewed tomato fennel vegetable and olive-mashed-potatoes
Tonka-beans panna cotta with raspberry compote and dark chocolate mouse
40€ per person

Vegetarian alternative:

Spinach-ricotta gnocchi with brown butter, parmesan and confired cherry tomatoes

Wifi

Dear participant,

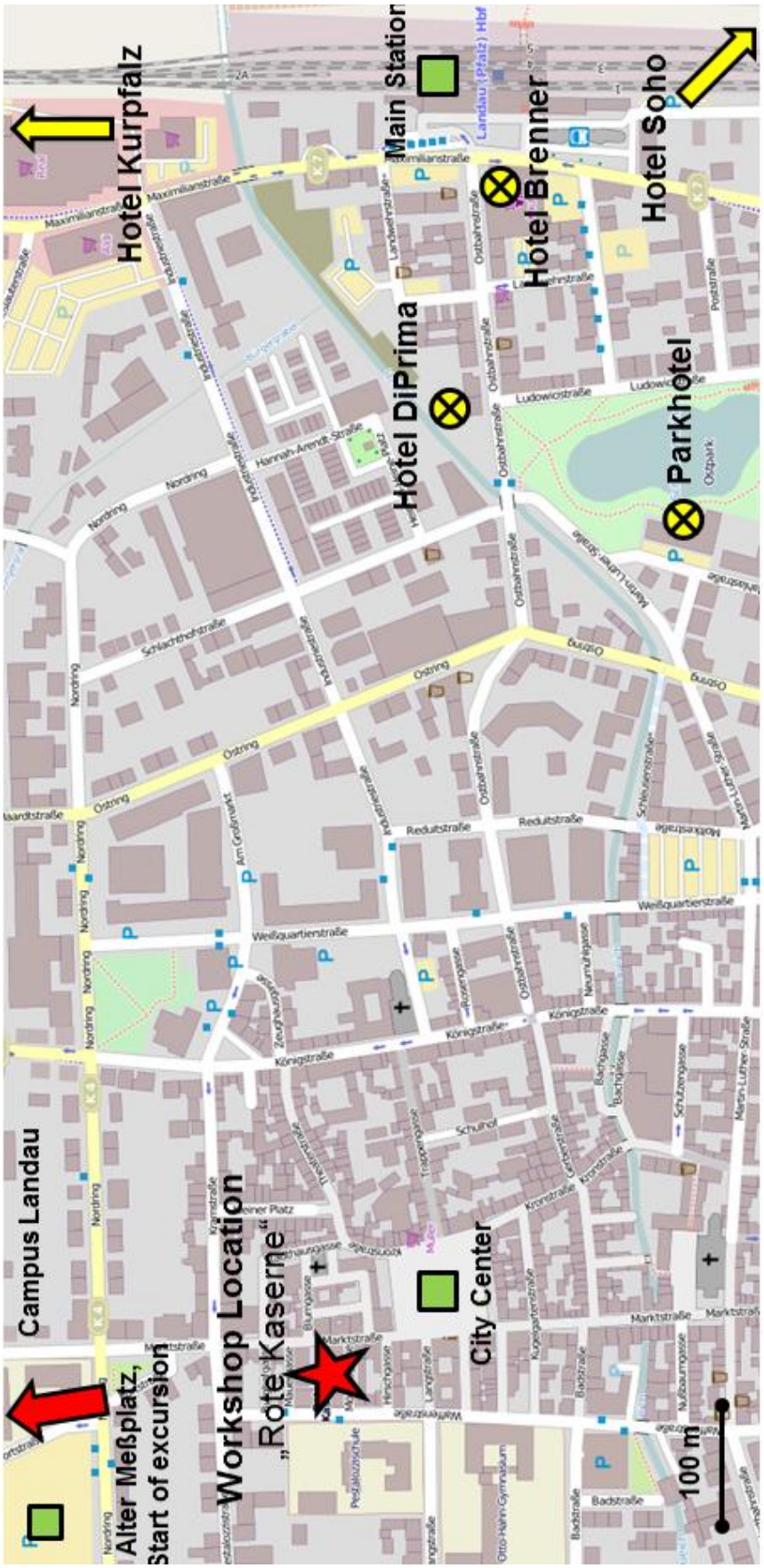
During the workshop Soil-Waste-Water 2013 you can access the university wifi:
If you already use EDUROAM you can also log in with your account at the university network.
Network name: eduroam
Authentification: WPA Enterprise
Method: PEAP or MSCHAPv2

Network Name: Uni-Landau
Username: sww13
Password: 31SWWUNI

If this is not the case, you have to install a certificate of the university which you can get by the local organizing committee. In some systems it is already installed, but sometimes you need do to the following steps and install the certificate manually:
- Install the certificate into "Trusted Root Certification Authorities"
- Choose than "Properties" of your Wifi in your "Network Places" and klick "Add"
- Name the SSID "Uni-Landau" or "eduroam", set network authentification as "WPA" and data encryption as "TKIP" (For Windows 7 it is "WPA2 Enterprise" and "AES"
- Tick "Connect even if this network is not broadcasting (SSID)"
- In the next slide "Authentification" choose "Secured EAP (PEAP)" in the field "EAP-Type" and click on "Properties"
- In the "Trusted Root Certification Authorities"-list tick "Deutsche Telekom Root CA 2" and click on "configuration". Remove there the tick.
- Then open the wifi connection which is now shown in the taskbar, type in the account name and the password and you are online!

If you face any problems getting access to Wi-Fi, please inform us during the workshop.

City map


Hotel Kurpfalz
Main Station
Hotel Brenner
Hotel Soho
Hotel DiPrima
Parkhotel
Campus Landau
Alter Meßplatz,
Start of excursion
Workshop Location
„Rote Kaserne“
City Center
100 m

Welcome

by the Steering Committee of the workshop

Dear participants and guests,

We are very pleased to welcome you to our 1st workshop Soil-Waste-Water 2013 in Landau. Taking into account increasing use of olive mill wastes and low quality water in agriculture due to water scarcity in many countries, this conference aims to bring together specialists from soil science, environmental chemistry, ecotoxicology and agriculture and to integrate their efforts in a joint discussion on the interactions in soil and on how to sustainably use agricultural wastes and low quality water in agriculture.

The conference is organized in the frame of our trilateral project where we investigate the interactions between olive mill wastewater and soil in Israel and Palestinian Authority. We are looking forward to discuss our results with other researches from similar areas to get new insights into the highly topical relevant emerging environmental issue of reuse of OMW and low quality water.

It is our pleasure to welcome our keynote speakers from Greece, Italy, Israel, Spain and the U.S.A. giving lectures about challenges and approaches during their research.

Hoping that we have prepared an interesting scientific and social program, we wish you a successful and productive workshop in Landau. Enjoy your stay.

Gabriele E. Schaumann
UNIVERSITÄT KOBLENZ · LANDAU

Mikhail Borisover

Arnon Dag

Kostas Chartzoulakis
NAGREF

Jawad Hasan
AL-QUDS UNIVERSITY

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Acknowledgements

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Steering committee

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(University of Basilicata, Italy)
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(Agricultural Research Organization, Volcani Center, Israel)
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(Agricultural Research Organization, Volcani Center, Israel)
Roberto García Ruiz
(University of Jaén, Spain)
Laura Delgado Moreno
(University of California Riverside, U.S.A.)

Local organizing committee

Prof. Dr. Gabriele E. Schaumann
Markus Kurtz

About the venue

Landau in der Pfalz

The town of Landau is located in the district of southern Rhineland-Palatinate and is characterized by the culinary delights of viniculture and the cuisine of Palatinate and nearby France. The beautiful town center with an ample pedestrian area, neat parks, a lively market and friendly people tells a turbulent history. Landau is surrounded by vineyards and villages of the scenic German Wine Route and the Palatinate Forest invites for recreation. Workshop host is the University of Koblenz-Landau with the campus on the remains of the French star fort.

The autonomous city is surrounded by the “Southern Wine Route” and is a long-standing cultural center and a market and shopping town in the heart of the Palatinate wine region. Additionally, its neighborhood to Europe’s largest contiguous forest, the Palatinate forest, and its long history with beautiful main sights like the main square (*Rathausplatz*) and the market hall (*Altes Kaufhaus*) makes it always worth a visit.

Landau’s variegated history is being reflected in our workshop location the red barracks (*“Rote Kaserne”*). It was built in the 17th century as barrack-outpost of the fort and was used by the French army, Bavarian troops, as youth center and finally as outpost of the University Koblenz-Landau.

Campus Landau

The University of Koblenz-Landau is one of the youngest universities in Germany. It was transformed from a teacher’s training college to a modern and research-orientated university in 1990. Since then, new Departments and Institutes have been founded and the university expanded and raised its research profile in Psychology, Education, Humanities and Natural Science.

