3RD INTERNATIONAL SYMPOSIUM ON ORGANIC GREENHOUSE HORTICULTURE

11 - 14 APRIL 2016
IZMIR, TURKEY

ABSTRACT BOOK

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Welcome to
3rd International Symposium on Organic Greenhouse Horticulture

Ege University, Faculty of Agriculture and the International Society for Horticultural Science (ISHS), represented by the Commissions for Organic Horticulture, Protected Cultivation and Horticultural Engineering, Working Group Organic Greenhouse Horticulture and the COST Action FA1105 Biogreenhouse have the honor to welcome all engaged in research, producers, teaching, extension, and public services, private sector and stakeholders related to organic greenhouse horticulture to attend the "3rd International Symposium on Organic Greenhouse Horticulture".

The Symposium is held in Turkey from April 11 to 14, 2016. The Symposium have both a scientific program and a technical program presented in parallel as well as one day field tour during which different organic protected cropping systems will be visited.

The scientific program includes three days of invited lectures, oral presentations, and poster sessions covering all aspects of organic greenhouse farming. The 3rd International Symposium on Organic Greenhouse Horticulture focuses on soil and plant health via the use of appropriate robust plant material, the soil, water and nutrient management, including compost quality, as well as the plant protection. Energy use efficiency and sustainability of organic growing systems will also be important issues. Major points such as market development, product quality and regulation will be discussed between researchers and all stakeholders. During this unique event, scientists are also invited to transfer their research achievements and knowledge to practitioners in order to establish close collaboration and fill fundamental and apply research gaps.

The technical program includes three days of knowledge transfer sessions covering all aspects of organic protected crops where stakeholders such as growers, suppliers (i.e. seed, fertilizers, compost, and nursery), managers, consultants, governmental advisors, educators, certification bodies and policy makers will exchange their expertise and discuss on key topics in order to provide innovative and practical solutions to important issues and barriers that the organic sector have to face to insure its competitivity and profitability.

We are also going to host FAO Workshop on Manual on Good Agricultural Practices for Greenhouse Vegetable in South-Eastern-European countries as a side event.
We hope that we will be able to share our experience and contribute to the development of protected organic horticulture during the meetings.
Have a nice time in Turkey and enjoy your stay here.
Best regards,

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ORAL PRESENTATIONS

3RD INTERNATIONAL SYMPOSIUM ON ORGANIC GREENHOUSE HORTICULTURE
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ORGANIC PROTECTED HORTICULTURE IN THE WORLD

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Land under organic farming has increased worldwide fourfold since 1999, reaching around 43 million ha in 2014, while organic horticulture farming (excluding hop, cocoa, coconut, coffee, nuts, olives, tea) has doubled during the last decade, representing 1.33 million of ha of cultivated organic land (290 137 ha of vegetables, 835 315 ha of cultivated fruits, 49 225 ha of berries, 146 657 ha of herbs and medicinal plants, and 706 ha of nurseries and ornamentals) (Willer and Lernoud, 2016). In response to increasing demand for organic products, sales of organic foods have increased fivefold between 1999 and 2014, reaching 80 billion of US dollars. In USA, the biggest organic market (35.9 billion US dollars of retail sales) grew by more than 11% in 2014 over 2013, while in Europe an increase of 7.6% was observed with 26.2 billion euros of retail sales, and this global organic market is projected to double by 2018 (Reganold and Wachter, 2016). The growing popularity of organic food products is driven by health values and safety issues (e.g. pesticides, hormones, antibiotics, GMOs), environmental benefits and equity concerns. Organic foods also give certainty to consumers about food origins and production methods. Although the demand for fruits and vegetables is around 30 to 40% of the global demand, the total area under organic vegetable production is only 0.5% of the total area of vegetables grown in the world. Forty-five percent of the total vegetable organic farmland is in Europe, followed by North America (22%), Latin America (18%) and Asia (12%). The five countries with the largest organic vegetable areas are the United States (59,669 ha), Mexico (46,573 ha), Poland (26,664 ha), Italy (25,930 ha) and China (22,331 ha). Main crops are fresh beans and peas, leafy and stalked vegetables and fruit vegetables. The world greenhouse industry represents around 473 466 ha, with a 14% increase over 2015. The total area for organic greenhouse crops in Europe is approximately 3 700 ha (~1500 ha Spain; 1 000 ha Italy, 500 ha France, 150 ha Germany, 100 ha The Netherlands, 80 ha UK, 57 ha Switzerland, 30 ha Austria, 32 ha Belgium, 46 ha Nordic/Scandinavia), which is almost entirely used for fruit vegetables and lettuce. In non-EU countries, organic greenhouses cover 500 ha in Israel, 230 ha Morocco, 30 ha in Egypt, (van der Lans et al., 2011, Meijer, 2016) and more than 1 500 ha in North America, mainly located in Mexico. In the USA, organic protected vegetables cover 186 ha (farm sale value of 76.2 million US$), while in Canada 241 ha of heated greenhouse are organically certified, representing 5.2% of all organic and transitional farms, and 15% of the total greenhouse area. Additional cultivated land for fruit and vegetable production is also managed organically but not certified, owing to substantial costs involved. In northern countries, organic protected production is often year-round conducted under high technology and heated greenhouses, while in the Mediterranean area greenhouse production is mainly done in unheated plastic greenhouses or high tunnels. Specific rules for organic greenhouse production were established by several countries such as the organic soilless growing systems in North America, which is not allowed under EU organic regulation. Although organic farming can be perceived by sceptical people to be ideologically driven and inefficient, recent international reports and scientific literature consider organic farming as an innovative farming system, balancing the four sustainability principles that will be of increasing importance in global food and ecosystem security (Reganold and Wachter, 2016). During this presentation, market opportunities for the greenhouse sector will also be discussed as well as the main gaps and research needs.

SESSION I: Robust Planting Material

OS 1-1
ORGANIC SEED TREATMENTS OF VEGETABLES TO PREVENT SEEDBORNE DISEASES

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Seedborne pathogens of vegetables are responsible for the re-emergence of diseases of the past, as well as the introduction of diseases into new geographical areas. Seed treatment can be used to eradicate seedborne pathogens or to protect from soilborne pathogens. The European Commission Regulation (EC) No. 1452 / 2003 states that only organic seeds must be used in organic horticulture. Starting crop production with clean seeds is the background for a healthy crop. Physical seed treatments, including mechanical treatments, thermal treatments, radiations, and redox treatments can be highly effective. The use of natural compounds, which could be of organic or inorganic nature, is another useful tool. Organic compounds comprise plant extracts, essential oils, as well as purified microorganism compounds. Biological control, based on the use of antagonistic microorganisms, can be effective and sustainable to control seedborne diseases. Indigenous or introduced seed-associated microorganisms might suppress seed infections by pathogens. Numerous filamentous fungi, yeast, and bacteria have been studied as biological control agents against seedborne pathogens. Microbial interactions on the spermosphere should be deeply investigated in order to develop effective BCAs. Seed treatments with elicitors may be helpful to initiate a defence response already early in plant development and has the advantage of being applied in a contained environment. The main advantages and drawbacks for every type of seed treatment will be described, together with the mains knowledge and technology gaps concerning vegetable crops. The cost-effectiveness of the seed treatments will be considered. Integrated control strategies, including different seed treatments, could be helpful to guarantee a high level of disease control and production yield.

OS 1-2
BIOSEEDLING: A CHAIN APPROACH TO THE PRODUCTION OF HEALTHIER SEEDS AND SEEDLINGS OF LAMB'S LETTUCE

Joelle Herforth-Rahmé, Jacques Fuchs, Veronika Hofer, Marisa Schnueriger, Hans-Jakob Schaerer, Martin Koller
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The project BIOSEEDLING "Robust planting material from seeds to young plants - an implementation oriented chain approach" aims to find improved production procedures for vegetable seedlings of lamb's lettuce. We started by analyzing the production of lamb's lettuce seeds of a professional seed producer and studied the effect of harvest time and seed size on the germination and disease rate in the seeds. With the results, we will provide a protocol to improve seed production. Then, using seeds naturally infected by Peronospora valerianellae and *Acidovorax valerianellae*, we have compared several seed disinfection methods: Aerated steam, hot water, sodium hypochlorite, ethanol, Calcium hydroxide, and compost pellet. After testing methods for the identification of the seed pathogens and the quantification of the infection, we have assessed how the different treatments reduce the pathogen and whether they alter the seed germination capacity. In a third step, substrates suppressive of the soil borne pathogens Rhizoctonia solanii and *Pythium ultimum* were developed and several elicitors were tested against Peronospora valerianellae. Furthermore, we tested the effect of night interruption on the sporulation of downy mildew using periods of lighting in the red and blue regions. Finally, the best methods resulting from all the experiments cited above are combined and compared to the current standard methods in on-farm experiments. The productivity using the new methods will be assessed in terms of quality (weight and health of the seedlings) and yield. All the results from single experiments as well as on-farm combined experiments will be presented.

OS 1-3
EFFECTS OF PLANT GROWTH-PROMOTING RHIZOBACTERIA ON ORGANIC TOMATO SEEDLING PRODUCTION

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The aim of this research was to determine the effects of different Plant Growth Promoting Rhizobacteria (PGPR) on organic tomato seedling growth in different growing media. Organic tomato seeds (cv. Melis) were treated with bacterial strains named as *Pseudomonas punonensis* strains 37 and 56, *Pseudomonas putida* strain 18/1K, *Ochrobactrum pseudintermedium* strain 80, *Pantoea agglomerans* strain 83, *Bacillus subtilis* strain 66/3, *Bacillus thuringiensis* strain 99, *Pseudomonas fluorescens* strains 112, S5/4, 30, and TR21/1. Treated and control seeds were sown into 4 different organic media namely peat (P), local peat + clinoptilolite + vermicompost (LP+CLI+VC) (1:1:1, v:v), local peat + perlite + vermicompost (LP+PER+VC) (1:1:1, v:v) and local peat+vermicompost (LP+VC) (1.5:1, v:v) on 24 July 2014. Each treatment had 4 replicates and each replicate had 64 plants in one tray. Trays were left in germination room for 3 days at 24/24°C (day/night) and 80% RH. After germination, plants were moved to a PE greenhouse which is specialized for seedling growing. Seedlings were fertilized by liquid composted farmyard manure (30 L ha-^{1}) and they were ready for transplanting after a month. Some physical and chemical properties of each growing medium, seed germination rate, fresh and dry weight and nutrient composition of seedlings were determined. Among the tested media LP+VC (1.5:1, v/v) was found promising for commercial use considering its effects on plant fresh weight, availability and cost. Bacteria showed different results in different growing media however some strains of *Bacillus subtilis*, *Pseudomonas putida*, *P. fluorescens* and *P. punonensis* were found as promising on plant growth in organic tomato seedling production.

OS 1-4
ORGANIC SEED PRODUCTION OF LETTUCE (*LACTUCA SATIVA* L.) IN TURKEY

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Organic seed production needs both seed production and organic agriculture knowledge. This study carried out, to get organic lettuce seed production knowledge for seed companies and farmers. The experiments were done both spring and autumn season in Ataturk Central Horticultural Research Institute organic field with Grise Maraichere lettuce variety between 2013 and 2014 growing season. The yield, weight of 1000 seed, number of seed per 1 g and germination rate properties were observed. The autumn growing season organic seed yield (18.5 kg da-^{1}) was found better than spring seed yield (11.5 kg da-^{1}). The results showed that 1000 seed weight 1.02 g and there is 1001 seeds in 1 g in autumn growing season. These properties were found 0.91 g and 1048 seed in spring season. The germination rate was found very reasonable for both seasons (90-100 %). Fungal diseases were determined as main issue especially gray mold (*Botrytis cinerea* Pers.) for the organic lettuce seed production in Yalova because of its rainy climate condition

SESSION II : Crop Management and Fertilisation

OS 2-1

SOIL FERTILITY MANAGEMENT IN ORGANIC GREENHOUSE: AN ANALYSIS OF THE EUROPEAN CONTEXT

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Soil fertility management systems in organic greenhouses are quite diversified within Europe. The challenge is to identify and implement strategies which are in agreement with the organic principles stated by (EC) Reg. 834/2007 and (EC) Reg. 889/2008 as well as environmentally, socially and economically sustainable. In this paper, written by a group of scientists of different geographical origin and with different background, the state of the art of the sector and the main characteristics of the European greenhouse cropping systems are described. The main bottlenecks and constraints are discussed with a particular reference to the regulatory framework in force. The more relevant issues that may influence the enforcement and future development of the sector have been identified as specific knowledge gaps. For each of them, the appropriate research needs were elaborated in a multidisciplinary perspective as forthcoming challenges for the whole sector. Far to be exhaustive, given the wide heterogeneity of the implemented systems, this paper is able, for the first time, to give a structured outlook, on soil fertility in protected organic condition at an European scale.

OS 2-2

HAIRY VETCH BECOMES AN ALTERNATIVE BASAL N FERTILIZER IN FRESH-MARKET TOMATOES PRODUCTION IN PLASTIC HIGH TUNNEL

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Large amount of chemical fertilizers have been used in fresh-market tomato production systems. However, concerns about reducing environmental problems, high cost of chemical fertilizers, and rising demand for organic vegetables have become major driving forces for the development of alternative production systems based on cover crops. As a cover crop, hairy vetch (*Vicia villosa* R.; HV) has been used mainly in production of field crops worldwide. However, limited information is available regarding its use in greenhouse systems. Consequently, the objective of the present study was to assess the effect of hairy vetch on soil organic nitrogen, tomato growth and yield in plastic high tunnel in Sapporo, Japan. The treatments consisted in HV seeding densities (HV20, 20kg/ha; HV50, 50kg/ha) and Ammonium sulfate (AS100, 100kg/ha) applied as basal N fertilizer and the CONTROL with no basal fertilizer. In all plots, 150 kg/ha of N were added as topdressing LPS100 fertilizer. HV aboveground biomass (dry weight) was 5.85 ton/ha and 7.19 ton/ha in HV20 and HV50, respectively. Nitrate in petiole sap was found higher in HV20, HV50 and AS100 plots, and lower in the CONTROL plots throughout the cultivation period with exception of the first 14 days. The HV plots had greater soil organic nitrogen than AS100 and CONTROL, and slightly increased soil carbon after tomato production. The Growth index (GI) was higher in HV20 (47971), HV50 (46285) and AS100 (43397), and lower in CONTROL (39847) at 49 days after transplanting. Higher marketable yields were found in tomatoes grown in HV50 (130 ton/ha), HV20 (129 ton/ha) and AS100 (114 ton/ha), compared with CONTROL (97 ton/ha). The results highlighted the effectiveness of HV as basal N fertilizer.

OS 2-3
DYNAMICS OF NITROGEN DERIVED FROM HAIRY VETCH APPLIED AS COVER CROP IN TOMATO PRODUCTION IN PLASTIC HOUSE

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Fresh market tomatoes (*Solanum lycopersicum* L.) are mainly grown in plastic house in Japan and usually a large amount of Nitrogen fertilizer was applied for getting high yield. One of the ways to reduce chemical fertilizer application is the use of cover crops. The application effect of a legume cover crop, hairy vetch (*Vicia villosa* R., HV), on N dynamics in fresh market tomatoes, 'House Momotaro', was investigated using the 15N-labeling method in 2011 and 2012. Before transplanting, the 15N-labeled HV (1,319 mg N/pot, 260 kg N·ha^{-1}), and chemical fertilizers were incorporated into the soil. Tomato seedlings were transplanted into a 1/2000 a Wagner pot at 0, 80, and 240 kg·ha^{-1} of N application (N0HV, N80HV, and N240HV) in plastic house early June, 2011. The rate of N uptake derived from HV to total N uptake in tomato plants (%Ndfhv) was 24.8%, 34.4%, and 37.1% in N240HV, N80HV, and N0HV, respectively at 12 weeks after transplant. Nitrogen use efficiency from HV-derived N (NUE; N uptake derived from HV in tomato / Amount of N applied in HV) was the highest at 10 WAT, and N0HV (55.3%) was significantly higher than N240HV (44.5%) and N80HV (49.8%). The partition rate of HV derived N into fruits was 63.9%, and 39.7% of HV-derived N was distributed into 1st and 2nd fruit clusters. HV-derived N (Ndfhv) was taken up by the tomatoes mainly until 4 weeks after transplant. It was clarified that HV is expected to be an alternative N fertilizer because HV-derived N was absorbed effectively when a small amount of N fertilizer was applied. After the tomato cultivation in 2011, the soil was stored in a greenhouse without any water and fertilizer. Tomatoes were cultivated again in the Wagner pots in which contained used soil in 2011 and were added same rate of N fertilizer and unlabeled HV (935 mgN/pot) in 2012. There was no difference in the uptake amount of N derived from HV applied in 2011 (HV2011) into tomato among the N treatments (57.7 mg/plant on average), so nitrogen use efficiency derived from HV2011 in 2012 was 4.4% on average. It was recognized HV could be available for not only short-term N source, but also long-term N source.

