EHC
12-16 May 2024
Bucharest, Romania

EUROPEAN HORTICULTURE CONGRESS

S02: SUSTAINABLE VEGETABLE PRODUCTION FROM SEED TO HEALTH BOOSTER SOURCES

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BUCHAREST, 2024

S02: SUSTAINABLE VEGETABLE PRODUCTION FROM SEED TO HEALTH BOOSTER SOURCES; BUCHAREST, EHC2024, MAY 12-16

ORAL PRESENTATIONS

SESSION I - SEED, SEEDLING AND GRAFTING

PLENARY SESSION - KNS INVITED

S02-OI-1

Current and future approaches in the irrigation of outdoor vegetable crops: How do we meet the challenges?

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Irrigation of vegetable crops is caught between economic, resource-efficient, environmentally sound and political needs. This is due to intensive land use with numerous species, high yield and quality requirements, which are associated with high water demand and therefore high water use. In addition to water management, which comprises water supply and irrigation technology, irrigation scheduling (IS) offers great opportunities to meet the requirements of demand-based irrigation. The challenge of choosing and using the appropriate IS-system is based on crop, farm(er!) and regional constraints. In our key note, we will address these practical constraints and contrast them with different IS approaches. The approaches are differentiated by i. the physical basis for determining water demand, including soil sensors, water balance calculations, and plant signals; ii. recent advancements in automation and precision in water application, particularly variable rate irrigation (VRI) technologies; and iii. developments in digital technologies and modeling techniques involving artificial intelligence (AI) for predictive analytics in irrigation scheduling. At the end, we attempt a cautious evaluation and recommendation for the practical applicability of the approaches.

Keywords: Irrigation scheduling, precision irrigation, automation, digitization, artificial intelligence, water balance, decision support systems, open field crops

S02-OI-2

New advances in vegetable grafting

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New progress in vegetable grafting depends on increasing implementation of existing rootstocks, and on new advances for developing new rootstocks for usual and new species to face old and emerging specific problems threatening agricultural productivity and sustainability. While grafting in vegetable species is becoming a very common commercial practice in the main horticultural areas of developed countries, applied research is very active in developing countries. From agronomical and biological perspectives, this research mostly focuses on commercial rootstocks and usual problems like salinity, drought, soil contamination, and typical soilborne diseases However, an increasing interest exists in exploring new genetic diversity and interspecific interactions, as it occurs between tomato cultivars and diverse eggplant rootstocks, and in performing field experiments with complete growing periods under targeted environments affected by abiotic and biotic concerns. While domestication has favoured the selection of traits of interest for farmers to optimize crop productivity under well-fed conditions, ancestral traits related to resistance to salinity, drought, temperature, poor and compacted soils are still present in wild accessions. Root-mediated traits are difficult to incorporate into elite cultivars through conventional breeding but can be easily transferred to elite cultivars through grafting, but due to the strong GxE interactions, the investigation requires targeting very specific but relevant agronomical environments. For example, rootstocks with architectural ideotypes are useful for efficient uptake of resources such as water and mineral nutrients in soils with scarce water, N or P availability, but not necessarily in soilless growing systems. Exploring Solanum biodiversity has also identified rootstock germplasm with capacity to resists holoparasitic plants such as broomrapes. Rootstocks can also contribute to expand the biotic interactions and improving ecosystem services and not only in the rootzone through beneficial microorganisms (including rootstock-specific microbiomes). Recently, the foraging decisions of insect pollinators have been modified by the rootstocks, with increasing evidences that ancestral traits lost in modern varieties can improve this essential ecosystem service in horticultural crops, which, in turn can be coupled to other interesting traits of resistance to environmental stresses and fruit chemical composition, including primary and secondary metabolites and volatile organic compounds, opening new strategies for rootstock selection based on ecological decisions. While transgenic rootstocks have proven to increase resistance to pests, diseases, heavy metal and heat, the ancient tool of grafting can symbiotically associate with modern gene editing technologies to quickly produce transgene-free varieties through the use of graft-mobile gene editing systems that allow RNA transport from CRISPR-Cas9 transgenic rootstocks to wild type scions to achieve homozygous and heritable edited plants in one generation. This technology has been successfully proven not only in the model plant Arabidopsis thaliana but also in crop species as Brassica rapa, and could be applied to a wide range of crop plants and agronomic problems, with particular interest for increasing resistance to virus diseases. Basic research also aims at understanding physiological and molecular components controlling the viability of rootstock/scion interactions, which is key for increasing the interspecific or even intergeneric compatibility, thus widening the exploitation perspectives of vegetable grafting.

Keywords: ecosystem services, genetic biodiversity, graft compatibility, graft-mobile signals, root ideotypes

S02-OI-3

Treatments with seaweed-based biostimulants for seed production and seed quality in eggplant

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The seaweed-based biostimulants have a valuable chemical content, rich in macro and micro elements, essential amino acids for plant development and also bioactive substances. However, their influence for seed production on vegetable crops has been much less studied than their potential to increase fruit yield. The present scientific work aims to evaluate the influence of the use of three types of biostimulants based on seaweed on the eggplant seed yield. Two varieties of eggplant, 'Luiza' and 'Belona', were used as biological material. Three products extracted from different seaweed species were used for the treatments: Agrocean B (with *Laminaria digitata* (Huds.) Lamour. extract), E-Dalgin (with *Ascophyllum nodosum* (L.) Le Jolis. extract) and Kelpak (with *Ecklonia maxima* (Osbeck) Papenfuss extract). Four foliar treatments, at 14 days' distance, were done with these products, starting with the stage of first fruits setting. Eggplant seed production was determined. The seed quality was evaluated based on 1000 seeds weight, the final germination percentage, the vigor of seedlings at the age of 14 days, and the seed vigor index. Different varieties of eggplant may react differently to treatments, but in general, the use of foliar treatments with seaweed-based biostimulants can lead to better seed quality.