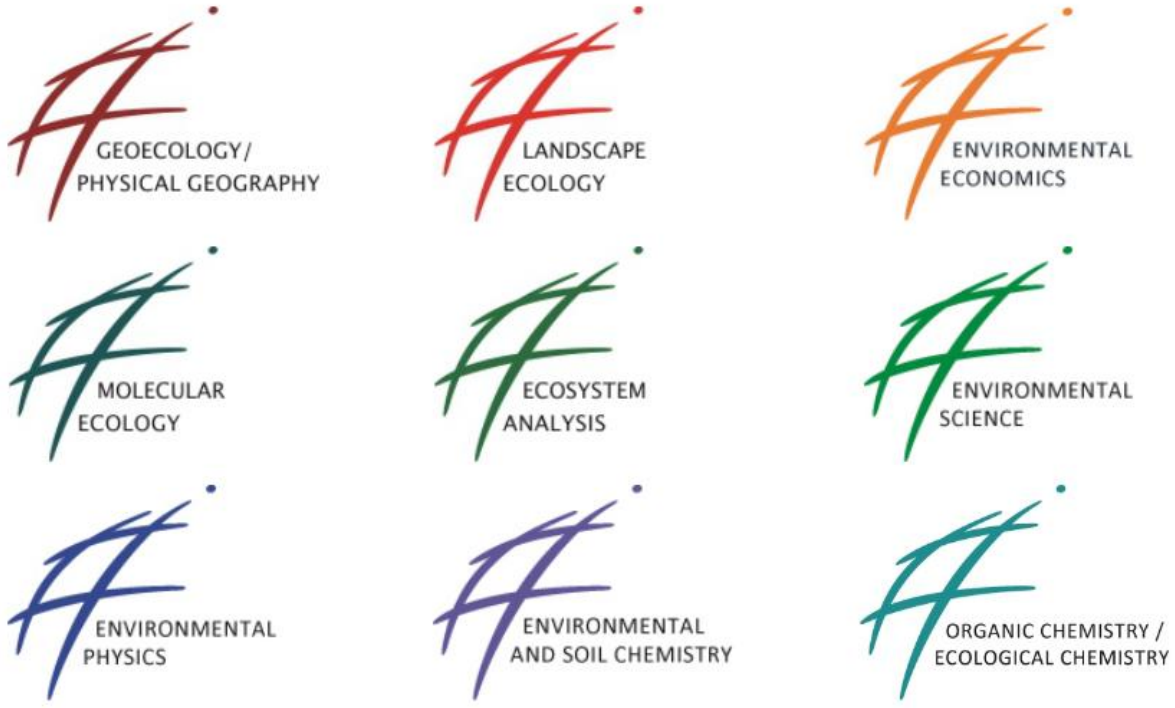
Research at Koblenz-Landau is above all oriented towards practical application. The transfer of academic work through co-operation with partners from industry, commerce and administration is of great importance. As a young university it has the necessary openness and flexibility to respond to the demand for work in the realms of research, development, consultancy, and provision of expert opinion.

A special feature of the University of Koblenz-Landau is its structure. Koblenz and Landau are the locations for research, teaching, and further education. The organizing link between the two campuses is the President's Office in Mainz, home of the university executive and the central university administration.

Institute for Environmental Sciences Landau

The focus of the research at the Institute for Environmental Sciences concentrates on new anthropogenic stressors in linked ecological systems. Transition zones between ecological systems contribute substantially to the regional biodiversity and are „hotspots" for many ecological and biogeochemical processes. They provide many „ecosystem services", like flood protection, retention and degradation of pollutants as well as the conservation of biodiversity and recreational areas, and are of high socio-economical importance. At the same time they are considered as particularly sensitive to environmental changes, e.g. by changing flooding dynamics as consequence of anthropogenic operations or global climate change.

Pronounced goal of the Institute for Environmental Sciences is the study of these interactions in interdisciplinary co-operation between the biologically, chemically, physically, geo-scientifically and sociologically aligned working groups



Presentations, Wednesday, 3rd April

Session 1: Low quality water and OMW in agriculture

Use of treated wastewater as alternative source for olive irrigation

Cristos Xiloyannis, Assunta Maria Palese

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Abstract
A medium-term experiment (2000-2010) was carried out in a mature olive orchard placed in Southern Italy and micro-irrigated with urban wastewater. Wastewater was treated according to low-cost simplified treatment schemes which excluded biological processes for organic matter and nitrogen removal to recover and use them as fertilizing substances. Annual irrigation volume was on average around 3500 m^{-3} ha^{-1}. The irrigated olive orchard was managed according to sustainable agricultural techniques based on: a) the recycling of internal carbon sources (pruning material, plant residues coming from a spontaneous ground cover) aimed to increase soil organic matter, to potentiate CO_2 sequestering action of the orchard system, to reduce soil erosion; to improve soil hydrological features and soil water holding capacity; b) an adequate fertirrigation performed taking into account soil and wastewater chemical analyses and the mineral element balance in the orchard system. Microbiological quality (*Escherichia coli*, enterococci, sulphite-reducing *Clostridium* spores and *Salmonella* spp.) of wastewater, soil and fruits was monitored to evaluate the risk of contamination. Chemical determinations were performed on the same matrices. Particularly, analyses of total heavy metals and bioavailable fraction were made on samples taken at different soil depths to assess their eventual accumulation and migration along the profile. Yield, merceological features of drupes (fresh weight, drupe size, pulp to pit ratio) and olive oil quality were determined. All analysis were carried out also in a rainfed olive orchard managed according to the conventional techniques adopted in the experimental area (tillage, 2–3 times per year; empirical mineral fertilization, no recycling of pruned material). An energy, economic and environmental analysis (LCA) was performed to compare the sustainable management with the conventional one. In addition, the environmental benefits coming from the application of the sustainable management were examined focusing on CO_2 stocks in plants and soil, anthropogenic and natural CO_2 emissions.

Keywords: sustainable techniques, vegetal residue recycling, heavy metals, contamination indicators

Application of olive mill wastewater on olive orchards: an environmentally acceptable and cost effective management method

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Abstract
The disposal of olive mill wastewater (OMW) produced in the Mediterranean countries creates a significant environmental problem. Although several OMW management methods have been proposed, their application at olive mill level is limited due to high investment and/or running cost and technical expertise required. Application of OMW to olive orchards can be a low cost alternative method to OMW treatment, in regions with small size olive mills. In an experiment fresh OMW (after one-day sedimentation) were applied for 3 years on the soil of an olive orchard consisted of 20-year-old olive trees. Annual rates up to 1,500 l/tree were applied in five equal doses, at 20-days intervals between November and February. Soil analyses were performed before the onset and after the end of OMW application period. The response of olive trees to OMW application was monitored by measuring plant nutritional status, photosynthesis and yield. Furthermore, the possibility of groundwater pollution by the application of fresh OMW was investigated in lysimeters.
OMW-treated soil had higher K content throughout the experiment. Phenols were decomposed rapidly, and therefore the phenolic content before the onset of a new OMW application period was negligible. The nutritional status, the physiology and yield of olive trees were not affected by the application of OMW. The total olive orchard area required for the annual OMW production is 3.6 ha (280 trees per ha), which is easily available around an olive mill. The cost of application is 0.007 €/lt of OMW, seems reasonable compared with sophisticated methods. Detailed study for each case to determine the application dose according to soil and climatic conditions of the area is required. The effects of OMW application on soil microbial community and olive oil quality, as well as the need for a directive applied in all Mediterranean countries are also discussed.

Keywords: olive mill wastewater, soil nutrients, plant nutrient status, olive yield, drainage water pollution

Anaerobic co-digestion of wastes from the production of olive oil in various European Mediterranean countries

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Abstract
Olive oil industry generates every year inevitable high amounts of solid (OMSW) and liquid wastes (OMWW) in a short seasonal period (around September to February). Although the environmental policy of the European Union prohibits discharge of untreated OMWW into nature, inadequate disposition in agricultural fields is still common, as well as storage in ponds to be evaporated over the year, which lead to serious pollution problems. Anaerobic co-digestion stands as a feasible treatment for OMWW. Hence, OMWW together with other agro-industrial wastes (co-substrates) may be used to generate biogas and by-products which can be marketed or re-used in the olive orchards.
The present study was aimed to evaluate the co-digestion of dairy wastewater (Da-WW) together with OMWW. Both wastes came from the same olive oil production areas: Spain, Italy and Greece. Experiments were carried out in fed-batches using 1-Liter double-wall reactors with active digester sludge as inoculum at 35 °C. 3 g Total Volatile Solids –TVS of a mixture of substrate and co-substrate from Italy and Greece, respectively, was added for each feed. In contrast, 0.82 g TVS of the substrate/co-substrate from Spain was added to the reactors due to the low organic content presented in this OMWW. The experiments were carried out in two directions. For Direction A, the fed-batch started using 100%OMWW-0%Da-WW, and the ratio was gradually switched to 0%OMWW-100%Da-WW. For Direction B, the fed-batch started in the other way round.
The results showed an enhancement of biogas production by anaerobic co-digestion. The maximum cumulative specific methane production (SMP) was achieved in direction B within two weeks. The dissolved COD removal efficiency (d-COD) of all experiments was between 75 and 100%. The average values of were 266.4 □ 53.2, 306.9 □ 25.6 and 295.7 □ 28.1 ml N CH_4/g COD added for Spain, Italy and Greece respectively.