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OS 2-4

EFFECT OF PLANT BASED ORGANIC FERTILIZERS AND CHICKEN MANURE EXTRACT ON PLANT GROWTH AND ROOT ZONE ACTIVITIES OF TOMATO

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The aim of the present study was to investigate the effects of fertigation with chicken manure extract, lupin sap or a combination of the two on nutrient concentration, pH and electrical conductivity (EC) in the growing medium and on growth parameters of tomato (*Solanum lycopersicum* L.). Six fertigation treatments were established in a completely randomized design under greenhouse conditions. Two were control treatments, one without liquid fertilizer (W) and the other one based on inorganic fertilizers (IN). Two organic treatments received only either lupin sap (L) or chicken manure extract (C) the third was a 1:1 (v/v) mixture of C and L (CL) and the fourth treatment received L + inorganic micronutrients (LM). The shoot fresh and dry weight, and total leaf area were higher in the IN treatment than in the organic treatments and among organic treatments C had higher values than L. The pH of the growing medium solution was around one unit higher in C compared with IN and another half to one unit higher in L compared with C. The high EC measured in L was primarily due to a high concentration of potassium. Other nutrients such as phosphorus, nitrogen and most of the micronutrients were present in deficit levels in L. In the growing medium of the C treatment the concentrations of nitrogen, calcium and magnesium were lower and the concentrations of potassium, chloride, sodium and iron were higher than in IN. When the two organic fertilisers were compared, C resulted in higher phosphorus, sulphur, sodium and micronutrient concentrations but lower potassium and magnesium concentrations in the growing medium than L. This study indicates that chicken manure extract has the potential to support a higher biomass production if the soil pH is controlled at an optimum level and concentration of available nitrogen is increased.

OS 2-5
DEVELOPMENT OF DISEASE-SUPPRESSIVE ORGANIC GROWING MEDIA

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Vigorous seedlings are an important base for vegetable production. Beside the availability of appropriate amounts of nutrients, the health of seedlings is decisive. Soil-borne diseases are a challenging problem in organic seedling production. Here, we present results on the development of disease-suppressive growing media. Three aspects were examined: (i) use of different components of growing media (peat, coconut fiber, wood fiber, compost), (ii) influence of selected organic nitrogen fertilizers and (iii) use of different microorganisms (including commercial biocontrol agents (BCA)). Two plant-pathogen systems were used in this study: cress-*Pythium ultimum* and basil-*Rhizoctonia solani*. Green waste compost showed a good capability to protect cress against *P. ultimum*. This effect was improved by using a chitin-containing N-fertilizer. However, an inappropriate storage of the compost diminished its efficacy. In contrast to coconut fibers, wood fibers showed a suppressive activity against *P. ultimum* when used as partial substitutes of peat. None of five tested commercial BCAs could improve the suppressiveness of the substrates against *P. ultimum*. However, one of newly tested strains of *Trichoderma* sp. was very suppressive against *P. ultimum*. The tested growing media showed only small differences in suppressiveness against *R. solani* on basil. In contrast, two of the new strains of *Trichoderma* sp., which were intermediately active against *P. ultimum*, could efficiently protect basil against *R. solani*. At the moment, we test combinations of different *Trichoderma* strains, compost, different types of peat and peat substitutes. The aim is to determine whether it is feasible to manufacture growing media which allow the production of healthy and robust seedlings also in the presence of high levels of pathogens.

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SESSION III: Crop Management and Microorganisms

OS 3-1

BIOESTIMULANT AND SUPPRESSIVE EFFECT OF *TRICHODERMA HARZIANUM* ENRICHED COMPOST FOR MELON CULTIVATION FROM GREENHOUSE NURSERY TO FIELD PRODUCTION

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Trichoderma harzianum T-78 (Th T-78) enriched compost was assayed as growing medium and organic amendment by testing the bioestimulant, biofertilizer and suppressive effect on melon crop since the nursery to the field at biogreenhouse conditions. Th-T78 enriched compost showed the highest plant fresh weight and the lowest pathogen incidence both under artifitiicial plant pathogen at the nursery conditions. At natural fields conditions, the amendment into soil of this advanced compost also reduced natural infection percentage on melon plants and increase melon yields. Furthermore, muskmelon plants grown previosly sowed on the above compost combination showed lower pathogen incidence and higher melon yield than plants grown on tradicional peat plus Th T-78. Therefore, this advanced composting proccess would be able to permit a more environment respecful melon production with less chemical inputs.

OS 3-2

COULD THE ARTIFICIAL INOCULATION OF AM FUNGI IMPROVE THE BENEFITS OF USING PEA (*PISSUM SATIVUM* L) PLANTS FOR SOIL AMENDMENT PURPOSES IN GREENHOUSES?

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The study aimed to investigate the effects of commercially available AMF inoculate (*Glomus* sp. mixture) on the growth and the nutrient acquisition of field pea (*Pissum sativum* L) plants. Inoculated (AMF+) and non-inoculated (AMF-) pea plants were subjected to two levels of NaCl salinity (0 and 50 mM NaCl). Several times during the growing cycle, randomly selected plants were analyzed for dry matter of roots and the aboveground biomass. Plant tissue samples were analyzed for N, P and K concentration and the total uptake, specific absorption rate (SAR) and specific utilization rate (SUR) of these elements were calculated. Raised salinity drastically decreased the dry matter of roots and aboveground biomass and significantly deteriorated the specific utilization rate (SUR) of main nutrient elements in pea plants. The presence of AM fungi significantly reduced the dry matter of roots, but on the contrary significantly increased the dry matter of shoots and the overall plant dry matter. Furthermore, AM fungi inoculation significantly increased the specific absorption rate (SAR) of N, P and K under both; control and saline conditions and enhanced the specific absorption rate (SUR). As a conclusion, the inoculation of field pea with AM fungi significantly increased the volume and improved the biomass production in pea grown as greenhouses soil amendment crop (green manure).

OS 3-3
POT-GROWN SWISS CHARD AND KALE RESPONSES TO VARIABLE RATE OF MANURE COMPOST IN MYCORRHIZAL FUNGI INOCULATED MEDIUM

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The proper use of composts has immense environmental and agro-ecological benefits. However, ecosystem services and plant growth are impacted when compost is misapplied. A study was carried out to determine the effects of variable rates of manure compost on mobility of soluble chemicals in recovered leachate, and growth of kale (*Brassica oleracea* L. 'Ripbor F1') and Swiss chard (*Beta vulgaris* L. subsp. cicla 'Silverstar') in pots. The percentage cattle manure compost treatments were: 0% (no manure compost, Pro-mix BX Mycorrhizae alone), 25%, 50%, 75% and 100% (manure compost alone). An increase in rate of manure compost application increased soluble chemical mobility in the potted mix. The planted-pots recorded higher soluble chemical mobility and percentage leached dissolved solids than the unplanted-pots. Leaf production and plant height were significantly ($P<0.05$) increased by the 25% or 50% treatment, but were reduced by the ≥75% treatments. Leaf greenness was increased by increasing manure compost but poorly correlated with yield due to salinity constraints. Application of 25% or 50% treatment significantly ($P<0.05$) improved leaf fresh weight yield at first harvest. Nevertheless, yields for the second harvested kale plants were reduced in all five treatments while those of the Swiss chard plants were increased by the ≥75% treatment. There were consistent increases in leaf tissue N, P and K with increased manure compost application rate. In summary, the 25% or 50% proved to be the best mix for improving growth of potted kale 'Ripbor' and Swiss chard 'Silverstar'.

OS 3-4
E. COLI O157:H7 GOES ORGANIC: DOES THE SOURCE OF ORGANIC FERTILIZER MATTER FOR FOOD SAFETY IN GREENHOUSE GROWN LEAFY GREENS?

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Organic manure has been identified as an important vehicle for transmission of enteric organisms causing food illnesses. We tested if the colonization of greenhouse grown leafy vegetables by *E. coli* O157:H7 is affected by the choice of a "safe" (pig hair pellets, PHP) or a "worst case scenario" (uncomposted chicken manure, CM) fertilizer. Also the impact of the choice of organic fertilizer source on the microbial phyllosphere community structure in the presence of *E. coli* O157:H7 was analyzed using high throughput technique. Baby leaf rocket and red Swiss chard were grown under greenhouse conditions for four weeks with six replicates. The fertilizers were mixed into the growing medium and fertilizer supply was based on comparable nitrogen levels (80 kg ha^{-1}) in the two treatments. *E. coli* O157:H7 tagged with a green fluorescent biomarker (gfp) was inoculated twice a week starting when the first true leaves had reached 2 cm length until the end of the experiment. Our results showed that the source for organic N-fertilizer affected the growth and development as well as biomass production of the two crops. No differences between the treatments were found in total bacterial counts in the phyllosphere for either of the crops. However, log values of *E. coli* were significantly higher in the treatments with PHP as compared to CM. The same trend was found for intestinal enterococci. Crop and nutrient regime dictated the microbial community structure in the presence of *E. coli* O157:H7.

OS 3-5

SHORT-TERM IMPROVEMENT OF SOIL BIOLOGICAL ACTIVITY IN BIOCHAR-AMENDED ORGANIC GREENHOUSE TOMATO CROPS' NO EFFECT ON CROP PERFORMANCE

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Several studies have shown that adding biochar as soil amendment to agricultural land can increase the sustainability and productivity of cropping systems by sequestrating C from the atmosphere into the soil, by minimizing the emission of greenhouse gases such as N_2O and CO_2, by improving soil properties and soil fertility via its effects on porosity, particle aggregation, soil structure, water and nutrients retention, and by improving microbial activity and plant health. Thus, we tested the hypothesis that biochar amendment to different types of soil enhances soil microbial activity, mycorrhizal colonization, plant nutrient availability, plant growth, productivity and reduces greenhouse gas emissions when fertilizers are applied monthly or bi-monthly. The experiment consisted of 36 experimental units (~0.65 m^3 containers) randomized in a complete block design with three replicates. The following organic soils were investigated: 1) a loam, 2) a sandy loam, 3) a sandy soil, 4) a muck soil, 5) a reconstituted organic soil with 40% air porosity and 6) a peat soil amended with sawdust. Half of the experimental units were amended with 20% (v/v) biochar (balsam fir + white and black spruces; pH 7.1, EC 0.38). Tomato plants (*Solanum lycopersicum*'Trust') were cultivated from May to October 2014. The crop was fertilized at 4-week (May to July) and 2-week (August to October) intervals using certified organic amendments. Irrigation was controlled for each soil based on the matric potential measured at 15-cm depth. Effluents from each container were continuously collected and their nutrient content analyzed. Regardless the type of soil, our results showed that biochar amendment increased soil microbial activity expressed by the hydrolysis of fluorescein (FDA) by 27-30%, and led to greater soil CO_2 efflux (~12% and 23% when fertilizers were provided at 4- and 2-week intervals, respectively). No significant effect of biochar on root colonisation by mycorrhizae was observed. However, adding biochar to organic soils reduced by 49% the earthworm population. Macronutrients in the soil solution were lower in the biochar-amended soils, except for PO_4 which concentration was equal to control soils. Plant growth and crop yield were not influenced by biochar amendment. In conclusion, biochar amendment to different organic soils improved the microbial activity, which might in the long term have beneficial effects on crop performance. In the short term, we were not able to validate our hypothesis that a 20% (v/v) biochar amendment increases crop productivity. The impact of 4- and 2-week fertilization intervals will also be discussed in terms of soil biological activity, nutrient availability and crop sustainability.

OS 3-6
MOLECULAR DIFFERENTIATION OF PLANT BENEFICIAL *BACILLUS* STRAINS USEFUL AS SOIL AGRO-INOCULANTS

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Plant rhizosphere is rich in bacterial cells of *Bacillus* species. This bacterial genus includes a large number of strains with beneficial properties for plant protection and growth promotion. We selected twenty-seven beneficial strains of *Bacillus* spp., from food products, legume rhizosphere and agricultural soils from South and South-East areas of Romania. The selection was based on their ability to inhibit the growth of several plant pathogens and to produce different enzymes and metabolic compounds with beneficial traits for plant protection and growth promotion. For a successful use of such beneficial bacteria as agro-inoculants, their survival in natural ecosystems should be in sufficiently high levels to produce the intended purpose. The best way considered for the evaluation of their fate is the analysis in situ of the inoculated bacterial strains. Using strain specific markers, inoculated bacteria can be accurate detected after their application in soil. In order to identify strain specific markers, molecular differences between the tested Bacillus spp. need to be found to distinguish the inoculated strain from native soil bacteria. In our study, RAPD and rep-PCR fingerprinting were used for the molecular analysis of selected strains in order to identify specific and stable markers. Based on repetitive extragenic palindromic PCR patterns, one SCAR (Sequence-characterized Amplified Region) marker was detected, whose specificity and sensitivity were validated.

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SESSION IV: Soil Fertility

OS 4-1

IRRIGATION MANAGEMENT IN ORGANIC GREENHOUSE: HOW TO COMPLY WITH SUSTAINABILITY GOALS

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Irrigation in protected cultivation is essential due to the absence of natural precipitation. High evapotranspiration, due to higher temperature and prolonged cropping period, requires ample an adequate supply of water. The water supply in a greenhouse is solely carried out by irrigation and thus enables full control over the water management of the greenhouse soil. There are no specific prescriptions for organic greenhouse horticulture (OGH) regarding water sources or irrigation. However, according to the basic principles, growers are obliged to responsibly use natural resources such as water. Thus, efficient water use and/or water recycling are important issues for organic farming. Salinity should be avoided through proper fertilisation management and the use of water sources of adequate quality. Moreover, rainwater collection is strongly encouraged or requested for operation sites situated in climatic suitable areas. Optimal and tuned irrigation is quite challenging for OGH. Obviously, supplying the crop with sufficient water is an important precondition for optimum crop health and performance. In addition, sufficient soil moisture is required for optimal functioning of the soil biota to secure mineral delivery from the applied organic amendments. As well accumulation of undesired salts must be avoided. On the other hand, nutrient leaching should be avoided or limited to a minimum. The irrigation management should take heterogeneities due to irregular water delivery of the irrigation system as well as site variations in soil and plants into account Minimizing leaching should be one of the main drivers for optimization of irrigation in OGH. Since OGH in Europe are strictly soil bound cultures, leaching and nutrient emission to groundwater is a thread. For soils with groundwater within reach of the root zone, capillary rise may add to the water supply of crops. However irrigation strategies aiming at deficit irrigation, in other words relying on capillary rise, can be used for the short term only. Given the presence of a surplus of ions in groundwater not only salts like Na and Cl, but also Ca, Mg, SO4 and even K, salinity problems will occur on the long run. Irrigation management tuned to crop requirements is an important issue for sustainable organic greenhouse production. To achieve sustainable management of OGH production, irrigation should be tuned to the demand of the crop, taking into account also the variations in climatic zones, soil types, growing seasons, planting dates and cultivars. Consequently, tools are required for irrigation management with the flexibility to deal with such variation. This paper will review the important aspects of the crop water demand and tools for irrigation management in organic greenhouse vegetables.

OS 4-2
ASSESSMENT OF CROP WATER STATUS BY MEANS OF CROP REFLECTANCE

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Aim of this work is to present the procedure for precise plant reflectance measurements in order to estimate the plant water and chlorophyll status in a controlled environment. The method could be applied to conventional or organic greenhouse conditions. A hyperspectral camera was used to provide remotely plant reflectance measurements during periods with normal or low substrate water content. The optic sensor was calibrated into a light-controlled growth chamber. Reflectance measurements were carried out in tomato plants (*Solanuml lycopersicum* cv. Elpida) grown on perlite slabs. Well-irrigated pants were used as a reference point during the experimental period, while water stress was applied by withholding irrigation. Radiometric calibration includes the elimination of a variety of noise sources, such as photon noise, thermal noise, read out noise and quantisation noise. The proper number of lens aperture (f/) and exposure time (ms) ranges of the camera for the specific light signal conditions were evaluated, in order to achieve the most suitable readout values. Different algorithms and statistical methods (spectral threshold methods, supervised classification algorithms, unsupervised clustering algorithms) were used to detect and classify the object and extract the suitable information from the plant. Crop reflectance tended to increase as the substrate moisture content decreased from the first hours of irrigation pause. The combination of more than one spectral regions led to reflectance index estimations. The best indices for plant water stress detection were the mrNDVI and mrSRI values as they had the higher correlation with substrate water content. VOGREI and TCARI gave good correlation with plant chlorophyll and nitrogen content, with correlation coefficients up to 0.70.

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OS 4-3
IMPACT OF ORGANIC PRACTICES ON GROWTH, YIELD, AND GREENHOUSE GAS EMISSIONS BY THREE LOCAL PEA LANDRACES

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Legume crops constitute an essential component of rotations in organic farming systems due to their ability to provide plant available nitrogen to agricultural ecosystems arising from symbiotic N_2 fixation. However, there is a general need to increase grain legume protein production in Europe so as to meet the increasing demand while reducing resource utilization, thereby contributing to mitigation of global climate change. Taking this need into consideration, a field-based experiment with pea (*Pisum sativum* L.) was carried out in a field certified for organic agriculture in Kopaida, near Aliartos (95 km northwest of Athens) from November 2014 to June 2015 within the framework of the European (FP7) research project EUROLEGUME. The experiment was laid out in a split-plot design with two main treatments (conventional and organic farming system) and four sub-plots per main plot corresponding to four different pea genotypes, particularly one commercial cultivar ('onward'), and three local landraces ('Amorgos', 'Andros' and 'Schinousa'). Standard inorganic fertilizer (11-15-15, N:P_2O_5:K_2O) and sheep manure were used as base dressings in the conventional and the organically-treated plots, respectively. The aim of the experiment was to test the performance of each pea genotype in organic farming crops as compared to conventional cropping, in terms of: green seed yield, and greenhouse gas (GHG) emissions. The results of this study indicate that 'Andros' increased significantly the above-ground biomass and the fresh green seed production on the harvesting date when compared with all the other genotypes. In addition, there were significant differences in cumulative N_2O fluxes between the pea cultivars with 'Schinousa' producing the highest N_2O amounts and 'Andros' the lowest. In conclusion, the pea genotype seems to have a strong influence on both GHG emissions and production and therefore, appropriate selection of cultivars is imperative for efficient use of this legume in organic cropping systems.