Keywords: *Ascophyllum nodosum*, *Ecklonia maxima*, *Laminaria digitata*, seed vigor index

S02-OI-4

Effects of biochar in the seedling growth of lamb's lettuce

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Biochar, used as a soil conditioner, is carbon-rich solid material that emerges by subjecting raw materials to high heat in an oxygen-limited or oxygen-free environment. Building upon the positive effects of biochar on soil fertility and plant development, this study aimed to determine the effects of adding biochar to the seedling growing medium on the quality of lamb's lettuce seedlings. Biochar (BC) was mixed with peat (P) in volumetric ratios of 0% (0%BC+100%P, control), 5% (5%BC+95%P), 10% (10%BC+90%P), and 20% (20%BC+80%P), and the prepared mixture was moistened and filled into 45-cell foam trays. One lamb's lettuce seed was manually sown in each cell. The trays were kept in a dark germination chamber at 18±2°C and 85% humidity for 3 days, and then transferred to the greenhouse. Until reaching transplant size (32 days), only watering was applied as needed to the seedlings in the greenhouse. Some agromorphological and physiological measurements were measured on seedlings with 4-6 true leaves and ready for transplanting. The data obtained showed that as the proportion of biochar added to the seedling growing medium increased, the morphology and quality of the seedlings improved. The application with 20% biochar (20%BC+80%P) provided better results compared to other biochar-added applications and yielded nearly the same results as the control with peat, which is a commercial seedling production

medium. In conclusion, the addition of biochar to the seedling growing medium improved the seedling growth and quality of lamb's lettuce seedlings, and it was suggested that different mixing ratios should be explored.

Keywords: corn lettuce, seedling, biochar, peat, biomass

S02-OI-5

Morpho-physiological changes and metabolomic profiles of cucumber seedlings following seed treatment with *Trichoderma* strains

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As plant growth-promoting fungi, many Trichoderma species and strains are recognized for their ability to foster root development, defense mechanisms against pathogens, biosynthesis of antioxidant enzymes and secondary metabolites to enhance tolerance to abiotic stresses. Trichoderma species are usually applied to the soil, but some evidence indicates the advantage of applying directly to the seeds. Film coating with spores of Trichoderma promotes the formation of the plant-microorganism mutualistic linkage from the earliest stages of development and facilitate the establishment of the microorganism in the rhizosphere. Therefore, the treatment can boost seedling quality promoting the branching ability of root system and reducing the time which the plant takes to occupy its portion of soil. The aim of the present study was to investigate the effects of different Trichoderma strains (TL41 belonging to T. longibrachiatum and TATU, TA56, TAT11, TA117 belonging to Trichoderma atroviride) on root structure and seedling growth but also on biochemical parameters that may detect the onset of stress phenomena (proline, antioxidant enzymes, phenols). Cucumberseeds (Cucumis sativus L., cv Marketmore hybrid, La Semiorto Sementi srl, Sarno, Italy), were externally treated with Trichoderma strains at the inoculation dose of 1x104 spores/seed and sown in polystyrene plug trays on a sterile substrate (sand: peat; 1:1) (25°C; 16-h photoperiod). At the end of experiment, an increase of vigor and dry biomass of seedlings was highlighted for treatments with T. atroviride strains TATU, TA56 and TA117. Moreover, TATU strain was effective in promoting root development compared to control (non-inoculated seeds) and other treatments. All seed treatments by using Trichoderma strains, with the exception of TA117 strain, determine an increase of phenols whereas TL41 favored the chlorophyll accumulation in leaves. Considering the antioxidant enzyme activities, TATU strain resulted in a significant decrease of the enzyme GPX involved in protecting cells from damage induced by free radicals, respect to other treatments. Moreover, Trichoderma treatments changed the metabolomic profile at epigean and radical level suggesting different biochemical responses in the seedlings following the colonization of their roots by beneficial microorganisms. In conclusion, the results revealed the efficacy of seed treatment with Trichoderma but also evidenced specific strain-plant interactions with significant biostimulant action.

This study was carried out within the Agritech National Research Center and received funding from the European Union Next-GenerationEU (PIANO NAZIONALE DI RIPRESA E RESILIENZA (PNRR) – MISSIONE 4 COMPONENTE 2, INVESTIMENTO

1.4 – D.D. 1032 17/06/2022, CN00000022). This manuscript reflects only the authors' views and opinions, neither the European Union nor the European Commission can be considered responsible for them.

Keywords: germination, seedling quality, oxidative stress, root development, phenols, antioxidant enzymes

S02-OI-6

Increasing the productivity of cucumbers to high nutrient solutions concentration by grafting on different rootstocks

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High concentrations of salts in the root zone of plants are a common problem in greenhouse vegetable production, leading to reduced yields and yield deterioration. The aim of the performed study was to establish whether grafting cucumber plants (Cucumis sativus L., 'Kiara F1') onto different local cucurbitaceous and hybrid rootstocks (Lagenaria siceraria (K/LS); Cucurbita moschata 'Moschata 51-17' (K/CMo-M); Cucurbita maxima x Cucurbita moschata 'Carnivor F1' (K/CMM-C) could increase productivity to high nutrient solution concentrations (NSC). The experiments were carried out in a greenhouse during 2013–2015. Grafted and non-grafted plants were cultivated at 3 nutrient solution concentrations [1,8 mS cm-1 (optimal), 3,7 mS cm-1 and 5,5 mS cm-1] till full maturity. EC levels were prepared by adding all macro and micronutrients to the irrigation water. During this period, the influence of high nutrient solution concentrations on early maturity, total and marketable yield, total number of fruits, average fruit weight, and length were studied. Salinization during the reproductive period adversely affects the productivity of non-grafted and grafted cucumber plants; the reduction is greatest at higher nutrient concentrations. In terms of early maturity, the concentration of the solution has the strongest negative effect on the graft combination Kiara/Cucurbita maxima x Cucurbita moschata 'Carnivor F1' (K/CMM-C). The least affected cultivar is 'Kiara F1'. Early maturity is highest in the graft combination Kiara/Lagenaria siceraria (K/LC). The highest values are total and standard yields as Kiara/Cucurbita maxima x Cucurbita moschata 'Carnivor F1' (K/CMM-C) in all nutrient solution concentration levels, respectively, from 17.06%, 19.69%, and 42 to 21% (EC 3,7; 5,5 mS cm-1) above the control. The plants from this combination show higher viability, and fewer deviations in biometric, physiological, and biochemical parameters, which characterize them as a tolerant genotype.