Keywords: Olive mill waste water (OMWW), dairy wastewater (Da-WW), environmental pollution, anaerobic co-digestion, fed-batch operation, methane production, bioenergy

Vertical Flow Constructed Wetland for Treatment of Olive Mill Wastewater (OMW)

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Abstract
Abstract: The goal of this work was to test the performance of a mobile unit that perform sequentially starting at filtration unit, followed by UASB module, coagulation-flocculation module and finally polish stage of vertical flow constructed wetland (VFCW). A mobile unit is a new concept designed for small mostly family-own, olive mill facility. The VFCW consists of four portable containers 1.5 m^3. The first container exhibited coarse tuff, the second and third contained medium tuff, the fourth contained fine tuff. We used *Vetiveria zizanoides* known for its endurance. The VFCW was artificially aerated to create a mixture of oxic/anoxic conditions. Partially diluted OMW were applied at a rate of 0.5 m^3 per day. The mean COD concentration in the inflow to the VFCW was 27,000 mg l^{-1} while in the effluents the level was less than 1400 mg l^{-1}. The TC and TOC concentrations entering the VFCW were 1800, and 402, respectively while the effluents were 510 and 340 mg l^{-1} respectively. The mean TN concentration in the influents was 215 mg l^{-1} while TN level in the effluents was 28 mg l^{-1}. The TP concentration was reduced from 50 mg l^{-1} in the influent to 6.8 mg l^{-1} in the effluent. The pH shifted from mildly acidic (5.35) to slightly alkaline (8.4) because of organic matter decomposition followed by CO_2 degassing. The mean EC value decreased from 4.8 to 2.5 dS/m probably due to cation exchange processes and potentially plant uptake. These results suggest that the VFCW module alone can be used to reduce the concentrations of most organic constituents in the partially diluted OMW to a level which allowed release to standard water treatment plant without causing major malfunctioning of the plant or alternatively using the treated wastewater for farming.

Keywords: mobile unit, treatment wetlands, OMW

Wastewater from Olive Oil Mills in Israel and Palestine: Interactions with Soil, Organic Contaminants and Soil Organic Matter- a Trilateral Project

G. E. Schaumann[1], B. Peikert[1], J. Hasan[2], M. Borisover[3], A. Nasser[3], A. Marei Sawalha[2], A. Dag[3], Y. Keren[3], M. Abu Garfha[2], N. Tamimi[2], M. Kurtz[1], M. Njoum[2], N. Bukhanovsky[3],

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Abstract
Olive oil production is an important economic factor in Israeli and Palestinian agriculture, which produces large amounts of olive oil mill wastewater (OMW). OMW is acidic, has a high concentration of organic material and is hardly microbially degradable due to toxic components (e.g., polyphenols). Wastewater treatment plants do not accept this wastewater because it interferes with the treatment process. Due to the lack of alternatives, this often leads to uncontrolled disposal of OMW, which is environmentally risky. Although OMW can fertilize soil, it can also reduce soil quality, e.g., by acidification, increase in salt content or water repellency. Up to now the extent and risk of soil degradation due to the OMW disposal is unknown, and systematic investigations on the fate of the OMW components and their impact on soil are missing. The objective of this trilateral project is to understand the mutual interactions between OMW, soil, water and agrochemicals.
This contribution gives an overview about the research program. In a combined field and lab study we have been analyzing effects of OMW application under various climatic conditions. The objective is to find conditions under which application of OMW in a way that soil properties are improved without negative effects. We will further present first results on a screening study about OMW effects on various soils in the West Bank and in Israel after spreading olive oil mill wastewater
OMW-contaminated soils contained significantly increased amounts of nutrients including potassium, organic matter and nitrogen. Most of the contaminated samples revealed significantly reduced wettability, indicated by high contact angles (110° ± 5°) and long water drop penetration times up to 20 min. This reduced wettability has negative effects on soil quality. It would therefore be promising to minimize the hydrophobizing impacts without losing fertilizing effects of the olive oil mill wastewater.

Keywords: olive oil mill wastewater, soil, water repellency, soil quality

Session 2: OMW toxicity

Phytotoxicity of raw and soil-applied olive mill wastewater: causes and bioassay methodology

Yael Laor[1], Ido Aviani[2,3], Ibrahim Saadi[1], Michael Raviv[2] and Yitzhak Hadar[3]

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Abstract
Controlled land spreading of olive mill wastewater (OMW) is now adopted in several Mediterranean countries, as a practical alternative for their disposal. This approach has been supported by a large number of studies showing their potential fertilization value and the absence of negative effects on soil properties. However, the inherent phytotoxicity of OMW deserves critical consideration regarding the selection of sites, crop types, and for proper synchronization between land application and cropping.
Multiple studies conducted by our group in recent years aimed at identifying the contribution of organic and inorganic components of OMW to their overall phytotoxicity and developing a bioassay methodology to measure the potential phytotoxicity of soils amended with OMW. A large variety of OMW sources was used in these studies, including OMW from the milling of different olive cultivars, degree of fruit ripeness and levels of field irrigation. Phytotoxicity bioassays were conducted on the OMW alone or on soils amended with OMW, using Cress (*Lepidium sativum* L.) as the testing organism.
The collective findings reveal that major phytotoxicity of OMW is contributed by a relatively small molecular size fraction (<1000-Da) and the aqueous phase after extraction with ethyl acetate. These most phytotoxic fractions contained highest concentrations of dissolved organic carbon (DOC), total phenolic compounds (TP) and inorganic salts, as expressed by electrical conductivity (EC). Phenolic and presumably other organic compounds extracted into ethyl acetate exhibited lower or similar phytotoxicity compared to the aqueous phase, depending on the pH of extraction. Bioassays conducted on OMW samples before and after ashing suggested the importance of the inorganic fraction to OMW phytotoxicity. Specific heavy metals did not show a major role in the phytotoxicity phenomenon and the main effect was attributed to the low osmotic potential and possibly synergistic effects of salinity.
To explore the original and residual phytotoxicity along the incubation of OMW in soils, we developed an "*in solum*" bioassay and compared it with the conventional bioassay, based on aqueous soil extracts. The bioassay conducted using soil extracts seemed to overestimate either inhibition or stimulation effects, depending on soil type and the dose applied. Moreover, the phytotoxicity measured *in solum* correlated better with concentrations of DOC, TP and EC in the soil solution than the phytotoxicity measured by the extraction method.
Based on several field and lab studies on OMW-applied soils we found rapid soil phytotoxicity recoveries (commonly within one week) at application doses of up to 160 m^3/ha. Besides application dose, rates of recoveries were shown to be dependent on soil type and incubation conditions (temperature and moisture). The dynamics of soil EC during incubation and the resulted phytotoxicity was assumed to be affected by the degradation of DOC due to the original complexation of metal ions with dissolved organic compounds. Overall, the newly developed bioassay seems as a useful tool for refinement of general recommendations related to permitted application doses of OMW.

Effects of Olive Mill Wastewater on Soil Arthropods in Two Different Cultivation Scenarios in Israel and Palestine

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Abstract
Olive mill wastewater (OMW) is a challenging effluent which accrues during the olive oil extraction process. Considering the edaphic mesofauna, no ecotoxicological evaluation has been performed until now although OMW is applied in controlled and uncontrolled manner in all olive oil producing countries directly onto the soil. However, soil biota play an important role in soil processes like detoxification or decomposition of organic matter. This study investigated the effects of a controlled OMW application on Oribatida and Collembola in two contrasting cultivation scenarios in Israel (Gilat, intensive, irrigation, semi-arid, loess) and Palestine (Bait Reema, extensive, plowing, hot-summer Mediterranean, clay loam). In order to distinguish effects of moistening from other OMW effects, control plots were treated with tap water with the same amount of 14.7 L/m² in both fields. Additionally to the extraction of arthropods by custom-build modified Berlese-Tullgren funnels before and after the treatment, soil chemistry (pH, Cations, Humidity, Water drop penetration time, elemental composition) was determined. In Bait Reema, the abundance of Collembola increased in OMW and water treated plots. In contrast, emergence of Oribatida was suppressed in OMW treated plots only. Significant relationships between the community changes and pH were found. In Gilat, Oribatida abundance increased at the end of the study. In terms of soil chemistry, cation and organic carbon content as well as water drop penetration time increased after OMW application while pH decreased. The daily irrigation in Gilat attenuated soil acidification and hydrophobicity probably through elution of compounds into deeper layers. The observed effects of OMW on soil chemistry and soil biology in extensive as well as intensive managed olive orchards were a first step to monitor future changes and underlined the need for further research on the ecotoxicological profile of OMW. OMW affects soil biota and can be a risk for the soil condition.