OS 4-4
PERFORMANCE OF GREENHOUSE TOMATO (*LYCOPERSION ESCULENTUM* MILL.) UNDER COMPOST AND OTHER MULCH TYPES

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This study was conducted at The Princess Tasneem Bent Ghazi Technological Research Station, Al-Balqa'Applied University during the 2013-2014 growing season. The purpose of this study is to assess the impact of different soil mulches on field performance, yield and fruit quality of greenhouse tomato (*Lycopersicon esculentum* M.) under drip irrigation system. The experiment evaluated seven types of mulch treatments including black plastic, tuff gravel, clear plastic, compost, crushed stone, shredded wood, and the control. A randomized complete block design with three replicates was used. Different mulch types showed significant effects on vegetative growth, early, medium, late harvest, and total yields of the tomato fruits. Compost mulch resulted in the highest total yield. Higher early and medium yields were obtained using black and clear plastic mulches, respectively. In addition, larger fruits were obtained by applying compost mulch. Tomato fruit cracking was also affected in different ways depending on the mulch types used in this study.

OS 4-5
ORGANIC OR CONVENTIONAL FARMING: BIOTIC AND ABIOTIC STRESS MANAGEMENT

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In recent years, conventional and organic farming are facing increased biotic and abiotic stress challenges and by the same time required to meet strict standards of crop production. Restrictions for Pesticides, reduced quality of irrigation water and deterioration in environmental conditions have increased the need to adopt prevention and avoidance strategies in stress management. Using cultural methods, such as rotating between different crops, selecting pest-resistant varieties, and planting tolerant rootstocks, have an increased interest due to proven efficiency, cost-efficient and little to no risk to people or the environment. The Mediterranean region is characterized by warm climate, high sun radiation, air and soil temperatures, which may become a stress factor for different crops. High radiation negatively affect seedling establishment and high soil temperatures reduce root development and functioning. Radiation control becomes more favorable, mainly during summer planting, by shading nets and different soil mulches. The shading net and mulch color and transparency should be adjusted to the season and environmental conditions. Soil preparation should be started already at the end of the last cropping season. Sanitation, i.e. removing of previous crop residues helps to reduce sources for pathogenic inoculum. Soil solarization or other soil disinfection performance is improved when initial inoculum is low; frequent soil disinfection helps to avoid large scale epidemics by soil borne pathogens. Soil solarization can be combined with soil disinfection agents and improve its efficiency when applied as a pre-treatment. The combination of solarization with appropriate organic amendments, composts or manures enhance disinfestation efficiency at deeper soil layers and expand the spectrum of controlled pathogens. Application of organic amendments and composts in high rates can generate biofumigation - the formation of toxic volatile organic and inorganic compounds. Yet, it should be done carefully to avoid new infestation by contaminated raw materials (weed seeds, pathogenic propagules etc.) or phytotoxic effects in the next crop, for example due to high nitrogen residues. Most plant species show reduced growth, smaller leaves and a stunted root system when exposed to high ammonium concentrations, as well as to too high temperatures at the root-zone. The combined effect of high concentration of organic amendment or fertilizers and high soil temperatures increase ammonium toxicity. Similarly, low quality of irrigation water or inadequate amounts can increase soil salinity, which in turn, cause direct ion toxicity at the root and hypocotyl, reduce water uptake by the plant and decrease fertilization efficiency. Washing irrigation (leaching) after soil disinfestation and before transplanting of young seedling will help to avoid soil salinity and will exclude toxic residues from the root zone. Avoiding high soil temperatures and surplus water stress reduce the seedling vulnerability to soilborne pathogens and diseases. Biotic stress control should be based on integrated pest management. Physical barriers such as insect-proof nets help to reduce occasional infestation; advanced U.V. absorbing nets enables improved results. Indoor insect monitoring and trapping contributes to an effective pest control and other disease elimination, for example insects such as whitefly are vector for a large number of plant viruses.

Fungal disease management should take into account environmental conditions and avoiding preferential conditions for disease outbreaks. For example humidity reduction by soil mulching against foliar diseases; seedlings and plant treatments only when the foliage is dry against bacterial diseases, etc. One of the most promising tools to deal with biotic and abiotic stress is grafting. Selection of resistant rootstocks and research for high compatibility with scions which were selected for their horticultural qualities can overcome different stresses. For example, grafted seedlings reached higher yields and reduced disease incidence when grown in infested soils, compared to non-grafted control. Yet, rootstock resistance to stress is affected by environmental conditions, inoculum potential and density and therefore should be integrated with other pest management means.

SESSION V: Soil Fertility

OS 5-1

COMPOSTING PROCESS MANAGEMENT AND COMPOST BENEFITS FOR SOIL FERTILITY AND PLANTS

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Compost are recycled fertilizers with potential. They can influence the soil quality at different levels: supply of nutrients, enhancement of humus content in soil, improvement of soil structure and water hold capacity, reduction of erosion, and stimulation of biological activity. Compost can also suppress plant diseases. However, an optimal management of the composting process, from the choice of the raw materials used up to the storage of the final products is necessary to obtain such positive results. Different factors play a role in the compost production, and consequently the characteristics of the produced composts are considerably diverse. It is also important to choose the compost that is adapted to the target application. To consider here are factors such as climatic conditions, culture, soil type and season of application. With an adapted practice strategy, composts become helpful products for the plant growers, especially in organic production systems.

OS 5-2
SUMMER GREEN MANURING IN ORGANIC GREENHOUSES UNDER FRENCH MEDITERRANEAN CLIMATE

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Green manures are recognized to enhance soil fertility, weeds control and ensure a better crop rotation. In the French Mediterranean area, green manures can generally be implemented during summer, after spring crops or short cash crops like melon, zucchini or cucumber, but the species choice must be adapted to the high temperature conditions and short available periods under greenhouse in summer. Several trials have been conducted during summers in 2001 to 2002 and 2013 to 2015 under greenhouses. During the first period, we have screened a large panel of families and species to evaluate their performances in terms of biomass production, weed competition and sensitivity to pests and diseases. The second period was dedicated to legume green manures to enhance nitrogen availability for the crops. Performances of legumes were assessed and their effect on the subsequent crop of lettuce was measured. Our results showed that plants from the Poacea family, like sorghum-sudan grass species and pearl millet are usually the most efficient to reduce weeds and to produce a high biomass (8-12 tDM/ha) in less than 2 months. *Brassicacea* species, like mustards or fodder radish also produce high biomass but are the most sensitive to pests and diseases. Buckwheat is a very good green manure for short periods with a cycle of 30 to 40 days. Most of the species from the Fabaceae family are usually not adapted to hot temperatures under greenhouse. Tropical species of *Vigna sinensis* and *Dolichos lablab* gave the best results, and field pea was the only temperate specie to resist particular conditions of greenhouses in summer. However, higher biomass production and weed competition were obtained in mixtures of legumes and graminaceous species. First results on lettuce as the subsequent crops did not always show better results after green manuring of legumes, but more trials are needed to validate the interest for legumes in organic greenhouses during summer.

OS 5-3
FREE-LIVING (N_2)-FIXING BACTERIA AS POTENTIAL ENHANCERS OF TOMATO GROWTH UNDER SALT STRESS

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Azotobacter chroococcum 67B, *A. chroococcum* 17-1 and *A. chroococcum* 76A, isolated from compost, were previously selected for their plant growth promoting activities and high NaCl tolerance. The performances of these strains to increase plants' salinity tolerance were tested on tomato plants (cv. Microtom) in a greenhouse experiment. Tomato plants substrates were inoculated with *A. chroococcum* 67B, *A. chroococcum* 76A, alone or in combination. Plants inoculated with commercial product of PGPR and non-inoculated plants were used as controls. Inoculated plants and their relative controls were exposed to 3 salinization levels (0 g l^{-1}; 5 g l^{-1}, 10 g l^{-1} NaCl) and 3 fertilization regimes [Basic nutrient Solution (BS), BS + 0.5 g l^{-1} NH_4NO_3 and BS + 1 g l^{-1} NH_4NO_3]. Preliminary analysis revealed that all the bacterial strains did not significantly improve the total fresh biomass and fruits fresh weight of tomato under NaCl stress. However nutrient balance among soil, fruits and plant vegetative biomass will be necessary to assess if these strains enhanced nutrient use efficiency.

OS 5-4
PLANT BIOSTIMULANTS ACTIVITY OF BIOENHANCED AND PELLETIZED SPENT PLEUROTUS SUBSTRATE

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Spent mushroom substrate is considered one of the ingredients of growing media which could use for (partial) peat substitution in the near future. Our aim was to enhance the plant biostimulants activity of a spent *Pleurotus* substrate (SPS), resulted from mushroom cultivation on wheat straw, and containing 39.5 ±1.3% cellulose, 14.7±0.5% hemicellulose, 19.6±1.1% lignin, 7.8±0,3% chitin and 18.4±0.6% water extractible. We treated the dried SPS with a suspension of spores of *Brevibacillus parabrevis* B50 (NCAIM B 001413), reaching 107 cfu spores per g dried substrate. The *B. parabrevis* bio-enhanced SPS was pelletized into a pellet mill. Rate of survival of embedded plant beneficial bacterial spores where higher than 80%. We tested the release of soluble silicon and polyamines from the bioenhanced and pelletized SPS, using pelletized SPS (without bacterial spores) as control. Treatment with bacterial spores significantly increased the release of soluble silicon and polyamines, compounds with a plant biostimulant activity. We tested the bioenhanced and pelletized spent mushroom substrate on germination and growth of two vegetables, tomato (*Solanum lycopersicum* L. cv. Menhir F1) and cucumber (*Cucumis sativus* L. cv. Karolina F1), on greenhouse conditions. We made an experiment in a completely randomized design. The tested vegetables were grown in 6 different media, obtained from bioenhanced and pelletized SPS, mixed in various ratios (2:1; 1:1; 1:2; 1:3; 1:4, v: v) with peat. We used double controls: M1, peat, and M2, obtained from pelletized SPS (not bio-enhanced), mixed with peat (1:2, v: v). Both controls determined a similar growth and development pattern on tested vegetables. Compared to controls, significant increased plant height, stem diameter, fresh weight and dry weight were found on treatments with maximum 25% content of bioenhanced pelletized SPS, on both vegetables. On treatments with more than 50% peat substitution, with pelletized and bioenhanced SPS, biomass accumulation on both tomato and cucumber is reduced, as a result of a significant reduction of water holding capacity of the substrate.

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SESSION VI : Crop Health - Disease Management

OS 6-1

EFFECT OF LIGNIN-RICH CROP RESIDUES ON THE VIABILITY OF VERTICILLIUM IN ORGANIC GREENHOUSE SOILS

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Healthy soils are of vital importance for organic greenhouse cultivation. Due to the intensity of the cropping system, soil-borne diseases are of great concern. To achieve a more resilient system, growers use multiple strategies, including resistant rootstocks, organic soil amendments, biological soil desinfestation and plant stimulants. Soil-borne pathogens that form (micro) sclerotia are particularly difficult to manage due to their persistence in soil. Previous studies have shown that incorporation of lignin-rich crop residues can decrease the viability of microsclerotia of *Verticillium longisporum* in cauliflower fields. The purpose of this study was to evaluate the effect of lignin-rich amendments on the microsclerotia of *V. dahliae* in soils from organic greenhouses with a history of *Verticillium* wilt in solanaceous crops. In the laboratory, two greenhouse soils (river and sea clay) were mixed with 10% (w/w) broccoli (stem), bristle oat (whole plant), reed (stalks or leaves), Ethiopian mustard (whole plant) and corn (stalks or leaves). In the river clay soil, corn stalks, broccoli stem, reed and bristle oat significantly decreased the amount of viable microsclerotia. In the sea clay soil, only reed leaves and stalks had a significant effect. Only in the sea clay soil, a significant negative correlation was found between the amount of lignin added and the amount of viable microsclerotia detected. These results indicate that in the river clay soil, other mechanisms than lignin may be involved in *Verticillium* control. Surprisingly, real-time PCR analysis showed that the amount of *Verticillium* tricorpus was much higher than that of *V. dahliae* in both soils. Sequencing of a *Verticillium* strain isolated from the sea clay soil showed that it should be re-classified as *Verticillium isaacii* (formerly *V. tricorpus*). It is necessary to investigate the role of these different *Verticillium* species, before new control measures against *Verticillium* are further developed.

OS 6-2
IMPACT OF ORGANIC N ON CORKY ROOT IN ORGANICALLY CULTIVATED GREENHOUSE TOMATOES

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Corky root of tomato caused by *Pyrenochaeta lycopersici*, is a major soil-borne disease in Swedish organic greenhouse production where tomatoes are grown in soil-based substrate. The corky root attacks the roots of the tomatoes and results in a suberisation of the roots reducing the plants ability to take up water and nutrients. Currently, for most producers, corky root resistant grafted plants is a presumption for the production but apprehensions are that this will affect the taste and may result n a build-up of resistance. Other methods for controlling the disease are urgently needed. A way to decrease the problem is to replace the substrate but this is very expensive. In the present study we tested the hypothesis that a proper N fertilization regime decreases disease severity. A greenhouse study was conducted using ungrafted tomato plants which were grown in a substrate naturally infected with corky root at three levels of additions of organic N, combined with three different pH levels. A high N addition increased the yields whereas a high pH reduced the yields. We conclude that tomatoes can resist corky root better at low pH. The reduced tomato yield at high pH cannot be explained by a calcium deficiency due to calcium immobilization at high pH. For organic tomato growers, a substrate with a low pH and a proper N fertilization is recommended.

OS 6-3
IS COPPER FUNGICIDE THAT BAD?

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Downy mildew is one of the most important and severe diseases for greenhouse horticultural products. For disease control Copper-based fungicides are the most effective and used active ingredients in both conventional and organic pest management. Copper (Cu) use is being limited and its reduction becomes one of the main principles of organic production. This study is focused on the characterization methods to asses copper compound's toxicity on agricultural systems in the frame of Life Cycle Assessment. USEtox model has been used to calculate Comparative Toxicity Potentials (CTPs) for freshwater ecotoxicity, linking emissions to impacts through fate, exposure and effects. The ecotoxicological impacts of 8 different fungicides (Captan, Cymoxanil, Maneb, Chlorothalonil, Folpet, Azoxystrobin, Mancozeb, and Copper) for Downy mildew control were estimated in two different geographic scales: global default values and Europe. The resulting CTPs showed up to 2 orders of magnitude of variation across all active ingredients in both geographic scales. Chlorothalonil had the highest and Cymoxanil had the lowest CTP in both areas. Comparing the two landscapes CTPs, the organic active ingredients had similar values, making spatial differentiation less influential. However, in the case of Captan and Cu European CTPs were around 0.8 and 1.3 orders of magnitude higher. Cu ranked third among the eight fungicides in default landscape, while in the European ranked sixth, making differentiation according to water archetypes potentially relevant. These results show that Cu toxicity depends mainly on its capacity to interact with the surrounding environment (pH, T, humidity, etc), and the dynamics of this interaction (speciation). These results represent a better approximation to estimate copper toxicity, which may help the decision process on the use of copper fungicides. Even though, we recommend deepening in the assessment of the interactions with the conditions of the emission site. Therefore, a new model framework that takes into account specific geographic distributions is needed.

OS 6-4
ACTIVITY AND BIOFORMULATION OF *TRICHODERMA HARZIANUM* FOR MANAGEMENT OF TOMATO DISEASES CAUSED BY SOILBORNE PATHOGENS

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Protected vegetable cultivation in Turkey, which is economically important for both domestic consumption and export facilities, is done on around 61696 ha of area with 5.9 million tons of production. Therefore, disease and pest management have become one of the major restricting factors on protected vegetable cultivation in Turkey. Root rot, wilt, damping off diseases caused by soil borne pathogens such as *Fusarium* spp., *Rhizoctonia* spp. and *Pythium* spp. result in considerable yield losses in greenhouse grown vegetables unless soil disinfestation prior to planting is applied. Pesticide applications conducted after disease onsets are neither effective nor economical. In this study, three *Trichoderma harzianum* isolated from soil collected from Eastern Mediterranean Region were bioformulated. Various supporting materials, drying temperatures and spore concentrations were tested in bioformulation process. *Trichoderma* isolates were applied to seedling medium after formulation, colonization of roots was done for one month, and pot and greenhouse trials were completed. Tomato seedlings were planted both in solarized and non-solarized soil in greenhouse. The disease incidence was 46-64% in control pots and 15-23% in three *Trichoderma harzianum* isolates applied pots. Disease incidence of seedlings in solarized soil was lower than in non-solarized control parcels. The disease incidence effect was 27-67% in solarized soil and 39-59% in non-solarized control parcels when *Trichoderma* treated tomato seedlings were planted. No statistical difference was observed between commercial preparation T-22 Planter box and our isolates.

SESSION VII : Crop Health-Pest Management

OS 7-1
PEST MANAGEMENT IN ORGANIC GREENHOUSE HORTICULTURE

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The management of pests is one of the major challenges in organic greenhouse cropping systems. In this paper, I summarize both the currently most problematic and persistent, as well as the newly emerging pest species in organic tomato, sweet pepper, cucumber and aubergine crops in Europe. Furthermore, I discuss 3 new developments in biological pest control with arthropod natural enemies: 1) the integration of augmentative and conservation biological control, 2) the increased use of omnivorous predators as biological control agents and 3) the presence of other factors that affect directly or indirectly the performance of pests and natural enemies , such as endophytes, plant nutrition, disease control and greenhouse climate management. Finally, I suggest some directions for future research.