Keywords: salinity, cucumber, rootstock, grafting, yield

S02-OI-7

Heat stress responses of grafted tomato plants

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Climate change, which increases the intensity and frequency of heat stress, significantly limits tomato production in Texas. Grafting has been shown to enhance plant vigor and disease resistance of various horticultural crops, but its effectiveness in enhancing heat stress tolerance of tomato plants still needs in-depth investigation. Our study aimed to evaluate: 1) the thermotolerance of wild relative tomato species, Solanum pennellii and S. peruvianum, used as rootstocks, 2) the combined heat and water deficit stress responses of S. pennellii-grafted tomato plants, and 3) the physiology of tomato plants grafted onto commercial 'Maxifort' rootstock during the post-stress recovery period. S. peruvianum-grafted plants demonstrated less susceptibility to heat stress in fruit yield in a high tunnel and showed thermotolerant responses in a growth chamber, such as higher leaf amino acid content, enzymatic and non-enzymatic antioxidant capacity and photosynthetic traits compared to ungrafted/self-grafted and 'Maxifort'-grafted plants. On the other hand, S. pennellii-grafted plants showed the highest susceptibility to heat stress as evident for several physio-biochemical parameters including leaf gas exchange capacity, chlorophyll fluorescence, antioxidant enzymes as well as fruit yield. When exposed to combined heat and water deficit stress, we still could not observe any tolerance benefits in S. pennellii-grafted plants compared to the self-grafted controls. In the heat stress recovery study, 'Maxifort'-grafted plants showed noticeable recovery after 14 days of heat stress in electrolyte leakage, chlorophyll content, leaf superoxide dismutase and ascorbate peroxidase activities and root proline content, but several other parameters including leaf proline, malondialdehyde and chlorophyll fluorescence did not fully recover to the control level after a 7 day recovery period. Taken together, our study comprehensively identified the benefits and limitations of using commercial and wild relative rootstocks for enhancing the thermotolerance of tomato plants, providing new information to breeders seeking heat tolerance traits in rootstocks.

Keywords: rootstock, thermotolerance, *Solanum peruvianum*, *Solanum pennellii*, drought stress

S02-OI-8

Why does a pepper rootstock confer tolerance to water stress? The case of NIBER

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Drought incidence on plants triggers adverse effects on all plant levels: molecular, biochemical, physiological and morphological, leading to reduced crop yields. Vegetable grafting technique bases on the rootstock's ability to overcome water stress and to modify scion stress perception. Our research team obtained and registered NIBER® rootstock through a classic breeding program, which confers tolerance to water stress. In this paper, we summarize the main traits related to water stress mitigation on grafted plants using NIBER® as rootstock (V/N). The first evidence was the 1.8-fold higher marketable yield from V/N plants compared to ungrafted plants (V), associated with

higher biomass and root volume. These long-term advantages using NIBER® could be related to prompt strategies in the early phase of water stress (<48 h). To assess this hypothesis, the short-term modulation of water stress responses was evaluated with the analysis of gene expression, phytohormonal balance and metabolomic profiles. Constitutive differences in roots gene expression between NIBER® and a water stress sensitive accession were observed mainly for ROS detoxification-related genes and sustained ABA induction by NCED gene, that could be advantageous to NIBER® when the stress comes into play. NIBER® was able to develop a quick response to water stress in roots regarding the increase on DREBs, MYC2, aquaporins and chaperones gene expression. Under short-term water stress, minor oxidative damage was observed in NIBER® roots compared to sensitive rootstocks (lower GSSG) along with increased vitamin B6 synthesis in the scion leaves. In addition, NIBER® stimulated JA and ABA synthesis that promote stomata closure, and raffinose and trehalose acting as osmoprotectant sugars. Moreover, NIBER® increased protective metabolites related to suberin and cutin biosynthesis and anthocyanins. The results demonstrated that the drought tolerance observed in pepper grafted onto NIBER® is a consequence of both constitutive traits and activated mechanisms to overcome water stress.

Keywords: *Capsicum annuum*, drought, grafting, gene expression, metabolomics

SESSION II- VEGETABLE PLANT NUTRITION

S02-OII-9

Vegetative, physiological, nutritional and antioxidant behavior of *Sonchus oleraceus* (L.) in response to different nitrogen supply in hydroponics