Keywords: Olive oil, Waste Water, Oribatida, Collembola, Soil chemistry

Short-term effects of Olive mill wastewater application on degradation of polyphenols, ecotoxicology and carbon isotope ratio of a Mediterranean soil

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Abstract

Olive mill production wastewater (OMW), a by-product of the olive oil producing industry, comes along with different environmental problems like toxicity towards plants and microorganisms or degradation of soil/water quality. We investigated the influence of OMW on total phenolic content (TPC), carbon isotope ratio and its potential toxicity towards plants and microbes. We hypothesized that the application of OMW on soil leads to time-dependent changes in soil carbon isotope ratio ($\delta^{13}C$) due to soil interaction processes and/or microbial degradation. These changes might give us a deeper insight in the fate of OMW derived substances in soil. A short-term incubation of an Israeli soil for 60 days with OMW was conducted. Soil microbial respiration was measured over the whole experiment and incubated soil was extracted for several defined time steps via sequential ASE using three solvents of different polarity. Each sequential extraction step was followed by IRMS measurements to look for changes in $\delta^{13}C$. Soil extracts were tested on TPC and phytotoxicity towards *Lepidium sativum* by seed germination/growth parameter determination. Results showed phytotoxic effects of methanol soil extracts towards *Lepidium sativum* and an increase in microbial respiration during first three weeks of incubation. With time, a decrease in phytotoxicity was observed, going along with a decrease in TPC of methanol soil extracts and changes in $\delta^{13}C$. These observations were most likely due to adsorption processes in soil and soil microbial degradation of OMW derived substances. It was concluded that changes in carbon isotope ratio can be used to monitor microbial activity and the potential fates/ pathways of OMW derived substances in soil.

Keywords: OMW, phytotoxicity, carbon isotope ratio, IRMS, ASE, TPC, phenols, Lepidium sativum, incubation, extraction

Presentations, Thursday, 4th April

Session 3: OMW soil-interactions

Composting olive mill pomace: converting a waste into a resource. Environmental benefits of its application in olive oil groves

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Abstract
Olives for oil production comprise one of the main crops in Andalusia (Southern Spain), covering ca. 1.5 million hectares. The Andalusian olive oil industry generates annually about 4 million tonnes of an organic slurry-paste called olive mill pomace (OMP), after the two steps oil extraction procedure. This large amount of OMP produced over such a short period of time, presents important management and disposal problems. Recent developments in EU policies to foster environmentally-friendly agricultural practices have led to widespread interest in the value of agricultural by-products such as OMP. We will provide information, obtained through field and laboratory experiments, complemented with data of other researchers, on the re-utilization of composted olive mill pomace (COMP) as an organic fertiliser and/or soil conditioner, and on the environmental benefits of its application in olive oil groves. The quality of COMP (e.g. nutrients and organic matter contents, phytotoxicity etc.) for agricultural use is generally adequate, but is highly dependent on the raw materials co-composted with OMP. Net nitrogen mineralization and nitrification during decomposition of COMP was negative during at the short term after application and therefore, the combination of COMP with other nitrogen rich fertiliser during the first years is recommended. Importantly, nitrate leaching and N_2O emissions during COMP decomposition were very low, compared with other organic (manure and commercial materials) and inorganic fertilizers. COMP-carbon mineralisation (e.g. COMP-C derived CO_2 emissions) was very low suggesting that application of COMP to olive oil grove soils is a worthwhile strategy for the accumulation of soil organic carbon. Soil fertility (organic matter and carbon contents, cation exchange capacity, soil aggregate stability, available phosphorus and potassium) and functioning (soil enzyme activities related to nutrient recycling) were significantly improved after three years' continuous application of COMP. Overall, composting of OMP is a sound strategy to reduce the environmental problems linked to the disposal of OMP, and to increase the sustainability and ecological services of the olive oil cultivation.

Keywords: composted olive mill pomace, organic fertilisers, fertility, nitrogen and carbon availability

Application of olive oil mill wastewater in summer? A laboratory incubation study

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Abstract
During olive oil production high amounts of olive oil mill wastewater (OMW) accrue. It is hardly microbial degradable and up to now it is not allowed to be discarded into the normal sewage system. Thus, the disposal in an uncontrolled way is still a significant environmental problem. OMW is normaly disposed on soil in the winter period. Such disposal can increase salt content, water repellency, carbon and nitrogen content and it can acidify soil. The negative effects of the OMW might be reduced if OMW is disposed in a season providing better conditions for biodegradation, i.e. at warmer temperatures. The objective of this study was to investigate how OMW affects soil properties when applied at higher temperatures. Conducting incubation experiments we investigated the impact of a defined amount of OMW under hot and dry (summer) and hot and moist (summer with addition irrigation) conditions. We incubated the samples for up to 60 days under controlled moisture and temperature conditions and measured respiration activity via adsorption of CO_2 by NaOH and titration with HCl. After drying samples were analyzed for carbon content, pH and EC. Water repellency was determined via contact angle (wilhelmy plate method) and water drop penetration time (WDPT). We observed and increase in carbon, EC, respiration activity and water repellency for both scenarios compared to the control. Under hot and dry conditions samples were more water repellent showing contact angles up to 106 ° and WDPT up to 154 s, whereas under the same conditions with additional irrigation contact angles and WDPT were lower (94 ° and < 5 s). We conclude that application of olive oil mill wastewater under warm conditions has positive effects (increased respiration, carbon, EC) but still induces water repellency. This negative effect is reduced under moist conditions.

Keywords: Olive oil mill wastewater; water repellency; contact angle, respiration, soil

Effect of Olive mill wastewater spreading on soil under different climatic condition in a semi humid area: A field study in Bait Reema – West Bank – Palestine.

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Abstract
Olive mill wastewater (OMW) is generated seasonally in large amounts during the olive oil production in Palestine and it is often discharged in the open environment. OMW has a high amount of phototoxic compounds, high salinity and acidity and therefore is challenging when disposed on soil. The objective of this study was to understand the effect of OMW disposal on soil, and to identify short-term and long-term effects associated to OMW application on soil water chemical interactions. In order to understand how climatic conditions at the time of OMW disposal affect the development of soil properties, we conducted a field study in Bait Reema village in the West Bank – Palestine.
The study site is characterized by 1.5 m thick brown rendzina and has an annual average rainfall of 550 mm. On an extensively used olive orchard field, we implemented 16 plots (2.5 x 3.5 m). OMW application (14 L / m^2) was conducted either in winter, spring or summer on two replicate plots distributed randomly among the 16 plots. To test the effect of soil moisture on the persistence of OMW effects, we implemented an OMW application in summer on two additional plots, but kept those plots moist for 2 weeks before OMW application until start of the rain season. For each of the treatmant variants, we implemented two control plots which were treated in the same way as their counterparts, but with tap water.
Soil samples at 0-5, 5-10, 10-15, 15-25 and 25-35 cm depth were collected after 2 days, 3 weeks, 6 weeks, 3 months, 6 months and 9 months. EC, pH, soluble cations and anions were determined and analyzed in aqueous soil extracts (1:5), the total phenol content was determined by using Folin–Ciocalteu's reagent, and wettability in the field was determined via WDPT for control and treated plots.
While all control plots remained wettable during the whole year, OMW lead induced water repellency in all treatments analysed by now. The extent of hydrophobization was strongest in the dry summer application plots, intermediate in the spring application plots and weakest in the moist summer application. The results of OMW application during spring showed increase in EC, Na, WDPT and total phenols with the highest concentrations found in the upper layer. pH was significantly reduced by OMW application. In addition, we found a secondary acidification also weeks after OMW application, which probably was due to microbial degradation of the N containing organic OMW constituents. Interestingly, most of those effects disappeared after the rain season except for the acidity in deeper layer and K addition. Latter may be due to additional specific K binding in clay minerals. In addition to these effects, seasonal changes of the parameters were observed especially during summer time.

Keywords: Olive mill wastewater, Tap water, Water drop penetration time, Electrical conductivity, Acidity, Total phenol.

Effect of olive mill waste compost on the physical fertility of a calcareous soil

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Abstract
The addition of organic matter to the soil in arid and semi-arid regions is essential in order to sustain the productivity and prevent soil degradation. The application of organic amendments as compost improves soil physical properties. However, its influence depends on the amount and the physical, physicochemical and chemical characteristics of the organic material. Several doses (12, 24, 48 and 96 ton ha^{-1}) of a compost made from olive mill waste ('alperujo') were applied to an unfertilized calcareous soil. Mixtures were incubated in 4.5 L containers (6 per treatment for one year at a humidity between 50% and 100% field capacity. The physical properties were analyzed one year after the addition of the compost and they included bulk density, aggregate stability, pore size distribution, water retention curve and saturated hydraulic conductivity. Results showed that 'alperujo' compost improved soil structure and increased water retention capacity and hydraulic conductivity. Speciphically, the assayed doses increased the storage of water readily available for plants which is a desirable effect for soils under Mediterranean conditions where water deficit is typically prevalent. Moreover, the highest dose (96 ton ha^{-1}) caused a decrease in bulk density and an increase in porosity, macroporosity and stability index of aggregates larger than 50 microns, hence, improving soil structure. It can be concluded that 'alperujo' compost is an appropriate organic material to improve soil physical fertility this being a successful way to reclaim olive mill waste.