OS 7-2
EXPLORING OPPORTUNITIES TO INDUCE EPIZOOTICS IN GREENHOUSE APHID POPULATIONS

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Aphids are a huge problem in organic greenhouse production systems of sweet pepper, eggplant and cucumber in Northern Europe. Biological control with arthropod natural enemies is often not effective, resulting in large crop losses yearly. Entomopathogenic fungi of the order Entomophthorales are known for their ability to cause epizootics and reduce host populations dramatically in a short time. These abilities make them potentially more affective biological control agents of pest species than commercially available entomopathogens of the order Hypocreales (e.g. fungi of the genus *Beauveria*, *Metarhizium*, *Lecanicillium* and Isaria). However, a major stumbling block to utilizing these fungi as biological control agents has been the difficulties encountered in growing them in vitro, which is one of the reasons why the biocontrol industry did not develop commercial products based on these fungi. Another approach in utilizing these fungi could be to try inducing epizootics by introducing inoculum of infected aphids into the crop. Here we present our attempts to induce such epizootics with banker plants of wheat with grain aphids infected by the entomophthoralean fungi *Pandora neoaphidis*. The system of introducing "Pandora bankers" has now been applied by 8 organic greenhouse growers in The Netherlands with various results. The requirements for causing a successful epizootic with this fungus will be discussed.

OS 7-3
BEHAVIOURAL STUDY ON HOST PLANTS SHARED BY THE PREDATOR *DICYPHUS ERRANS* AND THE PREY *TUTA ABSOLUTA*

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In the Mediterranean basin, tomato has been attacked seriously by the exotic tomato borer, *Tuta absoluta* (Lepidoptera: Gelechiidae), reported also on other Solanaceae. Some generalist predators, belonging to the tribe Dicyphini (Hemiptera: Miridae), have demonstrated a good potential in controlling this pest. Among them, the Palaearctic *Dicyphus errans* occurs naturally in organic tomato in NW Italy, preys upon several pests and lives omnivorously on several plants. This predator seems to share various host plants with the tomato borer, characteristic that could be exploited by means of proper habitat modifications to enhance its predation during all the year. Therefore, host plant selection of both predator and prey was investigated in multi-choice assays with 10 plant species (aubergine, bean, broad bean, courgette, datura, European black nightshade, herb-Robert, pepper, potato, tomato). Development and emergence rate of both predator and prey was assessed on tomato and European black nightshade, which is abundant in agro-ecosystems in NW Italy. Furthermore, behavioural responses of *D. errans* reared on tomato or European black nightshade were tested in olfactometer. Both predator and prey females oviposited on all tested plant species. However, significantly higher numbers of *D. errans* nymphs emerged on herb-Robert, whereas *T. absoluta* larvae were found almost exclusively on species of the genus Solanum. Despite the numerous eggs, no larvae could develop on courgette. No significant differences were found in developmental time on tomato and European black nightshade for both predator and prey. In olfactometer, *D. errans* did not show any significant preference between tomato and European black nightshade, independently of the rearing plant. In a perspective of conservation biological control, herb-Robert and courgette seem to be suitable plants to use as companion plants and in consociation with tomato to favour the predator and hamper the prey, respectively.

OS 7-4
POLLEN PROVISIONING FOR THE PROMOTION OF BIOLOGICAL CONTROL BY *OMNIVOROUS PHYTOSEIIDS* IN ORGANIC GREENHOUSES

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It has become evident that most species of the predatory mite family Phytoseiidae are in fact omnivores that obtain nutrients from both prey and plant sources. The ability of omnivores to feed on both sources makes them ideal candidates as biological control agents (BCAs). Their unique nutritional ecology allows them to persist in the habitat and maintain populations by consuming plant food sources when prey is scarce. Pollen is a well-known food source that supports and sustains omnivorous populations that are natural enemies of pests, and improves pest suppression. In this short review we discuss the conservation of *Omnivorous phytoseiid* for the control of pests. We review: 1) the attributes of omnivores as BCAs; 2) pollen provisioning for the conservation and augmentation of BCAs: 3) the intimate relationship of *Omnivorous phytoseiid* predators with their plant host; 4) pollen provisioning for the augmentation of phytoseiid predators in organic protected cropping systems and conclude with some remarks for proposed future research.

OS 7-5
HOW AGRO-ECOLOGICAL SERVICES CROPS AFFECT SOIL ARTHROPOD DIVERSITY IN MEDITERRANEAN ORGANIC GREENHOUSE PRODUCTION

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Conventionalization of organic agriculture through input substitution, aimed to fulfill certification requirements, without improvement of natural ecological cycles in agroecosystem, is a relevant concern especially for the organic greenhouse (OGH) sector. Following a holistic approach, more resilient agroecosystems may be designed by taking advantage of Agro-ecological Services Crops (ASC) cultivation during the crops sequence and by using organic matter amendments for the soil fertility management. In this framework, we investigated ecological sustainability of three OGH production systems by studying the soil arthropods taxa. Following systems were under assessment i) SUBST – bare soil priori to cash crop + organic fertilizer; ii) AGROCOM – ASC as green manure priori to cash crop + compost and iii) AGROMAN – ASC as dead mulch + animal manure. Monitoring of soil arthropods was performed by using pitfall traps and divided in two phases: the pre-crop period (during cultivation of ASC or bare soil in SUBST) and cash crop (kohlrabi) production. Collembola was the most abundant group during cultivation of ASC, in all tested systems and their activity density (AD) was higher in SUBST compared to other two systems. Isopoda, Araneae and Staphylinidae were significantly more abundant in AGROMAN, where manure was applied before ASC sowing. During kohlrabi cultivation Collembola group was confirmed as the most represented in all systems, with the highest values in AGROMAN. Moreover, significant differences were found among the systems for Opiliones, Myriapoda and Staphylinidae groups; with the highest abundance of all these taxa in the AGROCOM system. Results obtained indicate that an agroecological practices (ASC cultivation, compost and manure application) could contribute to ecological sustainability and the development of organic agriculture under protected environment.

OS 7-6
COMPARISON OF ORIUS NIGER WITH ORIUS LAEVIGATUS BIOLOGICAL CONTROL EFFICIENCY TO WESTERN FLOWER THRIPS *(FRANKLINIELLA OCCIDENTAILS* PERGANDE) ON SWEET PEPPER IN GREENHOUSES

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Frankliniella occidentalis is the prevalent pest causing serious damage in protected pepper cultivation. Synthetic insecticides have been and are still used to control of this insect. However, these chemical applications create enormous problems such as environmental pollution, resistance to insecticides, ineffectiveness, residue etc. This study was conducted in order to assess the biological control possibilities for *F. occidentalis*. *Orius niger* and *Orius laevigatus* were tested to determine their optimum dose and selecting of convenient predators considering their comparable performance after releasing by 1, 2, 4 and 6 adult m^{-2} doses against this pest. These trials were carried out in 2003-2004 and 2004-2005 sweet pepper growing period in Antalya. In first year trial, predators were only released one time at beginning of the growing season. However, single autumn release did not lead to sufficient control of the pest at the beginning of spring term. Therefore, a second release was done, which was required in the spring period in the second year. *Orius laevigatus* showed a more rapid colonization of plants than *O. niger* and lead to efficiently control of *F. occidentalis* on sweet pepper with two releases of 4 adult m^{-2} in October and March.

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SESSION VIII : Energy and Greenhouse Climate

OS 8-1

ENERGY USE FOR GREENHOUSE HEATING IN ORGANIC PRODUCTION IN SOUTHERN EUROPEAN COUNTRIES

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The vast majority of Southern European greenhouses are unheated. Nevertheless, during the coldest months growth is retarded, since average minimum temperatures in the warmest European areas are between 7 and 9 °C. Therefore heating is highly desirable in the winter, but in spite of the positive response of crops to heating its economic profitability is open to debate. Heating is accepted by most organic regulations in different countries; provided it is done efficiently and if the energy source is predominantly renewable energy, heating fits well with the concept of organic production, since it is aligned with the idea of achieving maximum potential of available resources. Little data is available on the energy use for heating in greenhouse horticulture in Southern Europe. This study tries to cover this gap of knowledge since its presents the energy consumption for heating in three locations particularly devoted to greenhouse production: Almeria (Southern Spain), Faro (Southern Portugal) and Acate, Ragusa province (Southern Italy). Daily heat requirements based on the temperature difference between the night set-point temperature and the minimum open air temperature were calculated by a simple model. Cumulative heat requirements were estimated by the summation of daily requirements. Calculations show that heat requirements grow exponentially with the set point temperature. As expected, calculations for Faro and Ragusa presented higher values since the open air night time temperature was lower than in Almeria. Heat requirement can be reduced with the help of energy saving techniques such as double walls and thermal curtains. Our study presents the expected energy savings for the three locations under consideration in greenhouses with a polyethylene thermal screen. It also shows that the greenhouse can benefit from the use of passive means, that is, without the application of external energy.

OS 8-2
HEATING AND DEHUMIDIFICATION IN PRODUCTION GREENHOUSES AT NORTHERN LATITUDES: ENERGY USE

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The majority of greenhouses in northern latitudes are heated, in the winter mainly for temperature control and year round to control of humidity. Heating is accepted by most organic regulations in different countries; if heating efficiently and the energy source is predominantly renewable energy, heating fits well into the concept of organic production, since it is aligned with the idea of achieving maximum potential with available resources. It is a fact that energy use for humidity control is more important than for heating. Indeed, the improved thermal performance (insulation) of high-tech greenhouses has decreased heating requirements while decreasing the discharge pathways of vapour at the same time. The need to control humidity is especially important in organic greenhouses, given the limited options to fight fungal diseases once they develop. Excess vapour can be discharged in three ways: through exchange with dry outside air (ventilation), through condensation on a cold surface and through hygroscopic adsorption. Ventilation can be uncontrolled (natural) or controlled (forced), and in the latter case can be controlled by a heat exchanger, recovering sensible heat in the ventilated air. Even then, however, the latent heat contained in the vapour (the energy used for evaporation) will be lost. In those cases where the greenhouse is dehumidified by withdrawing internal moisture, the loss of latent heat via ventilation is prevented and condensation on an internal surface recovers the latent heat. Obviously, it costs energy to cool the condensation surface and/or regenerate the hygroscopic salt. Experiments with these systems have been performed during the last years. Some growers have installed these types of systems and they have been monitored for their effect on moisture control and energy saving. The results of these experiments and model calculations to compare them are presented. In case dehumidification systems are well controlled they can save significant amounts of the energy and with an increase of technology level the saving can be improved. There is no generally best possible solution for dehumidification. The optimum system and it operation is dependent on desired temperature and humidity level in the greenhouse.

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OS 8-3
ASSESSMENT OF ENERGY CONSUMPTION IN ORGANIC TOMATO GREENHOUSE PRODUCTION. A CASE STUDY

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Greenhouse production has increased over the last decades in the Mediterranean region. Greenhouses allow protecting crops from adverse climate conditions, creating microclimate conditions appropriate for obtaining high production with high quality all over the year. However, greenhouse production is generally associated with high environmental impacts due to the use of high amount of inputs and the high quantity of waste generated. Sustainable greenhouse production is nowadays a goal and can be achieved by using appropriate technologies such as innovating crop practices and environmental control techniques allowing reducing agro-chemicals use and water and energy consumption. Organic farming is based on methods and practices that consider the environment (soil, water, air), which includes limitation on the use of synthetic pesticides and fertilizers and takes advantage of on-site resources, such as livestock manure for fertilizer. Demand for food produced without using agro-chemicals has increased; usually these products are sold at high price and associated to a particular nutritional value, taste and health. It is generally associated with lower yield and better quality. Greenhouse organic farming is not widely applied as farmers believe that yields are strongly reduced. However, there is a market opportunity to organic farming as a result of higher product prices and consumers demand. In order to compare the overall efficiency of crop farming systems, it is vital to consider energy consumption and efficiency. In this work a case study is analysed in terms of energy consumption and GHG emissions. The data were obtained directly from the grower and the main objective of this work was to characterize the organic greenhouse production system. The mostly important inputs were identified and were compared with other obtained with conventional greenhouse production.

OS 8-4
POTENTIAL ENERGY COST AND FOOTPRINT REDUCTION IN MEDITERRANEAN GREENHOUSES BY MEANS OF RENEWABLE ENERGY USE

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Greenhouses are intensive agricultural systems and require optimum combination of solar lighting, heating, cooling and ventilation. Various methods are suggested for the control of internal space factors of greenhouses but require significant amount of energy. Photovoltaics integrated in the greenhouse roof could be used to supply a part of this energy with no significant effect on greenhouse crop yield. Accordingly, aim of this work is to present the potential reduction of the cost of energy needed for greenhouse heating and cooling in South Europe and Mediterranean regions, by implementing renewable energy sources. Furthermore, the potential carbon footprint reduction resulting when using renewables compared to conventional energy sources is also studied. Thus, the integration of a PV system on the greenhouse roof for electricity production was studied and the effects on energy needs and greenhouse environmental impact were considered. Two case studies were considered for a 1 ha tomato greenhouse in Central Greece: (a) covering a small percentage of the greenhouse roof (0.65%) by a PV system of about 10 kWp and (b) covering about 6.5% of the greenhouse roof by a PV system of 100 kWp. It was found that a PV system covering only 6.5% of the roof surface could be enough to completely cover the electricity needs for the auxiliary processes of a greenhouse. The estimated PV electricity production could reduce the life cycle impact of a greenhouse by 5-10%.

SESSION IX : Sustainability

OS 9-1

VEGAN ORGANIC HORTICULTURE – STANDARDS, CHALLENGES, SOCIO-ECONOMICS AND IMPACT ON GLOBAL FOOD SECURITY

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Vegetarian and vegan diets have seen an increased interest in recent years all across the world. This is the case for 'vegans' who aim for 100% vegan food, but also for so-called 'flexitarians', meat and fish eaters including one or more vegan and vegetarian days in their weekly diets. This paper focuses specifically on vegan organic horticulture produced in greenhouses or in the open field. Vegan organic production (in contrast to vegetarian = eating no meat) excludes all animal inputs into plant production (e.g. manure, blood-meal or horn-meal). It uses ecosystem services supplied by the soil micro-fauna or wild bees for pollination, but uses no domesticated animals or any of their by-products like manure, horn or leather. This paper critically analyses vegan organic horticulture regarding three main topics: Firstly, it describes its current use in organic horticulture and agriculture. Based on this status-quo analysis it critically discusses the standards currently used for vegan organic horticulture and highlights on-going discussions in the organic movements on 'stockless', 'stockfree', 'vegan organic' and 'veganic'. Secondly, it discusses the agronomic challenges for intensive organic horticultural production. How to manage soil fertility long-term in such systems, while also reducing other external inputs (finite fossil fuels, like oil and peat) into the organic farming system? Thirdly, the paper studies the socio-economics of a large-scale uptake of vegan diets, or more vegan days in flexitarian diets. How can vegan organic contribute to make organic overall more resource efficient and help in the transition to more sustainable diets and consumptions, worldwide?

OS 9-2
COMPARING THE USEFULNESS OF ASSESSMENT TOOLS FOR ENVIRONMENTAL IMPACTS EVALUATION OF ORGANIC GREENHOUSE HORTICULTURE

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Organic farming is primarily meant to be sustainable; however, evaluating the sustainability of farming systems in a complete way is a complex issue. In recent years, a high number of sustainability assessment tools has been developed and used worldwide; nevertheless, even if they differ in terms of analysis depth, none of them seems comprehensive enough. Amongst all the existing tools we have chosen two of them, Life Cycle Assessment (LCA) and Public Goods Tool (PGT). In the case of specific farming systems such as organic greenhouse horticulture, a comparison between LCA and PGT has been done to evaluate the potential integration between both sets of results so that a single holistic assessment method could be obtained. This could help to understand which sustainability aspect these methods should focus on and which type and depth of data would be desirable. This paper mainly highlights the methodological differences and potential common points between the tools, referring to a chosen case study (Tolhurst Organic, a stockfree horticultural unit located near Reading, UK) that has been assessed with both, and then gives suggestions for future research. An updated and improved version of the LCA Excel tool, initially developed by the EUphoros project (2008-2012) and then integrated with data from PGT, was the main outcome of the comparison. While LCA gives quantitative results on impacts on key environmental categories, PGT shows ways to improve farming practices regarding a set of social, economic and environmental aspects through a simple scoring system. In this sense, trying to combine results from different assessment tools might be difficult because it highlights the lack of overall complementarity between them, but at the same time it could be a useful starting point for an integrated discussion on production, use of natural resources and improvements of practices among decision-makers.

OS 9-3
QUALITY AND POSTHARVEST PERFORMANCE OF ORGANICALLY-GROWN STRAWBERRY 'FESTIVAL' UNDER UNHEATED TUNNEL

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Presently, the same organic certification may obtained through very different systems of production. Organic techniques can rely on complex agro-ecosystem management or they can just replace chemical fertilizers and pesticides with allowed inputs. The aim of this research was to study the quality characteristics and their evolution during storage of organic strawberries produced by agroecological or conventionalized organic systems. Different organic soil fertility management strategies were compared under the same environmental conditions: i) a simplified organic production system based on organic commercial fertilizers (SUBST); ii) organic production system based on cover crops and animal manure amendment (AGROMAN), and iii) organic production system based on vegetal sources inputs like: cover crops and on-farm compost (AGROCOM). Strawberry fruits were sampled and stored in a cold room at 1°C under a continuous humidified air flow for 13 days. At 0, 3, 6 and 13 days after harvest respiration rate, morphological, physical, and sensorial characteristics, and nutritional quality attributes were monitored. At the time of harvest mean values for all measured parameters did not show significant differences among treatments, while after 13 days of refrigerated storage hue angle, vitamin C content and sensorial scores (sweetness and off-flavours)were significantly higher for the organic strawberry grown in SUBST compared to all other systems. In conclusion, the production system did not influence the quality of 'Festival' strawberry cultivated in greenhouse under Mediterranean climate conditions at harvest but they significantly affected postharvest performances during 13 days of storage.