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Water and nutrient use efficiency are related to active water management in agriculture, while the form of the nitrogen fertilizer may affect the quality and the productivity of leafy vegetables. Sowthistle (Sonchus oleraceus L.) is a widespread weed, which is greatly appreciated for its high nutritional value. The present study evaluated the effect of different nitrogen levels (N: 50-100-200-300 mg/L) and different ammonium/total N ratios (NH4/Total N: Nr 0.01-0.05-0.10-0.15) on plant growth, physiological parameters, antioxidant capacity and nutrient accumulation in different plant parts of sowthistle, grown in a hydroponic system. Young seedlings were exposed to different N levels and Nr ratios. Plant growth, total phenols, and antioxidant capacity were increased in middle N levels; whereas increased flavonoid content, nitrogen accumulation rates and water and nutrient use efficiency was noticed for plants grown with 200 mg N/L. Nitrogen was less accumulated in leaves and roots, while leaf stomatal conductance was increased as the N concentration was increased in the nutrient solution. The Nr ≥ 0.05 decreased the dry matter of the plant tissue, total phenols, flavonoids, and antioxidant capacity of the produced leaf extracts, and negatively affected the nitrogen translocation from the roots to the leaves. Sowthistle plants grown in Nr 0.05 revealed a less intense oxidative stress, with decreased lipid peroxidation and hydrogen peroxide production, but there

was an increase in the antioxidant enzymes levels of superoxide dismutase and catalase. Increased Nr resulted in the accumulation of phosphorus and magnesium in leaves while the greater water use efficiency was found at the plants grown under Nr 0.05. Thus, the recommendation for increased yield, nutritional value and efficient use of water and nitrogen sources in sowthistle is to employ 200 mg/Lof N and Nr of 0.05 in a close hydroponic system.

Keywords: antioxidants; mineral fertilizer; soilless culture; sowthistle; ammonium to total nitrogen ratio

S02-OII-10

Nitrogen, phosphorus and potassium levels in the nutrient solution affect *Sideritis cypria* growth, nutritional, and antioxidant status

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Medicinal and aromatic plantsplay an essential role in global health systems, since more than 80% of population use natural products in primary healthcare. Sideritis cypria Post, is an endemic plant in Cyprus and for the very first time it was introduced to hydroponics, to evaluate the impact of the mineral levels in the nutrient solution (NS), on plant's performance. Different levels of nitrogen-N (75-150-300 ppm), phosphorus-P (50-75-100 ppm) and potassium-K (150-350-550 ppm) were tailor-made in the NS, and a series of growth, physiological and biochemical parameters, and nutrient accumulation were assessed. Plants grown in NPK150-50-350 revealed the higher biomass, while the higher dry matter content was evidenced at the low N levels in the NS (NPK75-75-350). Higher total phenols and greater antioxidant capacity was obtained in plants grown in NPK150-75-350, while total flavonoid content was increased in plants with the NPK150-75-350 application. Mineral accumulation in the plant tissue mirrored the applied levels of the minerals in the NS, as the highest N, P, and K accumulations were obtained at 300 ppm N, 100 ppm P and 550 ppm K, in different NS. Calcium and magnesium were accumulated in plant tissue at the NPK300-75-350 which mirrored a low K:N ratio of 1.16. Increased K levels of 350-550 ppm (NPK150-75-350 and NPK150-75-550) resulted in increased oxidative stress as indicated by the increased levels of lipid peroxidation as assayed by malondialdehyde content, and this activated different antioxidant enzyme activities, such as superoxide dismutase, catalase and peroxidase. Chlorophylls (a, b, total) content was increased in plants grown at high P and K levels (NPK150-100-550). Considering the importance of the high antioxidant properties of S. cypria, It is recommended the NS of NPK150-75-350. Further research is undergoing to evaluate the biocidal properties of the produced plant extracts under different minerals levels.

Keywords: medicinal and aromatic plants; antioxidants; mineral fertilizer; soilless culture

S02-OII-11

Effect of root storage and forcing on the carbohydrate and secondary metabolite composition of Belgian endive (*Cichorium intybus* L. var. *foliosum*)

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Belgian endive is grown in a two-step cultivation process that involves growing of the plants in the field, cold storage of the taproots, and a second growth period in dark conditions called forcing to yield the witloof heads. In this study, the changes in the carbohydrate content and the secondary metabolite composition were studied in different tissues of Belgian endive during the cultivation process. Belgian endive heads contain between 336−388 mg/g DW of total soluble carbohydrates, predominantly fructose and glucose. The heads also contain phenolic compounds and terpenoids that give Belgian endive its characteristic bitter taste. The terpenoid and phenolic compound composition of the heads was found to be constant during the cultivation season, regardless of the root storage time. In roots, the main storage carbohydrate, inulin, was degraded during storage and forcing processes; however, more than 70% of total soluble carbohydrates remained unused after forcing. Additionally, high amounts of phenolics and terpenoids were found in the Belgian endive taproots, predominantly chlorogenic acid, isochlorogenic acid A, and esquiterpene lactones. As shown in this study, Belgian endive taproots, which are currently discarded after forcing, are rich in carbohydrates, terpenes, and phenolic compounds and therefore have the potential for further valorization. This systematic study contributes to the understanding of the carbohydrate and secondary metabolite metabolism during the cultivation process of Belgian endive.

Keywords: Belgian endive, *Cichorium intybus* L. var. *foliosum*, witloof, storage, forcing, inulin, chlorogenic acid, chicoric acid, lactucin, lactucopicrin

S02-OII-12

Yield and quality of asparagus spears as affected by crop method and product type

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Research was carried out on green asparagus in greenhouse in southern Italy with the purpose of verifying the chance to practise organic management to obtain both spears for 'fresh' market and industry, under the perspective either to use an eco-compatible crop management or to limit the imports. The experimental protocol was based on the comparison between eight treatments obtained by the factorial combination of two crop systems (organic and conventional) and four spear types ('fresh', appetized in water, in oil, or as a patè). The conventional management led to the highest yield, as a consequence of the higher spear number per plant, whereas the organic management resulted in the increase of both spear calibre and mean weight. Organic spears showed higher levels of dry residue, soluble solids and sugars, but a lower content of nitrate and fibre. Between the three industrial types compared (patè, in oil, in water), 'patè' showed the highest values of dry residue, soluble solids and lipids, whereas the fresh spears had the highest content of sugars, acidity, vitamin C and fibre, the latter being not significantly different from 'in water' product which displayed the highest protein content. From this research, it arose that organic farming had a positive impact on some important quality parameters of asparagus spears. Moreover, the fresh spears and patè showed the overall better quality, compared to 'in oil' and 'in water' ones.