Keywords: macroporosity, microporosity, aggregates, soil water characteristic, hydraulic conductivity

Session 4: Low quality water

Using treated wastewater in agriculture: the influence of combined excess boron and high salinity on crops

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Abstract

The global growth in population and improvement of standard of living leads to an ever increasing volume of sewage water requiring treatment and disposal. Together with this, freshwater is increasingly becoming scarce. The use of treated wastewater (TWW) for irrigation represents an effective and sustainable strategy to utilize this water resource, especially in water scarce semiarid and arid regions. Treatment of sewage leads to the effective control of health hazards to farmers or consumers. TWW used for irrigation contains organic and mineral forms of major nutrients including nitrogen and phosphorus, and hence can contribute to the conservation of diminishing resources. However, irrigation with TWW can introduce risk to both crop production and the soil environment. Potential risks including reduction of yield due to elevated salinity and specific ion to toxicity (such as B, Na and Cl), soil contamination with heavy metals, migration of pollutants to groundwater, and deterioration of soil structure. TWW contains a mixture of a wide range of components and the challenge is to evaluate the long-term risks posted by them and by their potential interactions. One example is the combination of excess B and salinity on plant growth and yield. Analysis of experimental results regarding the definition the nature of the interaction between B and salinity in a variety of crops implied amelioration of toxicity. Toxic effects on growth and yield were less severe for combined B toxicity and salinity than what would be expected if effects of the individual factors were additive. Antagonistic characteristics were found using data reported in the literature. The mechanism of relationships between B and salinity in plants is not clear and several options are discussed. Prominent among the possible explanations are reduced uptake of B in the presence of Cl and reduced uptake of Cl in the presence of B.

Keywords: treat wastewater, boron toxicity, salinity response

Irrigation olive with recycled water – the effect on oil production and quality

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Abstract

There is an increasing use of low quality water for olive irrigation due to the scarcity of fresh water. The aim of the present study was to evaluate the effect of irrigation with recycled waste water (RWW) on tree growth, fruit and oil yield, and oil quality. A six year field study was conducted comparing trees irrigated with RWW to trees irrigated with fresh water, on two olive cultivars, Barnea and Leccino. RWW was from secondary-treated domestic wastewater, and fresh water originated from the local coastal aquifer. For both cultivars, in each year, no significant differences were found between treatments regarding the following parameters: trunk diameter, fruit number, average fruit weight, oil content, fruit yield and oil yield. Oil quality, determined as free fatty acid level, polyphenol content and peroxide level, did not differ consistently and significantly among treatments. Organoleptic assessments revealed no negative attributes in the tested oils. Despite fundamental differences in total bacteria counts between the two types of water, the count in oil was nil and did not differ between treatments. Mineral analysis of oil showed high levels of calcium and sodium and no detection of heavy metals. Residues of medicines and hormones in the agricultural product, following irrigation with RWW, constitute additional concerns. We have developed analytical means, using mass spectroscopy, to measure carbamazepine, sulfadimethoxine, ciprofloxacine, tetracycline, estrone and 17b-estradiol in oil. None of these compounds or their potential metabolites were detected in oils from trees irrigated with RWW. The results support the use of RWW for olive irrigation with no observed negative effects on either tree physiology or consumer health.

Effect of Irrigation with Reclaimed Wastewater on Soil Properties, Olive Tree Yield and Oil Quality

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Abstract

The experiment was conducted for four successive seasons 2008, 2009, 2010 and 2011 on 'Nabali Muhassan' olive cultivar grown at a private olive orchard located in Ramtha area in the north of Jordan. Experimental treatments were carried out to compare between rain-fed (non irrigated), irrigation with well water and reclaimed wastewater. Total quantity of well water and reclaimed wastewater applied were similar during the irrigation period. Analysis of irrigation water showed higher EC value for reclaimed wastewater compared to well water. The average values of pH, EC, TSS, cations, anions, N, NO3, B, heavy metals, BOD_5, COD and fecal coliform in reclaimed wastewater were within the Jordanian standard for water use in irrigation of fruit trees, however the values of SAR, Cl and Na were higher than the standard limits. Results of soil analysis indicated that pH, EC, Ca, Na, SAR, ESP, P, K, Cu, Mn, Pb and B values in soil irrigated with reclaimed wastewater were significantly higher than in soil irrigated with well water. Olive trees irrigated with reclaimed wastewater or well water gave significantly higher increase in annual shoot length compared to rain-fed treatment. Average tree yield was significantly higher for well water treatment trees than the rain-fed treatment but not significantly different from the reclaimed wastewater treatment trees. Fruit oil content based on fresh weight and dry weight basis was significantly higher in rain-fed treatment than well water and reclaimed wastewater treatments. No significant differences were observed between rain-fed, well water and reclaimed wastewater treatments in terms of free acidity, peroxide value, UV absorbance and fatty acids composition of the extracted olive oil. Total polyphenols content was significantly higher in olive oil obtained from rain-fed trees than olive oil obtained from trees irrigated with well water or reclaimed wastewater treatment.

Keywords: olive, irrigation, reclaimed wastewater, well water, rain-fed trees, olive oil quality, total polyphenols.

Long term irrigation with treated wastewater (TWW) – how sustainable is it?

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Abstract
Stable soil structure and aggregates is central for maintaining soil quality and sustainability, and increasing agronomic productivity. The use of treated wastewater (TWW) for irrigation of cultivated fields has grown considerably in recent years, especially in areas suffering from shortage in fresh water (e.g., arid and semi-arid regions). For instance, In Israel 50% of the water used for irrigation is TWW. With this increased necessity to use TWW, farmers are faced with unique and unfamiliar problems among which is the possible degradation in soil structure and stability. Probable risks for adverse changes in the structure and stability of soils and their hydraulic properties following irrigation with TWW, may stem from the higher levels of dissolved organic matter, suspended solids, sodium adsorption ratio (SAR) and salinity in the TWW compared with its fresh water of origin.
Results from numerous studies conducted in Israel over the last 15 years show that the effects of long-term irrigation with TWW on different indices representing soil-structure stability were inconsistent. In the cases where long-term irrigation with TWW led to some deterioration in soil-structure stability, the magnitude of the deterioration seemed to be not very severe. Most of these studies concentrated, however, only on the upper soil layer (0-30 cm). Recently, there is growing evidence that point toward the possible buildup of undesired sodicity levels (exchangeable sodium percentage of 6-10), especially in clay soils, at depths >30 cm in orchards subjected to long term irrigation with TWW. Such sodicity levels can, under certain conditions, negatively affect water flow and aeration in this and above-lying soil layers. These preliminary findings suggest that long term irrigation with TWW may not be a sustainable practice. Attention should be given developing irrigation practices that will alleviate subsoil sodification following irrigation with TWW.

Keywords: treated wastewater, soil structure, soil sodicity

Irrigation of olives with brackish water: an overview and Israeli perspective

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Abstract

Cultivated olives are commonly subjected to salinity stress. This is particularly true when orchards are irrigated with brackish, recycled and other marginal waters. Literature concerning olive physiology, growth and oil production as a function of salinity emphasizes that, in spite of the olive's general high tolerance for stress including that caused by salinity, response to salinity and extent of tolerance mechanisms are strongly cultivar specific. Environmental conditions causing increased root zone salinity can lead to reduced photosynthetic activity, vegetative growth, and fruit and oil production and therefore, salinity is expected to harm production in commercial orchards. Regardless of this, several Israeli field studies report that exposure to moderate levels of salinity did not negatively affect yields. Additionally, salinity appears to contribute to positive attributes of olive oil. Proper management of water and salinity, including leaching of salts out of the root zone, can therefore allow optimization of high yields and high oil quality in orchards irrigated with brackish water.

Irrigation water salinity related damages have been reported in Israel under specific, possibly unique, conditions. Winter rainfall bringing surface accumulated salts into the root zone has been found to cause tree mortality. Additionally, long-term irrigation with water high in salts has been indicated to slow growth and reduce orchard production. Both these phenomena are apparently connected to specific soils and conditions. Their prevalence and possible prevention will be discussed.

Keywords: Olea europaea, salinity response, salt tolerance, yield, oil quality, irrigation, salinity management

The effect of irrigation of olive orchard with reclaimed wastewater on soil properties.