OS 9-4
STRUCTURE OF ORGANIC VEGETABLE FARMING, SHARE OF GREENHOUSE AREA AND FERTILIZER USE – RESULTS OF A SURVEY IN GERMANY

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A status quo survey was carried out by oral interviews among 100 organic vegetable farmers throughout Germany. Out of a wide range of topics the farm structure, share of protected cultivation and the use of fertilizers are analyzed. The farm sizes ranged from <1 ha up to >100 ha with a maximum between 1 and 10 ha. The range of vegetable area was found between 0.7 ha and 140 ha. The sum of all protected areas within the 100 farms resulted in 116,848 m^2. They were mainly covered by glass, less by plastics. Beside these stable houses, some farmers used low or mobile plastic tunnels. More than 60% of the covered area was not heatable, a clear indication for less intensive production systems. Farm yard manure was accessible as on-farm source at most of the farms, mainly as cattle manure. In addition purchased dung as cattle or horse manure was often used for the replacement of degraded organic matter in soil. Among other purchased fertilizers the use of organic nitrogenous fertilizers was dominating.

SESSION X: Soilless System in OGH
OS 10-1
THE ORGANIC NUTRITION ON HYDROPONICALLY GROWN GREENHOUSE MELON

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Greenhouse melon was grown by organic nutrition in 1:1 cocopeat-perlite mixture (v/v) The licensed fertilizers in organic farming were the treatments of the experiment. Three different organic fertilizers were compared each others and control. The treatments with their trade names were; 1) Biofarm (liquid), 2) Complex (liquid), 3) Pattrone+Chamlica (powder), 4) Control. The control plants were fertigated by the conventional nutrient solution that prepared by synthetic fertilizers. The experiment was carried out in the glasshouse during the spring cultivation period under the Mediterranean climate conditions. Plant growth parameters (plant height, total shoot fresh weight, number of leaf per plant, stem diameter) were not significantly affected by the treatments. However, melon yield was higher in the organic fed plants in comparison to control ones. The melon plants fed with Complex fertilizer produced the highest yield. It was 74% higher than the control. The other two organic fertilizers, Biofarm and Patrone+Chamlica, produced 17% and 15 higher melon yields than the control, respectively. Melon fruit Total Soluble Solids (TSS) and fruit mean weight were similar in the different organic fertiliser's fed plants and higher than control.

OS 10-2
USE RESOURCES WISELY: WASTE MANAGEMENT AND ORGANIC LIQUID FERTILIZER USE IN GREENHOUSE PRODUCTION SYSTEM

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Interest in local and organic food production, waste management and sustainable food production in controlled environments are gaining interest. Significant amount of food is wasted in the US. Converting solid food waste into useful products has substantial economic, social and environmental benefits. Therefore, there is a need for technological advancement with innovative technology, solving community problems with local resources, and, ultimately, changing the way of thinking and management of waste, and using resources wisely. This study focused on evaluating the effects of the organic liquid fertilizer obtained from food waste, using a patented technology (WISErg Corp., WA, USA), on overall quantitative and qualitative yield of lettuce crop growing in a sand culture system in a high tunnel greenhouse system. A comparative study was conducted using inorganic fertilizer for production in the Control greenhouse while organic liquid fertilizer was used in the Treatment greenhouse for the production. The results showed that the fresh weight based yield data indicated no significant differences for all lettuce varieties grown between the inorganic and organic fertilizer fed group plants. The yield of organic fertilizer fed Kale was slightly higher than those grown with inorganic fertilizer. Bioactive content analysis for Anthocyanin levels showed that they were slightly higher especially in the colored lettuce varieties (i.e. Cherokee, Magenta and Salanova Red incised) in the organic liquid fertilizer fed group compared to fed with inorganic fertilizer. This preliminary study provided promising results for potential use of liquid organic fertilizer reducing the demand on inorganic fertilizers, improving waste management practices and using resources wisely in controlled environment food production system.

OS 10-3
NUTRIENT AND WATER USE EFFICIENCY IN SCREENHOUSE CROPS: A BENCHMARKING APPROACH

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The extreme and unpredictable outside climate conditions and health and quality of life issues raised from the consumers, have led to a steady and gradual increase of screenhouses crops, especially in countries of the Mediterranean area. The screenhouse enclosure not only modifies the physical climate, by altering the radiative and convective heat transfer, but it also amplifies the interaction between crops and their microclimate. Furthermore, screening materials exclude insects that attack crops enabling an environmental friendly crop production. One of the critical constraints to higher crop productivity is the low efficiency of applied nutrients, especially N and P. The NUE is a function of (a) soil to supply adequate amount of N, and (b) ability of plant to acquire, transport in root and shoot, and remobilize to others parts of the plant. Inefficient nutrients use is a key factor pushing the cost of cultivation and pulling down the profitability in farming. Although there are several terms for expressing nitrogen use efficiency (agronomic efficiency, physiological efficiency, chemical efficiency, productivity), the present study applies the definition most commonly used by farmers and crop advisers i.e. the crop output per unit of nutrient input. Although the need for reliable indicators to monitor, measure and evaluate the real impact of proposed innovation on the environmental sustainability is evident, there is still a lack of indicators that farmers and water authorities can use to achieve their goals. Benchmarking tools and performance indicators can be efficiently used for this purpose. In the present study the nutrient and water use efficiency of a screenhouse pepper crop was analysed based in a benchmarking approach. The benchmarking has been done using as reference case a similar open field pepper cultivation. Results show that if farmers integrate and adopt in their production chain the available techniques and technologies, then the total efficiency of nutrients and water use can be significantly increased.

POSTER PRESENTATIONS

PS 1-1
WINTER-HARVEST: ORGANIC VEGETABLE PRODUCTION IN UNHEATED GREENHOUSES IN CENTRAL EUROPE

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Lettuces, salad herbs and many other leafy vegetables were much more frost hardy than supposed. New data of frost hardiness could be collected about these important vegetables. More than 100 varieties and cultivars were grown that were well suited for low input winter production in polytunnels. Sowing-planting-harvesting tables were compiled using these data from practical experiments on-farm and in research stations. Extensive nitrate analyses showed that none of the samples exceeded critical legal limits.

PS 1-2
EFFECTS OF DIFFERENT PLANTING SYSTEMS AND DISTANCES ON THE YIELD AND QUALITY OF GREENHOUSE ORGANIC TOMATO (*SOLANUM LYCOPERSICUM* L.) GROWING

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This study was firstly carried out in 2010 year to decide how various planting systems (single, double or triangular planting) and different distances (40x40, 40x50, 40x60, 40x65, 40x80) affects plants in greenhouse growing of organic tomato as out- of- season fruits. In the experiment; average fruit weight, ascorbic acid (vitamin C), dry matter content, yield per plant and total yield were determined. The highest average fruit weight was 276,3 g and this value was obtained in single row planting. Average fruit weight varied from 160,3 to 276,3 g. Dry matter content varied from 7,3 % to 13,8 % on tomato fruits. Ascorbic acid values changed in the range of 10,25-23,18 %. The highest yield (11,91 kg/m^2) was recorded in triangular planting and 40x65 cm plant spacing distance application.

PS 1-3
THE EFFECT OF DIFFERENT TRAINING SYSTEMS ON GREENHOUSE ORGANIC TOMATO CULTURE

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The present study was carried out to determine the effects of different training systems on growth, development and yield of tomato cultivar of 'Depar F1'. Two different training systems were experimented (I; traditional system and II; wire training system) during the cultivation period. Plant height (cm), stem diameter (mm), number of leaves, cluster formation rate (cluster day^{-1}), number of fruits, average fruit weight (g) and yield (kg m^{-2}) were examined in this study. Training systems had significant effects on all of the investigated parameters ($P<0.05$). The highest average fruit weight (114.9 g) and yield (8.1 kg m^{-2}) were obtained from traditional system.

PS 1-4
DEVELOPING ORGANIC TOMATO PRODUCTION IN THE PARTICIPATORY RESEARCH CONTEXT

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The roles of different actors in agricultural knowledge and innovation systems are currently converging and thus participatory approaches are becoming increasingly prevalent. These new platforms offer scientists and farmers a space for dialogue, where desirable and feasible solutions to common problems can be identified, analysed and implemented. A successful initiative in this context in Sweden is the project 'Plant nutrient utilisation in organic tomato production', which was carried out by a participatory research group that worked together in the period 1999-2010 on issues concerning organic tomato growing. The group included commercial tomato growers, advisors and researchers. When the plant nutrition project started, knowledge of plant nutrient supply in organic tomato growing was limited. It was common for most of the nutrient requirements of the crop to be supplied as large doses of farmyard manure before planting, which created problems with too leafy plants in the beginning of the season and nutrient deficiencies. The aim of the project was to develop organic tomato growing, for example through demonstrating the importance of tailoring fertiliser supply to crop requirements at a particular stage of growth, level of yield and local conditions. During the period in which the project ran, yield of tomatoes in the group's cultures increased by 49% on average and NUE was improved substantially for the major nutrient elements. Among other projects within the frame of the project the effect on pH of additives and, heavy metals in soil and plants are presented.

PS 1-5
EFFECT OF ORGANIC AND GREEN MANURING ON SOIL QUALITY AND PLANT NUTRIENT UPTAKE IN ORGANIC STRAWBERRY GROWN

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Evaluation of the relationships between the nutritional status of plants and soil productivity features together is important for more realistic and effective use of fertilizers and soil fertility management. The aim of this study was to determine the nutritional status, soil and plant analysis of strawberry plants organically grown under climatic conditions of Yumurtalık town of Adana, Turkey. The study was conducted between 2010 and 2012. In the trial; (1) cowpea (*Vigna sinensis* L.), and (2) bean (*Phaseolus vulgaris* L.) were used as green manuring crops; and one plot (3) was used as the control (plot where green fertilizer was not used and kept as fallow). Additionally, the effects of organic commercial compost material Ekoflora (N:P:K 1,5:2:2) and compost tea that was obtained from Ekoflora were also investigated on the split plots throughout the growing season. Green manure was used in trial conducted as four replications as treatments (control, cowpea and bean) being the main plots and farm manure used as sub plots. Fresh strawberry seedlings of Sweet Charlie variety were used in the trial. It was found that green manure + compost tea application increased organic matter, total nitrogen and available phosphorus and potassium contents of the soil and decreased available calcium and magnesium values. The organic matter (OM) content averaged to 2.32% in green manure applications, and organic matter average value of green manure+ organic manure application was 2.38% revealing that average organic matter level was increased by 0.06%. The results showed that green manure applications gave satisfactory results, even without compost tea applications.

PS 1-6
FRUIT QUALITY CHARACTERISTICS OF ORGANICALLY GROWN STRAWBERRY VARIETIES

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Organically cultivated fruits being more nutritious and the organic fruits had significantly higher levels of antioxidants and cancer-causing 'free radicals'. For this purpose organic strawberry cultivation is become very popular due to the providing health benefits comparing to the conventional cultivation. In this study, it was aimed to identified and quantified individual sugars such as fructose, glucose and sucrose, carboxylic acids such as malic and citric acid and L-ascorbic acid using HPLC (High Performance Liquid Chromatography) techniques. Total anthocyanin and antioxidant capacity of organically cultivated Albion and Benicia strawberry fruits were also compared.

PS 1-7
EFFECT OF ORGANIC FERTILIZATION ON THE QUALITY AND YIELD OF TWO RADISH CULTIVARS IN GREENHOUSE ORGANIC CULTIVATION

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The greenhouse study was conducted in 2013-2014 at Research Institute of Horticulture in Skierniewice. The area certified for organic production is 200 m^2 in separated block in Venlo type greenhouse. This greenhouse is designated for vegetable cultivation with crop rotation and cultivation according to the requirements for organic farming. The cultivars used in experiments were recommended for organic production in Poland. Radish was cultivated in early spring. The results of the two-year experiment showed that fertilizers had a significant impact on the yield of radish. The higher total and marketable yield of radish were obtained at the rate of 50 kg N. ha^{-1} and 100 kg N. ha^{-1} of organic fertilizer Fertilan L. The highest dose 150 kg N. ha^{-1} did not bring the expected results because the yield was lower compared to the yield obtained at the lower doses. At the dose of 150 kg N. ha^{-1} the marketable yield was higher in relation to the yield obtained from control plots and fertilized with eco-compost 30 t. ha^{-1}. It was also found that the means for yield were significant differ regardless of the type and dose of fertilizer compared to control. Each cultivar was also evaluated for its suitability for organic farming. The two-year study did not give a clear answer which one is better. The Rudolf's roots were a little bit more susceptible to cracking than roots of Opolanka, but Opolanka accumulated more nitrates in roots than Rudolf at the same doses of fertilizers.

PS 1-8
EFFECTS OF COMPOSTS OBTAINED FROM TWO DIFFERENT COMPOSTING METHODS ON ORGANIC TOMATO SEEDLING PRODUCTION

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Characteristics of growing medium and nutrition are the major factors affecting the seedling quality. In organic seedling production, those factors become more important due to the limitations in input use. Peat is the most common medium used in organic seedling production. However, it is a nonrenewable resource and peat bog exploitation is considered not sustainable over the long terms. The aim of this research was to develop growing medium as an alternative using different agricultural wastes as the raw material of compost to produce organic tomato (cv. Melis) seedlings. Therefore, the mixture containing rose oil processing wastes, separated dairy manure, poultry manure, and straw was composted in (1) aerated static pile and (2) turned windrow composting methods. In the experiments, different rates (25, 50, 75, and 100%) of composts obtained from the two different methods were added to peat which is locally available. Seeds were sown on 21.07.2015. Each treatment had 4 replicates and each replicate included 64 plants. After germination in growth chamber, plants were moved to a PE greenhouse which is specialized for seedling growing. Liquid composted farmyard manure was used fertilization. Seedling became ready for transplanting after a month. Some physical and chemical properties of each growing medium, germination rate of seeds and seedling vigor were determined. The effects of growing media in both types on seed germination, shoot fresh and dry weights and dry matter were found statistically different. Among the different ratio of composts, germination period was longest in 100% compost use and shoot biomass decreased with increasing compost rate. Results were discussed considering the physical and chemical properties of growing media. It was concluded that the mixture containing rose oil processing wastes, separated dairy manure, poultry manure, and straw composted according to turned windrow composting method could be a good alternative to use in seedling growing if included in the medium at 25%.

PS 1-9
EFFECTS OF COMPOSTS OBTAINED FROM OLIVE OIL PRODUCTION WASTES ON ORGANIC TOMATO SEEDLING PRODUCTION

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The aim of this research was to evaluate by-products of olive oil production in compost production and to test them in different rates as tomato (cv. Melis) seedling growing medium. Therefore, three different types of olive oil production wastes (two-phase and three phase olive mill wastes and olive oil waste water sludge) were composted with separated dairy manure, poultry manure, and straw using aerated static pile composting methods to obtain three different types of composts separately. Additionally, each compost was enriched with cotton seed meal and rock phosphate. In the experiments, different rates (25, 50, 75 and 100%) of six different composts were added to peat which is locally available. Seeds were sown on 21.07.2015. Each treatment had 4 replicates and each replicate included 64 plants in a tray. Seedlings were fertilized by liquid composted farmyard manure and seedlings were ready for transplanting after a month. Some physical and chemical properties of each growing medium, germination rate of seeds and seedling vigor were determined. Germination period extended with the increase of compost rates in peat. The highest shoot dry matter was in the mixture with 25 % of the enriched compost obtained from three-phase olive mill wastes with separated dairy manure, poultry manure, and straw and 75 % peat. Considering all results and physical and chemical properties of media, it was concluded that the performance of the enriched composts was higher with a rate of 25% in growing medium.

PS 1-10
PHYSICO-CHEMICAL CHARACTERIZATION OF CHERRY TOMATOES GROWN UNDER ORGANIC AGRICULTURE

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In Spain and especially in the province of Almería, where agriculture is a major livelihood, tomato crop (*Lycopersicon esculentum* L.) has great importance in the economic field. In recent years, research has given priority to issues such as increasing fruit production, resistance to pathogens and adverse temperatures, etc., achieving significant improvements in these points. However, now they are beginning to consider priority aspects as the organoleptic and nutritional quality. These values have been preserved in traditional varieties, for this reason, the research takes a new approach to improving organoleptic and nutritional fruit. In this work we have characterized both physico-chemical and nutritionally traditional tomato varieties grown under protected organic conditions in order to find varieties with better characteristics. Statistically significant differences ($p < 0.05$) were obtained between the parameters studied for each of the varieties (yield, weight, size, color, firmness, titratable acidity, pH, total soluble solids, ascorbic acid, lycopene, total phenol content and antioxidant activity). It can be concluded that the cherry varieties presented good taste characteristics, and a high content in some of the studied compounds, covering largely the nutritional recommendation. This study has allowed us to extend the limited supply of quality products and identify varieties that can serve as a source of genes for the development of new tomato varieties with higher organoleptic and nutritional qualities.

PS 1-11
BIOMARKERS FOR SELECTION OF PARTHENOCARPIC VARIETIES OF ZUCHINNI

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The current cultivars of zuchinni (*Cucurbita pepo*) grown in greenhouses at late seasons (winter) are supplemented with synthetic auxins to induce fruit set, in order to avoid the effect of harsh environmental conditions as low temperatures, inadequate humidity and the inactivity of pollinators. To elude the application of synthetic auxins and increase fruit set, the use of cultivars with an innate ability to set fruit should be a useful solution. Parthenocarpy is the capability of a plant to set seedless fruits in the absence of pollination and fertilization, but there are not parthenocarpic cultivars available in this crop. In *Cucurbita pepo*, parthenocarpy has been related with auxin and ethylene. Synthetic auxins are known to induce parthenocarpic fruit when are applied to several horticultural crops out of seasons, and ethylene has been related to ovarian growth in pollinated fruit, and recently has been associated with parthenocarpy. To select parthenocarpic cultivars in banks of germplasm, we have tested a method using the population of zuchinni mutant lines developed in IFAPA. The method is based on two biomarkers, phototropism selection (phenotype associated with deregulation in the auxin signalling pathway) and the pattern of ethylene release during early fruit development of *C. pepo*. Afterward, we have evaluated the efficiency of each biomarker to select cultivars useful for organic practices.