Keywords: *Asparagus officinalis* L., organic management, appertisation, sugars, fibre, amino acids

S02-OII-13

Effect of metallic and green-synthesized zinc nanoparticles on growth parameters and quality of swiss chard (*Beta vulgaris* ssp. *cicla* L.)

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Various metallic, green-synthesized nanoparticles (NPs) are increasingly incorporated into agricultural products. However, there are still considerable gaps in knowledge of the plant uptake capacity, permissible limit, and ecotoxicity of different NPs. Foliar spray of NPs is increasingly employed in agriculture, but the data regarding foliar uptake of NPs, associated biophysiochemical changes inside plants, and possible health hazards are limited. Zinc (Zn) belongs to micronutrients with poor bioavailability, though this element is essential for the vital functions of plants. In this respect, this study determined the effect of nano-enabled Zn (aquatic suspension of metallic ZnO and green-synthesized G-ZnO) delivery via the foliar application on Zn accumulation, physiological and biochemical changes in Swiss Chard (*Beta vulgaris* ssp. *cicla* L.). Plants were grown hydroponically in controlled environment growth chambers (PFD – 220 µmol m-2 s-1, 18

h photoperiod, 21/17 ± 2 ºC temperature, 60% ± 5% relative humidity) and exposed via foliar spray of different ZnO and G-ZnO NPs at 0, 200, and 400 ppm concentrations. The experimental results revealed that the foliar spray of 400 ppm NPs caused no visual damage in Swiss chard leaves. Moreover, it improved fresh and dry biomass, leaf area, antioxidant activity, and macro-and microelement uptake. ZnO and G-ZnO NPs treated Swiss chard leaves contained higher amounts of Zn. These results indicate that applying ZnO and green-synthesized ZnO NPs could be employed in Swiss chard production to improve yield and quality.

Keywords: ZnO; Zn; Green synthesis; Nanoparticles; Swiss chard; Antioxidants; Mineral elements

S02-OII-14

Zinc and copper oxide nanoparticles' combined impact with HPS and LED lighting on enzymatic and non-enzymatic antioxidants of Ice Plant (*Mesembryanthemum crystallinum*)

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Various metallic nanoparticles (NPs) are increasingly incorporated into agricultural products. However, there are still considerable gaps in knowledge of the plant uptake capacity, permissible limit, and ecotoxicity of different NPs. Understanding the interactions between NPs and plants is crucial in the comprehension of the impact of nanotechnology on agriculture, with a focus on plant toxicity concerns and risks to human health. Foliar spray of NPs is increasingly employed in agriculture, but the data regarding foliar uptake of NPs, associated biophysiochemical changes inside plants, and possible health hazards are limited. Zinc (Zn) and copper (Cu) belong to the micronutrients with poor bioavailability, though this element is essential for the vital functions of plants. This study aimed to evaluate the effect of Cu and Zn oxides NPs sprayed onto Ice plant (Mesembryanthemum crystallinum) leaves grown in hydroponic Ebb systems in controlled environment chambers (photoperiod of 18 h, day/night temperature 25/21±2 °C, and 60±5% relative air humidity) under two different lighting: the combination of white 65%, blue 5%, red 30% light emitting diodes (LEDs) and high-pressure sodium (HPS) light with 250 µmol m-2 s-1 intensity. The influence was determined on the enzymatic (GR, APX, CAT, SOD, MDHAR, DHAR) and non-enzymatic (TPC, DPPH, ABTS, FRAP) antioxidants. The results showed that the Ice plant's antioxidant activity was dependent on lighting. For instance, LED's increased DPPH and ABTS scavenging activity by 177 and 72%, FRAP antioxidant power was improved by 16%, and TPC increased by 44%. In addition, the same tendency was observed in enzymatic antioxidant activity. NPs also influence plants' antioxidant activity. The effect of NPs on plant antioxidant systems did not differ under HPS illumination. However, significant activations of the antioxidant system were found with LED lighting. The use of CuO NPs significantly increased Gr, MDHAR, DHAR, and CAT activity by 22, 35, 47, 17, and 15%. In conclusion, it can be stated that lighting has a significant influence not only on the antioxidant activity of the Ice plant but also on the effect of nanoparticles in plants.

Keywords: Ice plant, Nanoparticles, Copper oxide, antioxidants, Zinc oxide

S02-OII-15

Plant growth promoting rhizobacteria: a sustainable way towards improving yield and quality of saffron

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Saffron (Fam. *Iridaceae*) is worldly known for the most precious spice. The plant is sterile and reproduction is only vegetative through clonal corms. Therefore, horticultural practices are essential for the improvement of this crop. The interest in the use of bioinoculants, such as plant growth promoting rhizobacteria (PGPR), has recently increased as they are considered a sustainable agricultural solution to enhance plant quality and productivity, cope with the effects of climate change, and reduce environmental costs. In this study saffron was soilless grown in a protected cultivation system with the PGPR *Bacillus megaterium* CB97032 and *Paenibacillus durus* CB1806. The influence exerted by the PGPR during flowering and the vegetative-reproductive phases was investigated. The PGPR resulted to improve the saffron spice quality increasing the content of safranal, i.e., the principal aroma compound of saffron, and the total phenolic content (TPC).