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Abstract
Oil olives (*Olea europea*) are typically grown in water scarce regions. The lack of good quality water in these regions, together with the perception of olive trees as being relatively hardy in general, has led to the use of marginal quality water, including brackish and reclaimed waste water (RWW) for irrigation. In a 4 year study, three fertigation strategies were tested: (i) fresh water application with fertilization at recommended rates (Fr), (ii) RWW application with fertilization at recommended rates (Re+), and (iii) RWW application with fertilization at reduced rates, considering the amounts contributed by the RWW (Re-). The RWW contained an average of 20, 6 and 30 ppm nitrogen, phosphorus and potassium, respectively, whereas the fresh water contained 2.4, 0.04 and 3.5 ppm of these nutrients, respectively. It was calculated that irrigation with RWW could provide 30%-50% of the amounts of macro nutrients recommended by the extension service. The deficit irrigation regime practiced in the orchard led to saturated paste extract root zone soil salinity of up to 6 dS/m at the end of each irrigation season. Each season, winter rains leached the accumulated salts to their initial level and no long-term salt accumulation was observed. However, accumulated effects of the irrigation with RWW were evident regarding a number of soil properties. SAR and ESP values increased consistently throughout the study and soil profile analysis indicated that the amounts of chloride transported out of the root zone into deeper soil layers and, eventually, into groundwater, were higher in the Re+ and Re- treatments compared with the Fr treatment. The amounts of nitrates transported out of the root zone were higher in the Re+ treatment compared with the Re- and Fr treatments. Leaf analysis showed that nutrient content in diagnostic leaves was the same for all treatments and that Re- plants were not exposed to nutrient deficiency. We conclude that the nutritional constituents in RWW should be accounted for in olive orchard fertilization regimes in order to avoid over fertilization and thus save input costs, and to minimize groundwater contamination with nutrients and salts transported below the root zone.

Keywords: recycled waste water; fertigation; salinity

Presentations, Friday, 5th April

Session 5: Analytics and interactions with pesticides

Use of products derived from the olive oil industry to reduce the impact of pesticides in soil and waters.

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Abstract

Despite the beneficial impact of pesticides on agricultural productivity, the residues of these chemicals in the environment may represent an important source of air, water, soil and food pollution. Thus, the environmental fate of pesticides is a great concern today due to the problems resulting from the use of mobile and persistent molecules, and the associated effects on surface and groundwater quality. The need to protect the environment and to preserve water quality has increased the search for new methods to prevent or remediate pesticide contamination. An increased interest has recently been given to the application of exogenous organic matter on the behaviour of pesticides in soil. Use of organic agroindustrial waste to modify pesticide dynamics in soils could be a worthwhile solution to both problems related to pesticide residues in soil and the need for organic waste disposal. The effect of olive cake and its biotransformed products, i.e., compost and vermicompost, on sorption/desorption and on the degradation of different pesticides in soil and biobed systems was studied. Results showed that more polar pesticides were less influenced by amendment addition to soil. Moreover, organic amendments induced selective release of pesticides, and this effect varied with the maturity of the organic amendments achieved by their biological transformation. Water soluble substances derived from olive cake enhanced sorption for more hydrophobic triazines, while humin and mineral fractions played a major role in sulfonylureas sorption. In addition, enhanced pesticide degradation was observed with the addition of the most transformed amendments to soil. Behaviors of pesticide mixtures in the amended soils appeared to be complicated by competition phenomena. In conclusion, the efficacy of organic wastes from olive oil industry and its biotransformated products on reducing the impact of pesticide residues in soils depends on the pesticide characteristics and the maturation degree of these organic amendments.

Keywords: organic amendments, olive cake, vermicompost and compost of olive cake, pesticides sorption/desorption and degradation, triazines, sulfonylureas.

Review of antifungal potential of natural polyphenols extract from olive pomace against pathogens of fruit and viticulture

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Abstract
Phytopathogens such as grapevine downy mildew (*Plasmopara viticola*) may result in high crop losses and quality deficiencies. However, the only currently existing, fully effective and approved plant protection method in organic viticulture are copper based compounds. Due to its elemental form, copper is not subject to mineralization and therefor is not biodegradable and accumulates in the soil of the vineyards. With many years of use, copper has a harmful enviromental effect on soil biota with detrimental effects on the surrounding environment.
This presentation aims to contribute to the reduction and control of *P. viticola* in vineyards considering copper minimization. Therefore, the residues from two different manufacturing processes of the olive oil production are analysed whether they are capable to serve as substitues for copper-bearing crop protecting products. These residues are 3-Phase-Olive-Mill-Waste=3-POMW and 2-Phase-Olive-Mill-Waste=2-POMW, respectively. They are rich on polyphenolic compounds, which feature a high antimicrobial and fungicidal effectiveness.
After testing for raw material properties, polyphenolic-rich extracts were prepared from the dried residues. *In vitro* inhibition experiments were performed with different concentrations of the extract solutions against plant pathogens *Botrytis cinerea*, *Alternaria solani*, and *Colletotrichum gloeosporioides*. Subsequent experiments under greenhouse conditions on potted vines, showed a high efficiency against *P. viticola*. In this context, a positive correlation between efficiency and increasing concentration was observed. The highest efficiency of 83% was found with the 1.0g/L concentration of 2-POMW extract, which almost reached the values of synthetic plant protection products. Addition of wetting agents increased the efficiency evenmore. It is to be determined by future reasearch whether these extracts have an effect against other pathogens. The results indicate the opportunity to control *P.viticola* in wineyards in compliance with copper reduction with the additional effect of mitigating disposal problems of the olive oil producers by the utilization of residues.

Keywords: Olive mill waste (2-POMW; 3-POMW), Polyphenols, *Plasmopara viticola* (downy mildew), *Vitis vinifera*

Physico-Chemical Characterization of Olive Oil Mill Effluents

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Abstract
Different analytical methods for the characterization of olive oil mill wastewater (aker) and aker- treated soils were tested and optimized. Aker from the Gilat Research Center and soils (treated and untreated with aker) from several locations in Israel (Revivim, Neqba, Gilat) and the Palestinian Authority (Wadi Abu Elkamra and Wadi Rahal) were chosen for the implementation of the optimized analytical methods.
The analyzed parameters included:

- EC and pH were determined for Aker and saturated paste extracts of the soils. The results indicate an increase in pH values over time resulting from the degradation of polyphenols.
- Total organic carbon (TOC) for liquids and solids were determined directly for Aker and soils.
- Nutrients content was determined by measuring N and P by an autoanalyzer and K using flame photometer.
- Protein content was measured by two methods: calculating the protein content based on the optical absorbance at 280 nm and by the Lowry protein assay.
- Polyphenols were analyzed by two methods: colorimetric assay of the Folin–Ciocalteu reagent and GC-MS analysis after trimethylsilylation with N,O-bis-trimethylsilyl-trifluoroacetamide (BSTFA). This method was calibrated against nine polyphnols.
- Fatty acids were determined by a multi-step procedure that includes: extraction with hexane, esterification with acetyl chloride in methanol and analysis by GC-MS. The fatty acids were identified using GC-MS and the dominant three fatty acids (oleic, palmitic and linoleic) were quantified.

The impact of olive oil mill wastewater on organic compound – soil interactions: the survey

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Abstract
The effect of olive oil mill wastewater (OMW) on soil ability to interact with organic compounds was examined on various soils sampled at variable depths, with a differing history of OMW application. The organic chemicals tested included atrazine, simazine, diuron, caffeic acid and phenol. The long-term OMW land application was found to result in several-fold increases of the distribution coefficients describing the sorption of organic molecules from water by soil samples from the upper 0-3 cm layer. Even a single OMW application on sandy clay and loam sand soils may involve a meaningful effect on the soil capability to interact with organic compounds. In virtually all cases, the rise in simazine – soil interactions as induced by the prior OMW soil application was comparable to or less than the corresponding increase in the soil organic carbon (SOC) content. Therefore, the overall enhancement of simazine - soil interactions is controlled mostly by the SOC content increase. Possibly, an increased aliphatic character of soil organic matter (SOM) in the OMW-affected soils rendered the simazine-SOM interactions less effective and/or organic amendments could also partially block mineral and organic soil surfaces. In case of diuron, the enhancement of its interactions with soils contaminated with OMW could be even more significant than the associated increase in the soil SOC. The possible enrichment of SOM by phenolic and carboxylic groups, due to the OMW application, could contribute to stronger diuron-soil interactions. To summarize, the significant enhancement of interactions of organic compounds (agrochemicals) with soils can be expected due to the prior OMW – soil interactions. This enhancement may be related both to increase in SOC content and the change of the SOM composition; the latter effect on the sorbate-sorbent interactions should depend also on the capability of organic sorbates to undergo specific interactions with soils/SOM.

Keywords: sorption enhancement, olive oil mill wastewater, soil organic matter.

Herbicide interactions with soils affected by olive oil mill wastewater: sorption isotherms, possible change of the mechanism and irreversibility.

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Abstract
Olive oil mill wastewater (OMW) is the liquid byproduct of the three phase olive oil production. In the Mediterranean, the olive oil production is considered to be an important component of the agricultural sector. One of the ways to dispose OMW is land spreading, e.g., in olive orchards. In order to examine in more detail the effect of OMW land application on soil-organic chemical interactions, two herbicides were considered, simazine and diuron. Sorption kinetics measurements of these agrochemicals were conducted and followed by the sorption isotherms on the soils which differ in their texture and OMW treatment (i.e., no OMW application/moderate single OMW application/ long-term application). The sorption experiments were conducted at the presence of biocide, under protection against the light and during a time period that was much less than the half-life times reported for these agrochemicals. In addition, simazine sorption was also studied on soils after their lab incubation with OMW, for two and eight weeks, under variable conditions, at different temperatures and aeration extents. On the soil samples affected by OMW at the field conditions, the prior OMW-soil interaction seems to change the compound's sorption mechanisms: from the Langmuir-like sorption isotherm on native soils to the sigmoidal or linear isotherms on the OMW-affected soils such that the apparent sorption of agrochemicals increased following OMW land application. Sorption measurements on the lab OMW-incubated soils suggested the same effect: higher sorption as a result of the prior OMW-soil interactions. Desorption to an aqueous phase and to an organic solvent demonstrated a strong irreversibility of agrochemical-soil interactions, such that only a small fraction of sorbed organic compounds could be retrieved back after their sorption both by native and OMW-affected soils. Strong irreversibility is hypothesized to result from changes in soil (soil organic matter) upon the organic compound sorption.