PS 2-1
EFFECTS OF PLANT GROWTH-PROMOTING RHIZOBACTERIA ON ORGANIC LETTUCE PRODUCTION

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This study was conducted in order to determine the effects of plant growth promoting rhizobacteria (PGPR) on seedling and head production of organically grown iceberg lettuce (cv. Papiro). Seeds treated with Bacillus subtilis (strain 66/3), *Pseudomonas putida* (strain 18/1K), *P. fluorescens* (strain 112), *P. punonensis* (strain 56), *B. subtilis* + *P. fluorescens* were sown into vermicompost:local peat (1:1.5, v/v) on 14.01.2015. After germination in growth chamber (18/18°C day/night, 80% relative humidity for 3 days), seedlings were drenched with PGPR suspensions, then plants were moved to a PE greenhouse which is specialized for seedling growing. Seedlings were fertilized by liquid composted farmyard manure (30 L ha^{-1}) once a day. Germination rate and period of seeds, fresh and dry weight of seedlings and their nutrient composition were determined when they are ready for planting in 35 days. Then seedlings were transferred into a PE greenhouse and grown according to the rules laid down in organic Regulations. Heads were harvested in two months and yield and head quality parameters were determined. It was concluded that observable differences were obtained in the seedling stage. *Bacillus subtilis* treatment increased the seed germination rate and *B. subtilis* + *P. fluorescens* was found promising due to the higher seedling biomass. However the effects of PGPRs on yield, head size and plant biomass was found insignificant.

PS 2-2
RHIZOBACTERIA PROMOTED GROWTH AND YIELD OF TOMATO PLANTS AND CONTROL OF *FUSARIUM OXYSPORUM F. SP. RADICIS-LYCOPERSICI*

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Fusarium oxysporum f. sp. *radicis-lycopersici* (FORL) results in severe losses in the greenhouses and open field tomato crops. In this study, plant growth-promoting rhizobacteria (PGPR) were tested on tomato plants for the biological control of FORL and for their ability to promote plant growth and yield. Firstly, rhizobacteria strains isolated from tomato plants in commercial greenhouses were screened in vitro. According to the results of in vitro tests, 10 PGPR isolates (TR 2/1: *Pseudomonas fluorescens* bv 3, TR 6/1: *P. fluorescens* bv 3, TR 17/1: *P. marginalis*, TR 18/1: *P. fluorescens*, TR 21/1: *P. putida*, TR 23/1: *P. putida*, TR 39b: *P. fluorescens* bv 3, 70: *P. putida*, S 5/4: *P. putida*, 14/1y: *P. fluorescens* bv 5) were selected for in vivo tests realized in growth chamber. A sensitive "Kardelen F1" tomato variety to FORL was used as plant material. PGPR strains gave rise to significant increase in growth of tomato seedlings, TR2/1 and TR18/1 gave higher values in this respect. PGPR strains suppressed disease symptoms significantly, TR21/1 and 14/1y were most effective strains for control of FORL. TR 21/1 suppressed disease symptoms by 76%. Four PGPR (TR2/1, TR18/1, TR 21/1 and 14/1y) were selected for greenhouse experiment, and were tested to determine their effect on growth and productivity of tomato plants in greenhouse under healthy conditions without FORL inoculation. PGPR increased growth of tomato seedlings and cumulative yield. It was concluded that PGPR have potential for developing biofertilizers and biopesticides needed in organic farming which avoids the use of synthetic chemicals.

PS 2-3
EFFECT OF DIFFERENT SEED TREATMENTS AGAINST SEED BORNE DISEASES ON CORN SALAD

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Seed borne pathogens may cause high yield losses in various crops. It is therefore of vital importance that seed treatment methods that eliminate seed borne pathogens are available. The aim of this work was to evaluate the effect of selected seed treatments against two seed-borne diseases (*Acidovorax valerianellae* and *Peronospora valerinaellae*) on corn salad (*Valerianella locusta*). Treatments with ethanol, with caustic potash and a seed encrustation with compost powder were chosen for testing and were compared to a sodium hypochlorite treatment, a hot water treatment, an aerated steam treatment and to the untreated seeds. To test the efficacy of these methods naturally infected seed lots were used. The detection of *P. valerianellae* was done with the grow-out test; the detection of *A. valerianellae* was performed with a combination of a grow-out test and polymerase chain reaction. Additionally, the germination capacity of the treated seed has been tested. The caustic potash treatment had a very good effect (equal to the reference methods) against *A. valerianellae.* The effect against *P. valerianellae* was good, but a bit lower than the reference methods. More experiments are necessary to determine whether the effect of a caustic potash treatment against *P. valerianellae* is sufficient for economic production. For the ethanol treatment no effect against *A. valerianellae* was detected and against *P. valerianellae* only a partial efficacy was observed. The encrustation technique of the compost treatment is not yet mature and caused a great reduction of germination capacity. In the tested form this treatment cannot be recommended for practical use. The sodium hypochlorite treatment had a very good effect against *P. valerianellae* and *A. valerianellae* and a high germination capacity of the seeds was conserved. However, sodium hypochlorite is not permitted in organic farming because of poor degradability and potential toxicity. The hot water treatment and disinfection with aerated steam have proven in this study to be very effective against both diseases. With these results, pervious results of performance tests are confirmed and reinforced the relevance of these methods for seed treatments for organic farming.

PS 2-4
EFFECT OF PROPOLIS EXTRACT ON ZUCCHINI YELLOW MOSAIC VIRUS INHIBITION IN OILSEED PUMPKIN

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Propolis, the mixture of the nectar of flowers collected by honeybees, showed antiviral activity against human and plant viruses. Since Zucchini yellow mosaic virus (ZYMV, Potyvirus, Potyviridae) is the most important pathogen of oilseed pumpkin (*Cucurbita pepo* var. Styriaca) production worldwide, the aim of this study was to evaluate the effect of propolis extract on ZYMV infection in oilseed pumpkin. Propolis extracted by 95% ethanol was diluted in distilled water to concentration of 1, 2.5, 5 and 10%. Effects of different propolis concentration were evaluated in in vitro and in vivo experiments. In vitro, ZYMV inoculum was mixed with different propolis concentrations and oilseed pumpkin plants were inoculated immediately, 1 and 2 hours after mixing. In vivo, oilseed pumpkin plants were sprayed with different propolis concentrations before and after ZYMV inoculation immediately, 1 and 2 hours later. In each experiment 10 oilseed pumpkin plants in one true leaf stage were inoculated. Plants inoculated with ZYMV and sprayed with propolis were used as a positive and negative control, respectively. Symptom appearance was checked 10 days post-inoculation. Only 5 and 10% propolis concentration showed effect in reducing symptoms of ZYMV infection, in all experiments. In vitro, number of symptomatic plants was reduced to 80 and 70% after one-hour period, and to 70 and 60% after two-hour period. In vivo, propolis concentration of 5 and 10% sprayed before inoculation reduced number of symptomatic plants to 70 and 60% after one-hour period, and to 60 and 50% after two-hour period, while concentration of 5 and 10% sprayed after inoculation, reduced number of symptomatic plants to 80% each after one-hour period, and to 70 and 80% after two-hour period. In this study propolis exhibited the positive effect on reduction of ZYMV infection despite the fact that plants were challenged with high levels of the virus than it occurs naturally. Encouraging results of propolis capacity for direct virus control should be confirmed in the field under natural conditions.

PS 2-5
AGROECOLOGICAL INFRASTRUCTURES TO ENHANCE THE PRESENCE OF NATURAL ENEMIES AGAINST APHIDS

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The effect of agroecological infrastructures has been tested on *Aphis gossypii* Glover melon pathosystem. During a three-year project in Southern France, flower strips have been sown around melon crops with species known to attract natural enemies, and compared to a bare soil control. The development of the flower strips, the transfer of beneficials from the surroundings into the crop, the colonisation of natural enemies in the plot, and the reduction of aphids outbreaks were investigated. The trial, located on an organic commercial farm, showed that flower strips have to be carefully set up, in terms of irrigation, soil tillage, to ensure an optimal growth and floral diversity in the strips. Regarding arthropods population, it appeared that flower strips significantly increased the transfer of predators towards the crop (among them generalist ones as Carabidae and Forficulidae), but also specific enemies against aphids (especially Syrphidae and Coccinellidae). In the melon crop, specific enemies against aphids (especially Coccinellidae) established on larger number in the « strip » plot, with a significant effect. At the same time, aphids outbreaks were not significantly different between the control plot and the « strip » plot.

PS 2-6
PREDATORY EFFICACY OF *DICYPHUS ERRANS* ON DIFFERENT PREY

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The Palaearctic predator *Dicyphus errans* (Hemiptera: Miridae) lives omnivorously on various host plants, preying on a wide range of small arthropods, including some new invasive alien species. These characteristics make it a promising biological control agent (BCA) in organic greenhouses. The capacity of a BCA to find, kill and consume prey plays a fundamental role in trophic interactions and population dynamics in a predator-prey system. The functional response of a predator, which describes how the individual rate of prey consumption changes in response to prey density, is a key component to assess its effectiveness in pest control and the stability of its own populations. Therefore, the functional response of *D. errans* on different prey was studied to improve our knowledge on the potential of this mirid, which is naturally widespread in European organic greenhouses. Laboratory experiments were carried out on three exotic pests: the poinsettia thrips *Echinothrips americanus* (Thysanoptera: Thripidae), the greenhouse whitefly *Trialeurodes vaporariorum* (Hemiptera: Aleyrodidae), and the tomato borer *Tuta absoluta* (Lepidoptera: Gelechiidae), to build functional response curves. Prey was offered at different densities to single females of *D. errans* for 24 h. The predation behaviour of *D. errans* on all the prey species was defined by Type II functional response curves. The female could daily prey about 62 adults of *E. americanus*, 114 pupae of *T. vaporariorum*, and 236 eggs of *T. absoluta*. The high voracity of this generalist predator on different prey confirmed its suitability as a BCA. For effective and stable pest control strategies, a prior to pest establishment of *D. errans* in organic greenhouses may prevent pest escaping in case of high infestation rates, even if the type II functional response reaches saturation at very high prey densities.

PS 2-7
EFFICACY OF TWO PREDATORY MITE SPECIES TO CONTROL WHITEFLIES INFESTING POINSETTIA PLANTS COMPARED TO THE STANDARD PARASITOID *ENCARSIA FORMOSA*

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The two predatory phytoseid mite species *Amblydromalus limonicus* and *Transeius montdorensis* were tested as alternative for the control of the two whitefly species *Trialeurodes vaporariorum* and *Bemisia tabaci*. As standards the parasitoid wasp *E. formosa* was included as well as a chemical routine treatment. Efficacy of all beneficials to control *T. vaporariorum* was comparable to the chemical regime, and all treatments provided good pest control without significant differences. Shortly after release, individuals of both predatory mite species were found on nearly each plant but numbers decreased after three to four weeks. Hence, releases had to be repeated regularly. Control of *B. tabaci* instead was only sufficient. Efficacy of *E. formosa* and *T. montdorensis* was similar followed by *A. limonicus* with 20, 26 and 56 small larvae remaining per plant, respectively. Although numbers of beneficials had been increased for control of *B. tabaci* numbers were still not high enough. However, results indicate that successful control is possible.

PS 2-8
ANTIFUNGAL LACTIC ACID BACTERIA ISOLATED FROM ROMANIAN TRADITIONAL FOOD PRODUCTS INVOLVED IN THE REDUCTION OF *PENICILLIUM EXPANSUM* SPOILAGE ON APPLE FRUITS

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Spoilage fungi create significant quantitative losses and major qualitative depreciation in all kinds of agricultural products, including legumes, fruits, cereals or meats. Mould growth can induce mycotoxins contamination with hazardous effects. Several approaches are now described for fungal growth limitation, and avoid the mycotoxins accumulation. An important strategy for the prevention and decontamination of food and feed products is the use of biological control microorganisms, generally regarded as safe. Lactic acid bacteria (LAB) are promising bioprotectants, shown to have various mechanisms able to inhibit microbial contaminants of foods and feeds. The aim of our study was to evaluate six LAB strains for antifungal action against blue mould spoilage fungi on apple fruits. This *Lactobacillus* spp. strains (LAB 13, LAB 15, LAB 35, LAB 43, LAB 58, LCM5) were isolated from plant materials or some Romanian traditional foods and previously selected based on their antifungal activity against several mycotoxigenic fungi, capacity to produce organic acids and biosurfactants with antimicrobial action. The studies were performed on Jonathan apple fruits, subjected to artificial infection with *Penicillium expansum*. The preventive treatments were applied with supernatant from LAB cultures. Two kinds of tests were performed, on healthy fruits, with intact skin and artificial skin-wounded apples. Two reference strains of LAB, *Lactobacillus plantarum* ATCC8014 (Lpl) and *Lactobacillus paracasei* IC13239 (Lpa), were also used in these tests. Results showed a delayed development of the fungal contamination, with a reduced lesion size, during the 14 days of incubation, on apple fruits treated with Lpl, LAB 43 and Lpa strains, compared with the untreated control. However, the infection rates were considerably lower in wounded apples, compared to the unwounded fruits. The other strains did not exceed 10% blue mould inhibition after 14 days of incubation, except for LAB 58 and LCM5 strain which showed ~20% inhibitory effect.

PS 2-9
AEROMONAS MEDIA IN COMPOST AMENDMENTS CONTRIBUTES TO SUPPRESSION OF *PYTHIUM ULTIMUM* IN CRESS

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Soil-borne diseases such as damping-off caused by *Pythium* sp. are responsible for high yield losses in organic vegetable production and are difficult to control. Compost amendments have been shown to be able to improve survival and growth of plants in soils infested with soil-borne diseases. Yet, not all composts are equally disease suppressive and little is known about the microbial species directly involved in disease suppression. The objective of this study was to compare the microbial community in the rhizoplane of cress grown in substrates amended with composts suppressing *Pythium ultimum* damping-off at different levels. Cress was grown in a standard peat substrate amended either with coco fibre (conducive control) or with composts differing in their disease suppressive abilities. Bacteria were isolated from the rhizoplane and the most abundant species determined by Maldi-Tof MS. In a second experiment the most abundant bacterial species isolated of protected plants was added to all treatments to evaluate its role in disease suppression. The bacterial composition was essentially different with *Aeromonas media* being the main species present in the highly suppressive compost whereas Enterobacter cloacae was the dominating species in the less suppressive one. Addition of *Aeromonas media* improved suppressiveness against *P. ultimum* of less suppressive compost to the level of the highly suppressive compost. We can therefore conclude that presence of *Aeromonas media* in composts contributes indeed to disease suppression at least in this particular test system.

PS 2-10
PHYSICAL PROTECTION IS THE FIRST LINE OF DEFENSE AGAINST ARTHROPOD-TRANSMITTED VIRUS IN GREENHOUSE VEGETABLES

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The province of Almería, located in southeastern Spain, has nearly 30,000 ha of horticulture crops produced in greenhouses. Viral diseases are considered one of the biggest problems of this horticulture and of particular concern are so-called emerging viruses transmitted by whiteflies. About 1,300ha of the greenhouses are devoted to organic farming, whose standards recommend the use of methods of plant protection that include biological control, physical control and plant health treatments restricted to certain active ingredients that are not synthetic. To date, nine whitefly-transmitted viruses have been reported in Almería. Following the entry in 2000 of Cucumber vein yellowing ipomovirus, producers increased whitefly control significantly, and even the government of Andalusia issued mandatory and recommended physical-structural, hygienic and agronomic plant health measures. Since then, both biological control and the physical measures are implanted in the greenhouses of Almería, and significantly minimized the damage caused by viruses transmitted by whiteflies. With regard to physical protection, 99% of the greenhouses are using insect-excluding screens with different mesh sizes, most of them being 16x10 and 20x10 threads.cm^{-2}. In addition to the protection provided by the structure of the greenhouse and sealing, other physical protection methods are used such as double doors, plastics with anti-UV additives and independent internal mesh structures, among others. In 2013, Tomato leaf curl New Delhi begomovirus first appeared in zucchini crops from Almeria, and urged farmers to make use of thermal cloth thus intensifying protection against whitefly. These thermal blankets consist of a modern continuous composite of polypropylene fibers, applied directly onto the crop or suspended over a small and simple structure of arc. This research was financed by E_RTA2013-00020-C04-01 from INIA and co-financed by the European Union through the ERDF 2014-2020 "Programa Operativo de Crecimiento Inteligente".