Keywords: PGPR, *Bacillus megaterium*, *Paenibacillus durus*, *Crocus sativus* L., safranal, TPC

S02-OII-16

Effect of foliar application of seaweed extracts combined with other active ingredients on tomato fruits from plants irrigated with high Boron concentration

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Tomato (*Solanum lycopersicum* L.) is one of the most consumed and demanded crops around the world due to its numerous health benefits. However, its production and quality have been affected by various abiotic stresses, such as boron toxicity. Boron is an essential micronutrient for plants that, when found in high concentrations in irrigation water, can negatively affect crop quality and vegetative development of these plants. One of the agronomic strategies proposed to help plants mitigate the harmful effect of boron is the application of biostimulant products based on algae extracts. This raw material presents a wide and varied biochemical and nutritional profile, with a large number of chemical compounds with biological activity, which could be beneficial for plants grown under stress conditions. Thus, the objectives of this study were: 1) to know the morphological and physiological behaviour of tomato plants of the variety 'Óptima' when irrigated with water containing 15 mg L-1 of boron, and 2) to know if the foliar

application of the extract of the brown seaweed Laminaria digitata, together with metalloids, can alleviate or reverse the negative effects of B in this crop. The agronomic results of this study show that plant production was strongly affected by the high concentration of boron in the irrigation water, and this was due to a reduction in the average fruit weight, while the number of fruits per plant was not affected. Boron toxicity caused an alteration in primary metabolism in the leaves. On the other hand, the application of the products based on the brown seaweed extract did not decrease the negative effects on yield due to boron induced high toxicity, but they did influence the metabolic processes of the tomato plants, which might suggest that their application could be useful for irrigation with water of lower boron concentration.

Keywords: tomato, biostimulants, abiotic stress, agriculture, algae

S02-OII-17

Effects of nutrient solution concentration on growth and nutrient concentration of dill (*Anethum graveolens* L.)

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During the last two decades, there is a a growing interest towards more sustainable systems in crop production, and hydroponic production is one of them. The use of hydroponic systems is increasing worldwide, however nutrient solution recipies are required to modify and/or adapt for edible vegetables to optimize the productivity. In this study, 5 different concentrations of Hoagland and Arnon nutrient solution were examined in dill cultivation by changing the macroelement ratios (25%, 50%, 75%, 100% and 125%) using the floating water culture technique. Micronutrient concentrations were kept constant. Plant growth and yield parameters, plant color and leaf nutrient content were determined. The highest plant growth and yield values were obtained at the macroelement concentration of 25%. The nutrient solution having 125% macroelement concentration reduced shoot height, shoot fresh weight, root length, root fresh weight and shoot dry weight by 45.65, 69.41, 27.44, 48.57, 69.12 % compared to 25%. Macroelement content of leaves changed bewteen N (%) 3.62-4.41, K (%) 6.99-3.81, Ca (%) 1.13-0.41, Mg (%) 0.49-0.26. It was concluded that 25% of macroelement concentration of Hoagland and Arnon nutrient solution in a floating system for dill production could allow to reduce the cost of inputs and negative environmental impacts.

Keywords: *Anethum graveolens* L., Hoagland and Arnon, soilless culture, hydroponics, yield

S02-OII-18

Sustainable carrots (*Daucus carota*) cultivation methods using organic manure application rates under different plant arrangement methods

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Carrot (*Daucus carota*), an important vegetable crop cultivated worldwide, and valued for its nutritional content and culinary versatility required a sustainable production package. In the pursuit of sustainable agriculture, the optimal manure application rate that maximises crop performance at suitable plant arrangement methods remains uncertain. Experiments were conducted at the Federal University Oye-Ekiti, Ekiti State, Nigeria, to determine the effect of plant arrangements and organic manure application rates on the growth and yield of carrot. The experiments adopted a randomized complete block design replicated four times. The results showed that except for the number of leaves where there was no significant difference among plant arrangement methods, the moderate spacing of 50mX40m at a population of 50,000 plants/hectare performed better in the plant height and leaf length compared to lower responses from least spaced 50mX30m at a population of 66,000 plants/hectare and widely spaced plants at 50mX50m at a population of 40,000 plants/hectare in the parameters measured. The plants that received the maximum manure application rate at 15 t/ha had taller plants with more leaves and larger leaf length compared to the lower rate at 10 t/ha and the zero application rate that were not significantly different in responses. In conclusion, carrots performances were optimum when cultivated at 50 m X 40 m plant spacing and at 15 t/ha manure rate.

Keywords: Carrots (*Daucus carota*), sustainability, cultivation methods, organic manure application rates, plant spacing, plant population, plant growth and yield

S02-OII-19

Cultivating Nutrition: investigating environmental factors and variety effects of four cherry tomato varieties on carotenoid concentration and taste perception

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In today's consumer market, there is a growing demand for vegetables that are not only nutritious but also flavorful, with carotenoids playing a crucial role in meeting these preferences. Carotenoids, as plant pigments, serve as antioxidants in the human body when fresh vegetables are consumed. Additionally, they have been implicated in the biosynthesis of volatile organic compounds, which might contribute to taste perception. Tomatoes, renowned for their richness in carotenoids, exhibit variations in their concentration due to environmental conditions and varietal differences, influencing the final product delivered to consumers. To address these knowledge gaps, we conducted an experiment in a controlled environment agriculture setting, manipulating light spectra (i.e. enhanced blue light percentage) during the growth phase of four cherry tomato varieties selected from a previous germplasm screening. Subsequently, taste panels and a post-harvest experiment, in which the light was also manipulated, were conducted to

assess the cumulative effects of varietal (genetic), growing, and postharvest (environmental) factors on carotenoid concentration in tomatoes. By combining sensory evaluation with chemical analysis, we aimed to unravel the complex interaction between growing conditions, taste perception, and antioxidant content in cherry tomatoes.