Keywords: sorption enhancement, olive oil mill wastewater, soil organic matter.

Understanding soil and ground water pollution caused by on-land disposal of waste water generated by small scale palm oil mill farmers in southeastern Nigeria.

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Abstract

Management of oil mill waste water generated in large quantities during oil extraction is a problem in all vegetable oil producing areas. More than 80 x 10^6 tons of palm oil mill Effluents (POME) is generated in Nigeria. Small scale farmers constitute the major producers of these effluents in developing countries. In this study, some physical properties were studied in Obodoukwu in Ideato North local government area of Imo state in the Southeastern Nigeria. The objective was to understand the level of degradation caused by the on-land disposal of the effluent over a long period of over 20years. Auger and core soil samples were collected from three different sites: site heavily polluted (HP) with the waste water, less heavily polluted (LP) site and non polluted (NP) sites. Infiltration test was also carried out at the three sites. The farmers were also interviewed so as to incorporate them into the work to ensure the ease of adopting the technology for sustainable management of the effluent.

Result shows that the rate of infiltration was lowest at the HP site followed by LP and NP showing reduced rate of water penetration into the soil. The Polluted sites have neutral pH at the top soil with occurrence of acid layers at the sub soil. Bulk densities of the polluted sites were lowest at the top unlike in the non polluted sites that had higher BD on the top soil. The hydraulic conductivity was lower in the polluted sited than in the non polluted site. Result of the aggregate stability showed more aggregation at the top soil of Hp, 30.53% at the top soil of LP and 17.02% at the top soil of NP%. The LP site had more %silt of 11.28% on the top soil than the rest of the sites. Suggestions were made to improve the current conditions through changes in effluent disposal methods.

Posters

Removal of phenolic compounds from olive mill wastewater (OMW) using natural Zeolite

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Abstract
Olive mill wastewater (OMW) is produced annually in large quantities and disposed illegally in open lands of the Palestinian territories, causing a serious environmental problem due to high contents of microbial growth- inhibitor compounds like poly phenols and tannins. Zeolite is, an abundant and low cost mineral, well known for inorganic pollutants removal but was not considered for phenol removal from OMW yet. Chemical oxidation, coagulation, froth flotation and adsorption are methods normally used for OMW pretreatment. However; adsorption of phenols from OMW is a promising pretreatment for using OMW filtrate as a fertilizer for agricultural purposes, in case of efficient selective removal of toxic phenols and tannins.
Four columns of 5 cm depth of Zeolite were applied to filtered OMW in order to reduce the clogging with OMW total solids which is usually of high values. Limiting factors were grain size of Zeolite, contact time, adsorbent to OMW ratio, and surface area. Three columns were applied for OMW. First of 150 gm Zeolite of sieve diameter less than 2 mm. Second of 100 gm Zeolite of diameter between 1 mm and 90 µm. Third of 40 gm, diameter equals 90 µm or less. The fourth column of 150 gm Zeolite of diameter less than 2 mm was applied to synthetic tannic acid solution (5300 mg/l). Effluents show average total phenol reductions of 37, 33.8, 12.8 and 30 % of the initial amount of total phenols in the influent, respectively. However; Zeolites of particle diameter less than 90 µm (column three) gives best treatment method with highest phenol removal ability per gm Zeolite (up to 3mg/gm), and highest flow rate.
Results show that natural Zeolite has the potential to remove phenolic compounds from OMW and its efficiency is directly related to the Zeolite surface area. Further columns and batch studies can help for the determination of the maximum ability of Zeolite to remove phenols and any possible further improvements of the methods for phenol removal achieving better removal efficiency.

Keywords: phenols, tannic acid, Zeolite, column study, surface area.

Fertilizer derived uranium in vineyard soils of palatinate: Accumulation, dispersion, and effect of phosphate

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Abstract
Different fertilizers including mineral materials mined from natural deposits like industrial phosphorus fertilizers or organic fertilizers of animal origin (livestock manure) or of plant origin like, e.g., oil waste water are used in agriculture to cover lack or compensate lost on soil fertility. The use of phosphorus fertilizers in agriculture, horticulture and forestry may contributes to a continuous accumulation of uranium in soils. The purposes of the present study are, to determine the extent of uranium contamination in vineyard soils of palatinate, to assess the plant availability and mobility as well as the extent of dispersion by surface water, and to elucidate the effect of phosphate on uranium speciation and colloid-mediated mobilization. Soil and water samples were collected in September and October 2012 to determine U concentration in soil, sediment, and floodwater. Soil samples used for comparison were collected from conventional and ecological vineyard fields. Sediment and floodwater samples were taken from vineyards and forest areas situated downstream. Sequential extraction procedures according to Zeien and Bruemmer (1989) have been applied in order to determine the chemical form of fertilizer derived uranium in soil as well as its mobility and plant availability. Colloids of triuranyl diphosphate and Na-autunite have been synthesised and investigated on their stability over time. Higher U concentrations (up to 1.5 mg L^{-1}) have been observed in A horizon than in B horizon for conventional soils. A difference of 1.5 up to 4.5 mg L^{-1} has been found between U concentration values in conventional soils and that in ecological soils, suggesting a pronounced effect of P fertilization and related U accumulation in the respective vineyard soils. From 2.5 up to 7.3% of the total U concentration in soil are mobile and easily mobilizable and from 3.9 up to 15.2% of total U are potentially mobilizable. Uranium in vineyard soils has been predominantly observed in iron oxide fractions. The analysis of floodwater samples shows that viticultural areas feature an increased uranium concentration values comparing with forest areas. U concentration in sediments vary from 2.19 ± 0.27 to 6.57 ± 0.87 mg L^{-1}, which is much higher than that in flood water (max 50 µg L^{-1}). This indicates the strong capacity of sediment to trap and accumulate uranium. Synthesized uranyl phosphate colloids (UPCs) were with a mean size of ~ 170 nm. Synthetic UPCs showed a zeta potential less than – 40 mv and no aggregation during at least 6 weeks of reaction time, which indicates the high stability and mobility of these colloids. This study contributes information about uranium contamination in vineyard soils of palatinate due to the use of P-fertilizers, about the extent and behavior of dispersion as well as the influencing factors, and about the effect of phosphates on uranium speciation. This work studies the soil chemistry of UPCs, which are suggested to control predominantly the transport behaviour of fertilizer derived uranium in agricultural soils.
Key words: phosphorus fertilizers, uranium, vineyard soils of palatinate, mobility, availability, uranyl phosphate colloids, stability

MUTUAL COMPARISON OF TEMPORAL CHANGES IN YIELD AND WATER TEMPERATURE OF SELECTED SPRINGS IN THE NORTHERN PART OF SLOVAKIA.

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Abstract
Paper deals with analyzing of basic statistical parameters of groundwater springs, as – spring yield, groundwater temperature and air temperature. The parameters are initially evaluated using statistical characteristics, such as maximum, minimum, median, modus, arithmetic mean, variance, standard deviation, coefficient of variation, coefficient of asymmetry and coefficient of kurtosis. Mutual comparison of temporal changes of parameters was performed using cross-correlation of time series in one week time step. The parameters were also plotted in the form of time series in seasonal graphs in order to subtract the trends of input components. Emphasis was given to find the reasons of their relative interdependence in time, assuming that the observed differences are reflecting different mechanisms of groundwater circulation in the rock environment. The main indicator for assessing the time lag of yield and the water temperature was the value of correlation coefficient in the cross–correlation method. The time step of one week in the cross-correlation resulted from the fact that the observations performed by Slovak Hydrometeorological Institute, by which the input data were provided, were mostly based on weekly measurements in the basic monitoring network.