PS 2-11
SHORT FOOD SUPPLY CHAINS (SFSCS) IN HORTICULTURE PRODUCTS FROM SPAIN

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The global food system and the mainstream food supply chains are nowadays considered more and more unsustainable. In addition, consumer's demand and new habits are increasingly changing the original scenario of food production, distribution and consumption so that new food systems are currently required to replace the old schemes. Thus in recent years, sustainable farming methods and the creation of local and shorter food supply chains are getting increasingly important. In this framework, as traditional or alternative niches of food production, distribution and consumption, Short Food Supply Chains (SFSCs) play a key role in this emerging scenario, as opposite to the conventional markets. Reconnecting farmers and consumers, SFSCs can be considered as a sustainable alternative to global markets in terms of economical, social and environmental benefits. Furthermore, these innovative short circuits have increasingly gained foothold across Europe, in order to meet rising consumer's demand, reducing information asymmetry and creating new solid loyalty and trust relationships can be built. Following this new trend, both the new Common Agricultural Policy (CAP 2014- 2020) and research institutions are supporting SFSCs as a priority for rural and market development. In this context, exploring the situation of SFSC in the case of horticultural market becomes of primary importance. Thus, through the "Transforma" Project of IFAPA "Sustainable development in protected horticultural crops" we are conducting studies for the characterization and potentialization of short marketing channels in the provinces of Almeria and Granada, located in Andalusia (South of Spain) dealing especially with those that sell organic horticultural products. The information analyzed comes from a survey conducted in 2015 involving about 50 establishments. In this paper, results are presented on the commercial structure of the horticultural products in the channel, origin and source of the supply, type and range of products, forms of sale, and percentages of the organic products, among others

PS 3-1

PHYSIOLOGICAL AND CHEMICAL EFFECTS OF DIFFERENT WATER REGIMES ON CAPE GOOSEBERRY (*PHYSALIS PERUVIANA* L.) GROWN ORGANICALLY IN GREENHOUSES IN TURKEY

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The Cape gooseberry, *Physalis peruviana* L., although native to the Americas, is well distributed around the world as either a medicinal crop, a food crop or both. Interest in production of the crop has recently increased in Turkey. This project was undertaken to determine if Cape gooseberry could be produced under organic greenhouse conditions with several levels of reduced water supply in Turkey. The experiment used a randomized block design with 4 replications and 5 different water supply treatments. Leaf water potential, membrane damage to cells in the leaves, leaf temperature, total phenolic content of the leaves and totel chlorophyll content were measured. Plants grown under the lower water supply regimes had increased damage to cellular leaf membranes and also had higher leaf temperatures under the greenhouse conditions. Chlorophyll content in the leaves, measured with a SPAD meter, was highest under the highest water regime and decreased as available water decreased. Total phenolic content was also highest for the highest water regime and decreased with each decrease in available water. According to this research project, it does not appear the Cape gooseberry will perform very well under organic greenhouse conditions when the water supply is substantially restricted.

PS 3-2
IRRIGATION OF ORGANIC GREENHOUSE CUCUMBER WITH A LOW COST WIRELESS SOIL MOISTURE SENSOR

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This study was conducted to study a new soil moisture sensor for organic greenhouse cucumber production during the fall and spring seasons of 2013 and 2014. Irrigation scheduling based on a low cost, short-range, wireless soil moisture sensor was compared to irrigation based on Class-A pan evaporation. Total yield was higher in sensor controlled irrigation treatment in both growing periods. Total amounts of applied irrigation water were 129 and 298 mm in sensor controlled treatment in fall and spring growing seasons, respectively, whereas they were 141 and 353 mm in Class-A pan evaporation treatment. The water use efficiency based on yield and irrigation water applied was higher in sensor controlled treatment (53 kg/m^3), whereas it was 37 kg/m^3 in the irrigation treatment based on Class-A pan evaporation. It was concluded that water saving up to 17% could be provided with sensor controlled irrigation in both growing seasons.

PS 3-3
POTENTIAL OF DIFFERENT ENERGY SAVING STRATEGIES IN HEATED GREENHOUSE

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In heated greenhouses, large amounts of energy are used to optimize climate conditions (temperature, humidity). In conventional tomatoes production, the estimated annual energy consumption is 320 kWh.m^{-2} in France, with large differences across regions, 400 kWh.m^{-2} in Brittany and 240 kWh.m^{-2} in the South (ADEME, 2007). In Switzerland, it varies between 245 and 500 kWh.m^{-2} according to the regions. With increasing energy prices and environmental concerns, growers have to find solutions to reduce their energy use and to improve the energy efficiency. Several axes could be used to achieve this goals, one of them is climate management. Within the working group "Energy saving and neutral production" of the Cost Action FA 1105 "Biogreenhouse", a review on the potential for energy saving in heated greenhouse thanks to climate management was done. Basically, there are two ways to reduce energy consumption one is related to temperature control, and the other one to humidity control. The energy saving potential of lowered day and night temperature set points, temperature integration (TI) and screen management will be presented in relation to the effects on production. In Switzerland, three trials from 2006 to 2008 in tomato crops showed that an energy saving potential of 15 to 30% could be achieved with TI compared to the standard temperature treatment. An energy saving between 23 and 30% with a management of the screens based on external temperature and light intensity compared to a management according to the sunrise was obtained. To reduce energy consumption related to humidity control, dehumidification with heat recovery was studied. A traditional dehumidification by opening and heating was compared with dehumidification with a heat pump in tomatoes crop. In 2013, 15% energy saving was achieved with the dehumidifier. In 2014, it reached 25%. No difference in plant growth, yield and fruit quality was measured between the two types of dehumidification.

PS 3-4
CONTRIBUTION OF NOCTURNAL VENTILATION FOR THE SUSTAINABILITY OF GREENHOUSE PRODUCTION

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Environmental control techniques such as adequate ventilation and air temperature management may control the psychrometric characteristics of the greenhouse air and reduce high relative humidity levels, reducing leaf wetness duration and contribute to the minimization of the occurrence of diseases caused by fungus. Nocturnal (or permanent) ventilation offers a great potential for the control of humidity dependent diseases in greenhouse vegetables in the Mediterranean regions. Furthermore, this does not imply great changes in cropping practices, which could facilitate their adoption by growers, as well as their integration with other control methods. Studies by Meneses and Monteiro (1990), Meneses et al. (1994), Baptista et al. (2001), Baptista (2007) and Piscia (2012) have shown that permanent natural ventilation is an effective way to reduce high relative humidity inside greenhouses and that is the only option in unheated greenhouses. During spring/autumn periods growers tend to close greenhouses late in the afternoon with the objective of reducing heat losses. However, air humidity can increase too much losing this advantage and promoting favourable conditions for condensation and diseases development, such as grey mould caused by *Botrytis cinerea*. This ventilation management permits a better control of *Botrytis cinerea*, allowing reducing fungicides applications, and thus reducing production costs and energy use. Baptista et al. (2012) found a reduction in disease severity of about 50 %, with evident economic and environmental advantages, contributing for the production sustainability. Sustainable greenhouse production is nowadays a goal and can be achieved by using appropriate technologies such as innovating crop practices and environmental control techniques allowing reducing/avoiding agro-chemicals use and water and energy consumption. In this work the potential of night time natural ventilation in organic greenhouses is analysed taking in consideration the contribution for reducing total energy consumption, GHH emissions and production costs.

PS 3-5
INNOVATIVE APPLICATIONS IN HORTICULTURE. ELECTROMAGNETIC FIELDS TREATMENT OF AGRI-FOOD MATERIAL

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Electromagnetic fields can be used in soil disinfestation as an alternative, non polluting method instead of conventional methods based on fumigation. This technology ensures effective soil disinfestation without polluting the groundwater. On the other hand, low power MW fields can also be used in facilitate germination and growth rate of seeds ensuring more abundant crops in poor areas.Using advanced heating technologies based on microwave and radiofrequency electromagnetic fields can play a great role in improving sustainability of food processing. The potential for microwave heating to be applied to a process is dependent on the dielectric properties of the target material. Microwave treatments of agricultural soil samples were performed for evaluation of their effects on soil quality, seed germinability and sterilization efficiency as well as soil and seed disinfection and evaluate if MW treatments may be useful for agricultural practices. Moreover, some experiments were realized for evaluating the dosimetric parameters and the response of the soil (baula) in situ, giving also an estimation about economic benefits connected with MW treatments for soil disinfection with no mechanically complex apparatus, and without chemical compounds. Exposure of seeds of Eruca Sativa to Extremely Low Frequency Magnetic Fields are in progress. Some results from Lab exposures will be showed and discussed highlighting the peculiarity of the procedures. The MW exposition clearly influences germination of the assayed seeds, consequently this methodology might be particularly effective in weed and pest control of agricultural soils.

PS 3-6
EFFECT OF A NANOCOMPOSITE COVERING FILM ON GREENHOUSE HEATING AND COOLING NEEDS

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Heating losses due to both, conduction/convection through- and radiation from the covers of greenhouse represent the main cause of the unacceptably high energy consumption in today's greenhouses. In addition, greenhouse cooling during summer represents also a significant process in greenhouse climate control. Aim of this work was to study the effects of a new a polymer nanocomposite polyethylene (nPE) film with high reflectance and absorption in near infrared radiation and low transmittance in infrared radiation IR, on greenhouse microclimate and cooling load and the results observed were compared with those obtained in a glass covered greenhouse. The work focuses on the evaluation of the insulating and nanomechanical properties of the nPE cover which has been developed through the use of uniform dispersions of highly porous granulated nanoparticles. For this purpose, the greenhouse and outside microclimate parameters along with crop temperature were recorded. Measurements of cover materials optical properties in the lab allowed a first characterization of the nPE. In additions, the measurements carried out from February to July allowed the characterization of the nPE in the field. Especially, the energy requirements (daily and nightly) of a greenhouse covered by the nanocomposite film were evaluated and the results revealed that it offers improved thermal and optic qualities.

PS 3-7
REVIEW ON THE POSSIBLE DIRECT/INDIRECT SOURCES OF ENERGY FOR ORGANIC GREENHOUSE IN POLAND, EAST AND SOUTH-EAST EUROPE

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There is much climatic and economic diversity among the countries of Central, Eastern and South-Eastern Europe. This makes it difficult to assess globally the possibility of environment friendly and cost-effective use of energy systems needed for organic crops under cover. Within the Cost Action FA 1105 "Biogreenhouse" and Working Group "Energy saving and climate neutral production" a review was done of the options for direct and indirect energy use for organic crops under cover. Consideration was given to the sources and methods of renewable energy and the existence of natural energy resources, and to the advantages and disadvantages of technical systems and economic efficiency in Poland and some other Eastern and South--Eastern EU country. We analyzed both the source processing systems as well as energy storage for electricity and heating of greenhouses: solar energy (solar collectors / photovoltaic cells, vacuum-liquid collectors, air collectors, liquid collectors, solar ponds), aero, hydro and geothermal energy as well as energy from biomass (wood briquettes or pellets, sawdust, straw), biogas (from agricultural and sewage plants, landfill gas), waste heat. We tried to collect maximum information on storage and accumulate energy systems (stone, water or transition phase accumulator). However, such systems are profitable mainly for large farms, groups of vegetable producers or buyers of energy. For the needs of small farms with seasonal production, (dominant in the region) passive heating systems may be more feasible. It can be done on their own as soaked straw bales, manure backing heating, and manure beds. Such systems are also a natural source of CO_2. In 2020, a target for share of energy from renewable sources replace fossil fuel is on 20% of renewable energy in the economy. Present share in the region ranges from ca. 14% -16% (Poland, Czech Republic, Slovakia, Bulgaria) to 23% -25% (Estonia, Lithuania, Romania, Slovenia) and up to 40% in Latvia. However, the volume of energy consumption for the protected organic horticulture will depend on economic conditions affecting the amount of production and the demand for plant products

PS 3-8
STRONG POINTS AND RISKS FACTORS IN GREENHOUSE ORGANIC CULTIVATION OF SOME VEGETABLE SPECIES

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From 2008, in greenhouse belongs to Research Institute of Vegetable (nowadays Research Institute of Horticulture) are conducted experiments to identify opportunities of organic cultivation of various vegetable species, varieties and cultivars. Crops are conducted in soil fertilized with fertilizers permitted to organic farming in Poland. Under these principles, the plants are nourished and protected. The volume and quality of the yield as well as the vigor and plant health condition was evaluated. Also were identified most common pathogens. The main problem was to keep the vegetative/generative balance of fruiting vegetables and good phytosanitary status of plants. The cultivation of tomato and cucumber problem was maintaining vegetative vigor after 4 months of cultivation and long-term, high-yield-forming ability. But the fruits had very good quality and were tastier than conventional ones. Pests are mastered through biological protection, which could not be obtained in the case of running green bean. Green bean had a high yield potential, but cultivation destroyed the aphids. A similar problem has occurred with bell pepper. The best results are obtained in butterhead and crispy lettuce as well as radish. Yields were high, with good quality and were not attacked by pathogens. At the same time, in conventional crops fertilized and protected weakly or none are conduct observations of other species of plants for the occurrence of pathogens, yield, quality and taste. The aim is to find an alternative to common species and extension of assortment of vegetables for organic farming. For example, the cowpea (*Vigna unguiculata*) was less attractive for aphids than green been. Achocha (*Cyclanthera pedata*), whose fruits have a taste like cucumber, yielded abundant and was not attacked by powdery and downy mildew, mites, trips and aphids despite that grew close to infected aubergine. Of course, most attention is paid to the cultivation of vegetables with greatest commercial importance. However, in case of insurmountable difficulties of cultivation have to look for alternative species to increase the popularity of organic farming.

PS 3-9

EVALUATION OF YIELD, NITROGEN USE EFFICIENCY, NITRATE, FREE AMINO ACID AND SOLUBLE PROTEIN CONCENTRATIONS IN 16 PAKCHOI CULTIVARS UNDER ORGANIC AND CONVENTIONAL MANAGEMENT SYSTEMS

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The effects of different organic fertilizers on cherry tomato (*Lycopersicum esculentum* cv. "Sweet Million" yield components and fruit quality were evaluated in greenhouse conditions. Pots (10 L) were filled with a mixture of field soil and 4% (v:v) of vermicomposts from cow manure, sheep manure, yard leaves and municipal solid waste. Humic acid treatments (0 and 860 mg/L) were applied every 14 days, starting from two weeks after transplanting until the end of experiment. Fruits were harvested at the "red" stage. The earliest fruit formation and highest fruit set percentage were observed in the sheep manure vermicompost plus humic acid treatment. The greatest fruit number and total yield (from the five first trusses) were obtained from sheep manure vermicompost treatment with no humic acid. The total soluble solids were found the greatest in all treatments received humic acid. The greatest values for fruit vitamin C content was obtained in municipal solid waste vermicompost treatment, either with or without humic acid, while the highest total phenolics was found in municipal solid waste vermicompost treatment plus humic acid. The maximum antioxidant activity was observed in sheep manure and yard leaves vermicompost treatments with no humic acid. The potential exists to improve tomato fruit quality through a combination of different organic fertilizers.

PS 3-10

EVALUATION OF THE EFFECTS OF GREEN AND MIXED WASTE COMPOST WITH DIFFERENT N FERTILIZERS ON THE GROWTH OF ORGANIC TOMATO SEEDLINGS

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The effects of different organic fertilizers on cherry tomato (*Lycopersicum esculentum* cv. "Sweet Million" yield components and fruit quality were evaluated in greenhouse conditions. Pots (10 L) were filled with a mixture of field soil and 4% (v:v) of vermicomposts from cow manure, sheep manure, yard leaves and municipal solid waste. Humic acid treatments (0 and 860 mg/L) were applied every 14 days, starting from two weeks after transplanting until the end of experiment. Fruits were harvested at the "red" stage. The earliest fruit formation and highest fruit set percentage were observed in the sheep manure vermicompost plus humic acid treatment. The greatest fruit number and total yield (from the five first trusses) were obtained from sheep manure vermicompost treatment with no humic acid. The total soluble solids were found the greatest in all treatments received humic acid. The greatest values for fruit vitamin C content was obtained in municipal solid waste vermicompost treatment, either with or without humic acid, while the highest total phenolics was found in municipal solid waste vermicompost treatment plus humic acid. The maximum antioxidant activity was observed in sheep manure and yard leaves vermicompost treatments with no humic acid. The potential exists to improve tomato fruit quality through a combination of different organic fertilizers.

PS 3-11
SHOULD WE USE SOILLESS MEDIA IN ORGANIC GREENHOUSES?

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EC regulation 834/2007 suggests that growing in soil is the only acceptable method in Organic agriculture (OA) both in open field and in greenhouses. Therefore, the use of growing media in OA is forbidden in EU countries and in Israel. This is not the case, however, in China, the US, Canada, Australia, New Zealand, the Gulf States and few other countries. Few exception exist even within Europe: Several Scandinavian countries allow greenhouse growers to grow crops in natural substrates, assuming that containerized natural substrates are not inherently different from soil. Another acceptable exception, common to all EU countries, is the production of transplants and plants that are grown and sold in pots to the consumer. I intend to question this restriction and to show how, by changing it, Organic greenhouses will benefit, without damaging the environment and the logic of OA. There are several main reasons why this regulation should be reconsidered: 1. In many parts of the world, fertile soils are rare or do not exist. Overcoming this infertility requires high fertilization levels, leading to percolation and pollution of underground water. Leachates of container-grown plants, on the other hand, can be collected, treated and reused, thus leading to much high water- and nutrient-use efficiencies. 2. The possibility of greenhouse growers to maintain a proper rotation is very limited. This may lead to a rapid infestation of the soil with soil-borne pests and diseases. The few eradication tools available for Organic growers are inefficient. By growing the crops in a containerized medium such infestation may be prevented, and, if occurs, the medium can be replaced. 3. By including mature composts, growing media can be fully suppressive to soil-borne diseases. 4. Unlike soil, growing in soilless media is weed-free.