Keywords: Light quality, Antioxidants, Nutrients, Flavor, Shelf-life, Sensory Evaluation

S02-OII-20

Effect of pepper extract and *Trichoderma harzianum* on romaine lettuce fresh and dry weights

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Policy restrictions on nitrogen (N) losses to the environment are putting pressure on vegetable growers to reduce N applications and improve N use efficiency (NUE), especially for leafy green crops known for their low NUE. The objective of this project was to determine the effects of chili pepper extract (PE) and Trichoderma harzianum (Th) in combination with triple 15 chemical (CF) or triple 4 organic fertilizers (OF) on Romaine lettuce growth and yield. Twelve treatments consisting of different PE and Th with CF or OF were applied to lettuce plants grown in 30 cm pots filled with sandy soil. The fertilized treatments received 180 kg N ha-1 from. The crop was grown for 10 weeks in a greenhouse. The experiment was laid out according to a completely randomized design. Fresh and dry shoot weights, fresh and dry root weights, plant height at harvest, and SPAD value were measured.
Stacking PE with Th and the fertilizer resulted in the greatest shoot dry weight in both fertilizer types. PE enhanced shoot dry weight when combined with CF. Th did not increase dry matter unless combined with fertilizer. The results indicate the possibility of improving NUE using PE and Th in both conventional and organic systems.

Keywords: Organic production, chemical fertilizer, vegetables, biostimulants, *Trichoderma harzianum*, plant physiology

S02-OII-21

Damage in organically produced potted herbs: Effect of compost amendment and nitrogen fertilization

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In organic potted herb production, issues such as germination inhibition, growth reduction, and leaf abnormalities like chlorosis and necrosis occur regularly. Although the presence of mineral nitrogen as ammonium in growing media is a consistent factor, direct ammonium toxicity and ammonia formation due to elevated pH levels cannot solely explain observed damage. Previous studies indicated that even extremely high ammonium concentrations did not necessarily cause harm, and damages also occurred at pH levels below 6.5, making ammonia formation unlikely. Furthermore, interactions between composts and organic fertilizers influenced plant damage, with certain combinations exacerbating damages, while others mitigating it. This study aimed to evalu-

ate the effect of compost amendment alongside with different N fertilizers on damage occurrence in a plant response test with Chinese cabbage. The growing media consisted of peat mixed with 30% compost by volume, using two composts – one preventing damage (GWC A) and the other promoting it (GWC B) – either alone or in various mixing ratios. To assess the triggering effect of ammonium on the occurrence of damage, mineral N was added either as calcium nitrate or ammonium sulfate, each alone as well as in various ratios. Additionally, different types of organic fertilizers were included in the study. Weekly plant evaluations over one month revealed neither plant damage nor growth reduction when at least 25% of N fertilization was applied as ni-trate, irrespectively of compost mixing ratio. When ammonium-N or organic fertilizers were used, at least 75% GWC A by volume were necessary to effectively prevent damage and to promote nitrification and plant growth; in mixtures with 50% or less GWC A, severity of damage and growth reduction increased sharply. These results propose approaches to understand underlying mechanisms of damage in organic herb production, and thus help to prevent them.

Keywords: compost quality, plant response test, ammonium toxicity, nitrification

S02-OII-22

Application of new, microorganisms' containing fertilizers in vegetable production

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Global environmental problems, manifested in a degraded environment and uncontrollable climate change, pose challenges to agriculture. Biological agriculture forms a fundamental and interdisciplinary approach in the testing of new technological solutions and methods. Preparations containing microorganisms are an innovative solution for increasing the productivity of plants in organic farming systems.
The aim of the research is to create preparations for sustainable farming that could ensure vegetable growth, productivity and harvest quality.
The trials were arranged in vegetation containers with soil. Preparations, tested in experiments, contained manure (cattle, pig or poultry), peat and wood ash. Mineral fertilizer was used as a control option. All variants were balanced by N, but the proportion between N:P:K differed. The consortium of microorganisms was added to part of the vegetation pots. The size of the vegetation containers was changed, but when transplanting, fertilizer was mixed in and microorganisms were added, maintaining the original proportion. Experiments were done with basil 'Tuscany' and cucumbers 'Berlioz'. Plant growth parameters and yield was determined.
The results showed that the type of organic fertilizer significantly affects plant growth and yield. The growth of cucumbers and basil was better in variants with a preparation containing poultry manure. It was found that the positive effect of microorganisms was better observed in variants with the least fertilizer effect. The effect is more pronounced for plants with a longer vegetation period.

Keywords: cucumber, basil, microorganisms, fertilizers

S02-OII-23

Hydroponic tomato cultivation using organic fertilizer from bonito fish-based soluble

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Organic fertilizer used in hydroponic system often causes phytotoxic phenomenon that could inhibit the plant growth. However, processing the organic material by using multiple parallel mineralization (MPM) method could efficiently allow the decomposition of organic materials without the accumulation of phytotoxins and dissolved oxygen deficiency in hydroponic culture system. Organic material from dried bonito production waste could be the nitrogen source for organic fertilizer generation. In this research the effect of organic fertilizer from bonito fish-based soluble and conventional chemical nutrient solution in the yield and quality of tomato plants in the greenhouse were compared. There were no significant differences in the total yield per plant, total dry matter (TDM), sugar content, and fruit quality (GABA and lycopene) between organic and chemical treatment, except for citric acid in tomato fruits. Where the total yield per plant produced by organic fertilizer was 96.2% from conventional chemical fertilizer production. Therefore, with the better environmental impact, organic hydroponic production by using bonito fish-based soluble can compete with conventional fertilizer production.

Keywords: organic hydroponic, tomato production, bonito fish-based soluble, sustainable cultivation, multiple parallel mineralization

S02-OII-24

Optimizing tomato production by using *Bacillus* spp.