Keywords: spring yield, spring water temperature, cross-correlation, temporal changes

Use of white rot fungus Phanerochaete chrysosporium in dephenolization of olive mill waste water

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Abstract

Due to high levels of phytotoxic and antimicrobial compounds such as monomeric-polymeric phenols, volatile acids and polyalcohols, OMWW is toxic to plants and soil micro flora.
Proposed physico-chemical processes such as evaporation ponds or lagoons have not been efficient in decreasing the high toxicity of OMWW to reduce the ecological impact of OMWW due to economic and technical reasons. Moreover, these methods do not alleviate the high COD or toxicity of OMWW.
Biological remediation might be a promising alternative to the physico-chemical processes. Effective bioremediation resulting in significant reduction of phenolics allows safe and economical disposal of OMWW onto land or into surface waters. As another benefit, bioremediation may produce valuable products including an excellent fertilizer. In addition to that, effective bioremediation resulting in significant reduction of phenolics allows safe and economical disposal of OMWW onto land or into surface waters.
Olive production is considered the backbone of Palestinian agriculture. In 2011, about 93,565.7 tons of olive was pressed with an extraction rate of 22.2% producing about 200 thousand cubic meter OMWW (Zibar). Considering water scarcity in Palestine, treatment of OMWW could add extra water source that might be used in irrigation.
The aim of this work is to investigate the ability in reduction of phenolic compounds in OMWW using the white rot fungus Phanerochaete chrysosporium.
In vitro results revealed that the fungus was able to grow in different concentrations of OMWW. Maximum fungal growth was recorded at 75% OMWW after two weeks of incubation on a rotary shaker (150 rpm) at room temperature. Slight reduction in mycelial dry weight of the fungus was measured at 100% OMWW. In addition to that, the fungus was able to grow on solid waste of olive press (Jeft).

Keywords: Bioremediation, Fungus, Phenol.

Advanced plant-based, Internet-sensor technology increases water efficiency in agriculture: a proactive response to shortage of good quality water

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Abstract
The global progress of farmland salinization and scarce drinking water are two major problems farmers are facing. Improper irrigation management and the use of low quality water are the driving factors for increasing soil salinity. But irrigation with this low quality water is possible if it is managed on the demand of the plants.
Diurnal changes in leaf turgor pressure can be measured over several months with the leaf patch clamp pressure (LPCP) probe (commercial name: ZIM-probe). The non-invasive ZIM-probe can be applied to all leafy plant species and is characterised by high precision, operating convenience, automation suitability, robustness under field conditions and minimum costs. Data are sent by wireless operating telemetric units to a control station linked to an Internet server *via* mobile phone network. The ZIM-probe technique measures the pressure transfer function through a patch of an intact leaf, i.e. the attenuation of an externally applied clamp pressure by the leaf tissue.
Measurement of turgor pressure is entirely sufficient for setting of irrigation thresholds, because turgor pressure is the crucial parameter which dictates growth and productivity. For efficient growth and fruit production a turgor pressure of more than 100 – 300 kPa is required over the entire vegetation period.
In the last three years the ZIM-probe was tested successfully under laboratory, greenhouse and field conditions in many European countries as well as at many places in Australia, Africa, South America and the USA. Concomitant studies with other technologies currently used have shown the great potential of this novel water stress monitoring instrument in agricultural water management and reforestation.

Keywords: irrigation, leaf turgor pressure, ZIM-probe

The effect of olive mill wastewater on soil pollution build up: Screening Study- South West Bank

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Abstract
Olive mill wastewater (OMW) is considered as toxic pollutant because it is contain polyphenols compound affecting soil and biota. OMW from different olive mills located in and around Palestinian villages are disposed randomly into the environment (fields, wadies and water streams) without any treatment. This study investigates soil from different geographical areas (Al-Koom , Wadi abo Al Kamra in Hebron and Wadi Rhall in Betlehem). soils exposed to different OMW compositions to understand the effect of soil texture and structure on pollution build up. Samples were Collected in the end of summer from 0- 5 cm depth and Sieved by 2mm diameter then take the extracts and analyzed regarding phenolic content by foiln ciocalteau method.
Results show that the total phenol concentration in analyzed OMW samples shows differences ranging between (1.87 – 6.48 g/L). This discrepancy due to the type of oil extraction was reflected on the total phenol concentration buildup in the soil samples affected by soil texture and structure. Soil organic matter (SOM) shows differences to the control except Al-Koom where SOM shows no changes between polluted and control. The Sodium Adsorption Ratio (SAR) in control sample was higher than treated sample in Al-Koom . Soil samples which are rich with crystalline iron tend to adsorb total phenol more than soils with low crystalline iron concentrations. This could be attributed to the effect of crystalline iron on soil structure. We concluded that soil texture and structure influence the effects of OMW application on soil.

Keywords: Crystalline Iron , Al-Koom, Total Phenol, Soil Organic Matter.

Short-term effects of olive mill wastewater application on phytotoxicity towards *Lepidium sativum*, microbial soil respiration and extractable total phenolic content

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Abstract
Olive mill wastewater (OMW) accrues in very large quantities during the production of olive oil and has problematic properties (e.g. acidity, phenolic content, high organic load, etc.). In Israel the only authorized disposal procedure is the spreading on agricultural fields as fertilizer even though OMW has phytotoxic characteristics, which are mainly ascribed to its phenolic content. Furthermore, influences on the microbial community are manifold, but generally ascribed to be beneficial. However, the degree and extent of potential effects of OMW application has not yet been quantified under defined conditions, considering different climatical seasons. We investigated the acute and short-term phytotoxic effects of OMW towards *Lepidium sativum* (garden cress) and the short-term effects towards microbial soil respiration at Israeli spring conditions (15°C, 23% soil moisture). In addition, time-dependent changes in extractable total phenolic content (TPC) of OMW treated soil over 60 days were measured to assess potential relationships between plant growth and TPC. It was assumed that OMW application leads to changes in microbial respiration, going along with a decrease of phytotoxicity due to a decreasing TPC over the incubation time. Our results showed a dose-dependent acute toxicity towards *L. sativum* [$EC_{50\text{-}96h\ (shoot\ elongation)}$ = 4.50% OMW], leading to growth inhibitions of about 90% at the highest test concentration of 27% OMW. Incubation experiments showed significant increases in soil microbial respiration for the first weeks of incubation, coming along with a decline in TPC and phytotoxicity from the 3rd incubation week on. However, the phytotoxicity of amended soils towards *L. sativum* declined, contrary to the soil extracts, to a non-significant level within the incubation period. The differences between toxicity of OMW treated soil and soil extracts could be traced back to adsorption processes of toxic substances on soil, leading to changes in bioavailability. The decline in phytotoxicity towards *L. sativum* growth could be correlated to the decline in TPC, indicating a relationship between TPC and phytotoxicity of OMW. Based on these results, the spreading of OMW on soil can be an adequate way of disposal, when taking a sufficient dilution or time span for degradation into account.

Keywords: OMW, phytotoxicity, cress, soil respiration, microbial activity, spreading, soil

Validity of the Lowry assay and Folin–Ciocalteu method in mixed polyphenol-protein systems.

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The olive oil mill wastewater (aker) is rich in both polyphenols and in proteins. Inasmuch as both the Lowry reagent which is used to determine proteins and the Folin–Ciocalteu reagent which is used to determine polyphenoles, contain Folin, one has to ascertain that the simultaneous presence of both proteins and polyphenols does not interfere in their analyses. To that end, mixtures of a standard protein (BSA) and polyphenol (caffeic acid) were analyzed by the Lowry and Folin–Ciocalteu methods. The major findings are:

- The presence of BSA did not interfere with the caffeic acid analysis.
- The presence of caffeic acid strongly affected the BSA analysis.

In addition, the usefulness of caffeic acid as a reference for polyphenol analysis in the Folin–Ciocalteu analysis was tested. The response of a mixture of four polyphenoles (sinapic acid, syringic acid, vanillic acid, caffeic acid) to the Folin–Ciocalteu reagent was compared to the response of caffeic acid. The standard curve of the mixture of polyphenoles had a slope similar to that of caffeic acid, demonstrating the validity of the caffeic acid as a reference compound.

Phytotoxicity of olive mill waste water: germination tests with *Lepidium sativum* (garden cress)

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Abstract
Disposal of olive mill wastewater (OMW) is a major problem in oil producing Mediterranean countries. It is a problematic effluent with low pH, high salt content, phytotoxic properties. Its disposal may lead to water repellency, but also positive aspects like large quantities of organic material for fertilization are discussed. Discharge of OMW in sewage plants is not possible. Therefore OMW is often disposed in uncontrolled manner although the consequences are not adequately studied. The objective of our study was to find out whether phytotoxic effects of OMW are reduced when it is in contact with soil. We studied the phytotoxicity and its impact on soil during a defined period of time by means of the root lengths of cress germinations. Cress seeds were irrigated with different concentrations of OMW from 0 % (pure water) to 100 % (pure OMW). To test the ability of soil to reduce the phytotoxicity, samples were irrigated with two doses (7 and 14 L/m²) of OMW and incubated for 0, 4, 7 and 11 days, respectively. The cress seeds were placed on the incubated soils and germinated 72 hours under darkness and 25°C. The germination tests with cress seed showed a significant reduction of root lengths at OMW concentrations higher than 5 %. In presence of soil, root lengths increased with longer incubation times, even at the soil treated with 7 L/m². After 0 days of incubation root lengths differed statistically significantly between treatment and control. At 7 and 11 days these differences were statistically not significant anymore. After 7 days of incubation roots became statistically significant longer than the roots after 0 and 4 days incubation. The higher dose treatment only shows a slightly increase of the root lengths at the soil which was incubated 11 days. However this growth was not statistically significant. The phytotoxicity of OMW tends to decrease gradually in soils.

Keywords: OMW, incubation, phytotoxicity, germination-test, cress seed, *Lepidium sativum*

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