PS 4-1
GRAFTED ORGANIC SEEDLING PRODUCTION OF TOMATO AND WATERMELON

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Grafting is used as a common tool to increase tolerance of vegetables against biotic and abiotic stresses. However, grafted organic seedling production is not present in Turkey. This study was conducted to determine the crop performance of organically grown grafted tomato and watermelon seedlings. Rootstock and scion seeds of both species were sown in vermicompost:local peat (1:1.5 v/v) mixture. After germination in growth chamber (24/24°C, 80% relative humidity (RH) for 3 days), plants were moved to a greenhouse. When seedlings had 3-4 fully opened leaves, tomato (*Lycopersicon esculentum*) scion cv. 'Melis' were grafted with tube grafting method on two interspesific (*L. esculentum* × *L. hirsutum*) rootstocks, Beaufort and Sarafin; watermelon (*Citrullus lanatus*) scion cv. 'Asbal' was grafted with slide cut grafting method on three rootstocks, Argenterio (*Lageneria siceraria*), Jumbo (*Cucurbita maxima*) and Flexifort (*C. maxima X C. moschata*). Self-grafted seedlings were used as control. Grafted seedlings were left in a healing unit at 24-26°C, 80-90% RH, 16 h LED lighting/8 h dark for 10 days. Seedlings were placed again into greenhouse after healing for adaptation and watermelon and tomato grafted seedlings stayed there 14 and 21 day, respectively. Ten seedlings from each replicates were harvested from for seedling performance (root, rootstock and scion length, root and shoot diameter, shoot and root fresh and dry weigh). It was concluded that among the tested rootstocks, Beaufort for tomato and Flexifort for watermelon were found more appropriate as rootstock compared to the others due to the higher performance in root and stem length and diameter of rootstocks and scions and shoot and root fresh and dry weights.

PS 4-2

EFFECTS OF SOME REPELLENT PLANTS ON GREENHOUSE WHITEFLY (*TRIALEURODES VAPORARIORUM* (WESTWOOD, 1856) HEMIPTERA ALEYRODIDAE) IN GREENHOUSE TOMATO PRODUCTION

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Greenhouse vegetable production has an important place in Turkey. Tomato is the most important crop in terms of production amount and cultivation area. Pests have caused problems in greenhouse horticulture as in all agricultural areas. *Trialeurodes vaporariorum* (Westwood, 1856) (Hemiptera: Aleyrodidae) is one of the most important pest causing damages in production. The most common protection method is chemical one resulting in unconscious and extensive pesticide use. For this reason there is a need to study on sustainable protection tools in order to improve alternatives due to the increase of environmental awareness during the last decade. This preliminary study was conducted to determine the effects of repellent plants on whitefly population in greenhouse tomato production. Seven repellent plants namely basil (*Octimum basilicum* L.), mint (*Mentha avensis* L.), dill (*Anethum graveolens* L.), garlic (*Allium sativum* L.), onion (*Allium cepa* L.), parsley (*Petroselinum crispum* Mill.) and cilantro (*Coriandrum sativum* L.) were grown with tomato plants and control treatment without any repellent plant was included. In every plot there were 12 tomato plants with 4 replications. First the seeds of repellent plants were sown and then tomato seedlings were planted. 500 adult and pupae of T. vaporariorum were released to the greenhouse. Plants were counted twice a week after pests were implicated. The average population intensity in every leaf was found as; basil 0.90; mint 0.68; dill 1.20; garlic 0.23; onion 0.80; parsley 0.61; cilantro 0.16. It was concluded that cilantro due to the whitefly population intensity was found promising among the tested repellent plants and could be used in commercial production.

PS 4-3
CRACKING OF TOMATO FRUITS IN ORGANIC GREENHOUSE TRIAL

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The objective of the research was to study how the Estonian weather conditions influence the cracking of tomato fruits of different weight and origin. Three new for Estonian conditions tomato cultivars from the Netherlands ('Auris' F1, 'Minaret' F1 and 'Tolstoi' F1), two cherry type cultivars ('Gartenfreude' and 'Sun Baby') and five local widely cultivated cultivars ('Erk', 'Maike', 'Malle' F1, 'Valve', and 'Visa' F1) were included in the study. Four cultivars belong to the large (> 90 g), four to medium (45 g-90 g) and two to small fruits group (< 20 g). The trial was carried out in organic conditions at Estonian Crop Research Institute in 2014 and 2015. An unheated polyethylene greenhouse was used for cultivation in soil fertilized with bovine manure at the rate of 6 kg m^{-2} as the main source of fertilization. Chicken manure and seaweed solution was used three times during growing period as the additional fertilization. The number of cracked and regular fruits was counted 24 times during the vegetation period (from July to September). The weight of marketable yield and cracked fruits was determined. According to the results, it can be concluded that the percentage of cracked fruits was higher in 2014 because of higher fluctuations in daily temperatures and during the whole vegetation period. The most cracking resistant were the two small fruit cultivars and medium fruit 'Maike' showing minimal influence of the weather condition of the trial year. The varieties 'Minaret' F1, 'Maike', 'Valve', 'Visa' F1, 'Sun Baby' and 'Gartenfreude' produced quite high and stabile marketable yield in unheated organic greenhouse. The yield stability of the last five cultivars was good over the both years. From the Dutch cultivars large fruited 'Minaret' F1 had the best resistance to cracking in 2014 and medium fruited 'Tolstoi' F1 in 2015. Both mentioned cultivars can be recommended for Estonian organic growers for cultivation in unheated greenhouses.

PS 4-4
THE EFFECTS OF BIOFERTILISERS ON SOILLESS ORGANIC GROWN GREENHOUSE TOMATO

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In the present study, greenhouse tomato (cv. Jaledo) was grown with organic nutrition by the inoculation of some biofertilizers under the soilless cultivation rules. The treatments were three different biofertilizers; 1) Mychorrhiza, 2) Vermicompost, 3) Fermentation microorganisms (EM), 4) Control. The experiment was carried out in the glasshouse during the spring cultivation period under the Mediterranean climate conditions. The growing medium was the mixture of peat: perlite in the ratio of 1:1. The constant nutrition in all treatments with the certified organic fertilisers was used to feed the plants beside the biofertilizers. Some plant growth patameters such as plant hight and leaf number were similar in the treatments. The tomato yield was the highest in vermicompost. It was 8.3% higher than the control plants. Mychorriza treatment also increased the yield by 2.5%, however the fermentation microorganisms (EM) decreased the yield by 12.4%. The fermentation bacteria (EM) may be compete with the plant for available nutrients in the root medium. Mean fruit size and fruit volume was higher in vermicompost and mychorriza. Total soluble solids (brix) and titradible acidity were higher in the EM. At the end of the experiment, EC inside the growing medium was measured and the biofertilizers, especially mychorriza, decreased the EC. That could be important to prevent salinization in root medium during growing. Leaf nutrient analysis showed that the tomato plants were adequately fed under the experimental conditions, in some cases, the advantages of biofertilizers was seen, for example the leaf Na concentration was the lowest in mychorriza treatment. The results showed that as sustainable approach, the greenhouse vegetables can be produced under the rules of soilless cultivation in organic growing medium by the combination of organic nutrients and the biofertilisers like vermicompost and myhcorriza.

PS 4-5
THE OPTIMIZATION OF NITROGEN DOSAGES ON CUCUMBER PLANTS GROWN IN GREENHOUSE

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In recent years, the intensive usage of either pesticides or overdose fertilizers caused both increasing on plant production and showing up some products which would threaten the human health. The chemicals (pesticides, fertilizers, etc.) which are being used on agricultural production, have become to made their potential negative influence both human and society health evident. For that purpose, as a new mode of production "Organic Farming" was manifested. In organic fresh vegetable growing, one of the most important and still needs to be studied topic is "plant nutrition". The most important deficiency on plant nutrition is "Nitrogen nutrition". Nitrogen is the most commonly used plant nutrient element in production. Nitrogen sources that are being used in organic production are limited and their pure nitrogen contents are weak. Cucumber, is the second most growing vegetable just after tomato in greenhouses of Turkey. It is consumed both winter and summer and it is also a vegetable which is partaking on markets in every time of year. Besides, because of its long vegetation time and its tendency of making much vegetative texture, it is one of the most nitrogen using vegetable. This study was carried out in the greenhouses of Cukurova University, Karaisali Vocational College in Adana, in order to determine the optimum Nitrogen dosage to be applied in organic cucumber production under greenhouse circumstances of Spring season. For this purpose, a common organic certified fertilizer were applied as the Nitrogen source contending 10.21 % pure Nitrogen was used. The Nitrogen doses of 0, 0,5, 1,5, 2,5, 3,5 kg ha^{-1} were applied in totally six applications. During the trial, in order to investigate the effects of different Nitrogen dosages on plant growth parameters were measured. Also, nutrient element contents of leaves were analyzed, fruit physical characteristics and the yield values were measured. Consequently, it was determined that top two Nitroges dosages (2,5 and 3,5 kg ha^{-1}) increased the plant growth. In terms of the yield, it is concluded that the dose of 1,5 kg ha^{-1} would be enough for increasing this parameter.

PS 4-6
OPTIMISING FRUIT LOAD OF ORGANIC GREENHOUSE TOMATO GROWN UNDER A SEMI-CLOSED GREENHOUSE

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During the last decade, semi-closed or closed greenhouses have been developed to save energy, optimize resource use such as water, and increase crop productivity and quality of greenhouse vegetable crops. For example, it has been previously reported for a conventional greenhouse tomato that higher mean temperature, CO_2 concentration and relative humidity increased rates of leaf photosynthesis, crop growth, yield, and fruit quality in terms of fruit soluble solids, acids, lycopene, β-carotene, phenolics and ascorbic acid. In addition, greenhouse climate variability inside a semi-closed greenhouse may affect fruit maturity, fruit firmness, and shelf-life. In order to improve the sustainability of organic greenhouse tomato grown under Northern arid conditions, a semi-closed greenhouse using a fan coil geothermal system has been developed. Our previous results showed that this semi-closed greenhouse allowed maintaining high CO_2 concentration under high solar radiation. Moreover, this system showed a good performance for dehumidifying the greenhouse during the cold winter period without using any conventional ventilation. In order to optimize the productivity, we hypothesized that higher plant population or fruit load can be achieved under this semi-closed greenhouse because of the higher CO_2 concentration and better humidity and temperature management. To test this hypothesis, trials have been conducted in 2015 at the commercial level (Les Serres Jardin-Nature, New Richmond, QC, Canada). Two experimental semi-closed greenhouses of 225 m^2 each were used to compare three plant population treatments (3.0, 3.3 and 3.6 plants/m^2 with 42, 46 and 51 plants per experimental unit, respectively) and three fruit load treatments (70, 85 and 100 fruits per m^2 with 67 plants per experimental unit). The experimental design was a Latin square with three replicates. Climate parameters (CO_2, VPD, temperature, solar radiation), plant growth, yield and fruit quality (soluble sugars, titratable acids, color, firmness, ascorbic acid, carotenoids, phenols) were measured. Fertilization and irrigation management followed the commercial schedule. During the growing season, the mean CO_2 concentration was maintained at 708 mg L^{-1} in the semi-closed greenhouses as compared to 416 mg L^{-1} for the naturally ventilated greenhouses, which resulted in higher yield in the semi-closed greenhouses. However, increasing the plant population and fruit load per cultivated area did not result in higher fruit productivity; yields were 54.0, 50.7 and 50.6 kg m^{-2} for 3.0, 3.3 and 3.6 plant m^{-2} density, respectively, and were 53.0, 51.3 and 49.4 kg m^{-2} for the 85, 70, and 100 fruit m^{-2} load treatments.Fruit quality results are currently being analysed. In conclusion, this semi-closed greenhouse offers a great potential of increasing the sustainability and profitability of organic greenhouse tomato grown under cold climate. Complementary study is undertaken to improve climate management and optimize fruit load.

PS 4-7
ORGANIC HORTICULTURE IN PAKISTAN: STATUS & CHALLENGES

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Organic Horticulture is an environmental friendly management in which synthetic inputs (in all forms) are eliminated. Less than 1% of world crop area is under organic farming. Pakistan has an agriculture based economy and about 65% population comes under rural areas. Before 1960's Pakistani horticulture and other agricultural products were mixed organic / pure organic, out after green revolution introduction of synthetic inputs to enhance the per acre yield, slowly and gradually declined in the trend of organic farming. But in 2008 National Institute of organic agriculture was formed. According to its 2015 Survey, 25% farmers are using mixed organic / pure organic. But 35000 acre area is under organic farming. To promote organic farming, awareness at educational institutions and farmer community level through government initiative is required. New policies based on "good agriculture practices" are required because of big set-back from the EU regarding Pakistani horticultural products like Kinnow, Mango etc.

PS 4-8
USE OF TUNNELS FOR EXTENDING TOMATO GROWING PERIOD IN MEDITERRANEAN INLAND AREAS

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Organic production of open field in inland Mediterranean areas is limited by the weather conditions to a single cycle between May and October; with the beginning of the harvest in late July. The use of simple greenhouse tunnels without heating should increase the period of cultivation as well as yield and quality of production.
This paper assesses the feasibility of obtaining, two tomato growing cycles , with the help of a simple plastic film cover tunnel using only cow compost as a fertilizer. The trial was done in Vilanova de L'Aguda (Lleida, Spain) with Caramba variety of tomato.Plant density was 2.4 plants/m^2. Results show that it is possible to advance the date of planting tol late February starting harvest at the beginning of June till the end of July. This allows planting a second cycle summer-autumn harvest beginning in late October to end of November. However global productions (3.9 kg m^{-2} in the first cycle and 3.3 in the second one) indicate that greenhouse climate management should be improved to gain higher yields that open field tomatoes. The extension of the first growing season with pruning of tomato plants or better handling of ventilation of the greenhouse tunnel, including bigger window surface, are the best alternatives in order to achieve a cost-effective and superior production that justifies the use of this type of structures.

PS 4-9

ARBUSCULAR MYCORRHIZAL FUNGI CAN BE AN ALTERNATIVE TO THE APPLICATION OF CHEMICAL FERTILIZER IN THE PRODUCTION OF CORIANDER

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The widespread use of agrochemicals is detrimental to the environment and may exert harmful effects on human health. The consumer demand for organic food plants has been increasing. There is, thus, a rising need for alternatives to agrochemicals that can foster sustainable plant production. The aim of this study was to evaluate the potential use of an arbuscular mycorrhizal (AM) fungus as an alternative to application of chemical fertilizer for improving growth performance of the medicinal and aromatic plant *Coriandrum sativum*. Plants were inoculated with the AM fungus *Rhizophagus irregularis* BEG163 and/or supplemented with a commercial chemical fertilizer in agricultural soil. Plant growth, nutrition and development of AM fungus were assessed. Plants inoculated with *R. irregularis* and those supplemented with chemical fertilizer displayed significantly improved growth performances when compared with controls. There were no significant differences in total fresh weight between plants inoculated with *R. irregularis* or those supplemented with chemical fertilizer. Leaf chlorophyll a+b, shoot nitrogen, phosphorus and potassium concentrations increased in plants inoculated with R. irregularis by 82, 44, 254 and 27%, respectively, compared to controls. Inoculation with *R. irregularis* was equally or more efficient than application of chemical fertilizer in promoting growth and nutrition of *C. sativum.* AM fungi may thus contribute to improve biologically based production of food plants and reduce the dependence on agrochemicals in horticulture.

PS 4-10

SEED COATING WITH ARBUSCULAR MYCORRHIZAL FUNGI AS AN ECOTECHNOLOGICAL APPROACH FOR SUSTAINABLE PRODUCTION OF COMMON WHEAT

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The exploitation of arbuscular mycorrhizal (AM) fungi has become of great interest in agriculture due to their potential roles in reducing the need for agrochemicals, while improving plant growth and nutrition. Nevertheless, the application of AM fungi by dispersing inocula in granular form to open agricultural fields is not feasible because non-targeted spreading of inocula over large surface areas results in high cost per plant. Seed coating has the potential to significantly reduce the amount of inoculum needed, resulting in cost reduction and increased efficiency. The aim of this study was to assess whether seed coating with AM fungal inoculum is a feasible delivery system for production of common wheat (*Triticum aestivum* L.). Wheat seeds were coated with inoculum of *Rhizophagus irregularis* BEG140 and grown under different fertilization conditions: 1) none 2) partial or 3) complete. Data indicated that mycorrhizal inoculation via seed coating significantly increased the dry weight of shoot and seed spikes of wheat associated with reduced fertilization. Assessment of nutritional status of wheat showed that plants inoculated with *R. irregularis* via seed coating displayed enhanced stem concentrations of potassium, sulfur and zinc. There were no significant differences in root colonization between plants conventionally inoculated with *R. irregularis* in soil from those inoculated via seed coating. Seed coating with AM fungi may be as effective as conventional soil inoculation and may contribute to reduce the utilization of chemical fertilizers. The application of AM via seed coating is proposed as an ecotechnological approach for sustainable agricultural wheat production.

NOTES

PS 4-11
DISEASE MANAGEMENT IN ORGANIC GREENHOUSE HORTICULTURE: SOLUTIONS, NEW INSIGHTS AND BOTTLENECKS

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Plant diseases pose a major threat to horticultural crops grown in greenhouses. High relative humidity (RH) and the presence of a film of water on susceptible plant organs for long periods of time provide favorable conditions for the germination of conidia and infection by many pathogens: bacteria, fungi and fungus-like microorganisms. Conditions of excess nitrogen and unbalanced availability of N may be found in organic cropping systems. The unbalanced growth of plants may not only promote susceptibility, but also restrict air movement in the greenhouse, promoting epidemics. There are a limited number of control agents available for use in organic cropping systems and, in some cases, their efficacy is limited. The roles of calcium and potassium in restricting disease have been described. Cultural methods that restrict RH and condensation on susceptible plant organs have been shown to suppress disease. Plant spacing, passive heating of unheated greenhouses, polyethylene soil mulch, soil solarization and the addition of *Trichoderma*, biochar or compost to the soil can reduce plants' susceptibility to disease or induce resistance, as described. Integrated management that is based on sanitation, cultural means, sprayed control agents and weather forecasts is suggested as a potential effective system for keeping plants healthy in organic greenhouse cropping systems.

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