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Agriculture plays a vital role for ensuring the sustenance of humanity, occupying a substantial portion of the Earth's surface. In efforts to protect both soil vitality and human health, researchers are actively exploring biological solutions, notably leveraging the potential of microorganisms. These beneficial bacteria play a pivotal role in enhancing the soil's physical and chemical properties, fostering an optimal environment for the absorption of essential nutrients. Consequently, this approach facilitates increased crop

yields while simultaneously reducing dependence on synthetic fertilizers. It was tested two products based on Bacillus sp and the application of them, Rizobac and Bactilis on the Kingset hybrid resulted in insertion depths of 35.25 cm and 37.00 cm, respectively, compared to 38.27 cm for the unfertilized variant from the base. Moreover, the application of these products led to a notable improvement in the fruit set percentage, with increases ranging from 17% to 30%. In the case of Buffalosun F1, treated with Bactilis, the fruits weighed 623.8 grams, surpassing the control by over 100 grams (515.8 grams). This resulted in a significant increase in production, with a rise of 18% when treated with Rizobac and 29% with Bactilis compared to the control.

Keywords: biological, fertilizers, microorganisms, production, tomatoes

S02-OII-25

Water stress monitoring on two crops under effects of biofertilizers

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Biofertilizers are products containing living micro-organisms that help improve plant growth. They optimize soil functions and fertility through the action of the micro-organisms they contain. In this experiment, we studied the effects of doses of two bioproducts based on algae and phytohormone by foliar application on two plant models, namely broad bean (Vicia faba) and strawberry (fragaria vulgaris), to monitor growth parameters and morpho-physiological traits. The aim of this study is to monitor the effect of water stress on these crops under semi-controlled conditions in the greenhouse of the experimental station of the Department of Biotechnology and Agro-Ecology at the University of Blida. All our results show that the bioproducts and their doses are effective: (Period of application of treatments) BPHY 2 had a significant effect on the leaf part, while the products had no significant effect on the stem part. BPHY 1 had a satisfactory effect on the number of flowers, while all treatments had a significant effect on root development and dry biomass. (Post-stress period) BPHY1 has a significant effect on the number of flowers, BPHY 1, BALG A and BALG B are highly effective on the leaf part, BPHY 1 has a satisfactory result on the number of flowers, and our results show that BPHY 1, BPHY 2, BALG A and BALGB are highly effective on the stem part. Finally, all treatments showed significant efficacy on root development and dry biomass. Strawberry crop: (treatment application period) BPHY2, BPHY1 and BALG B were found to be highly effective on leaves and stems. BALG B is highly effective on fruit growth. (Post-stress period) BALG A was highly effective on the leaf and stem. Treatments BPHY 1, BPHY 2 and BALG A were highly effective on fruit growth.
Finally, all treatments showed significant efficacy on root development, dry biomass and number of flowers during both periods.

Keywords: Water stress, algae-based bioproduct, phytohormone-based bioproduct, growth parameters

POSTER SESSION I

S02-PI-01

An in-depth analysis of cabbage seed production with 'Silviana' cultivar across varied planting dates and densities

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Vegetable plants within the *Brassicaceae* family, particularly those belonging to the cabbage group, are typically propagated by seeds. The production of high-quality seeds constitutes a multifaceted endeavor, demanding expertise not only from a scientific standpoint but also encompassing organizational and technological perspectives. Efficient cabbage seed production is pivotal for agricultural sustainability, and this study explores the intricate relationship between planting dates, planting densities, and the resulting phenological attributes and seed yields in the 'Silviana' cultivar. Our research focused on two key aspects. The first aspect consists in an in-depth analysis of the phenological development, encompassing the reproductive phase of cabbage plants with a keen eye on flowering dynamics and inflorescence development. The second aspect is referring to a detailed examination of seed yields across the experimental variants. Preliminary results indicate a conspicuous interaction between planting dates and densities on phenological traits, revealing potential for optimizing cabbage seed production. The high planting density demonstrated promising yields, while variations in planting dates elicited distinctive phenological responses. This study not only advances our understanding of the 'Silviana' cultivar's phenotypic plasticity, but also provides practical insights for farmers aiming to enhance cabbage seed productivity. The approach to both phenology and seed yields establishes a foundation for informed decision-making in cabbage seed production, contributing to the broader goal of sustainable and efficient agricultural practices.

Keywords: seed yield, planting dates, *Brassicaceae*, morphophysiology, reproductive phase

S02-PI-02

Plant density and fertilization for fruit yield and seed production in round pepper

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Planting distances, combined with an appropriate fertilization with calcium nitrate, can strongly influence fruit yield and seed production in round pepper. The present scientific

experiment was carried out at Research and Development Institute for Vegetable and Flower Growing Vidra, Ilfov county, Romania. The bifactorial experiment aimed to establish an optimal planting scheme for both yield and seed production in round pepper, in the conditions in which fertilization works are applied or not. The first experimental factor consisted of three planting schemes, with three graduations: 70 cm between rows and 20 cm between plants, 50 cm between rows and 23 cm between plants and, respectively, 30 cm between rows and 25 cm between plants. The second experimental factor was fertilizing treatments, with two graduations: unfertilized and fertilized with a mixture of calcium nitrate and bioactive product Auxi 4C, by three treatments, at an interval of 10 days. As biological material was used the cultivar 'Asteroid 204'. The influence of these factors on fruit yield and fruit mass was studied. Regarding seed production, the quantity of seeds and their quality were studied. The weight of 1000 seeds and the final germination was measured, and the vigor of the seedlings at 14 days after sowing was determined by their mass, their length and the vigor index of the seeds. The use of fertilizer treatments led to an increase in yield and seed production, at schemes of planting of 50 cm between rows and 23 cm between plants and, respectively, at 30 cm between rows and 25 cm between plants.

Keywords: *Ascophyllum nodosum*, calcium nitrate, fruit yield, seed quality

S02-PI-03

The effects of different dormancy breaking applications on germination in garlic (*Allium sativum* L.) seeds

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Garlic production and reproduction are done using garlic cloves. However, the production method with garlic cloves requires high cost labor. Some garlic clones are able to produce seeds, but the garlic seeds show dormancy. In order to use garlic seeds in garlic cultivation and breeding, the dormancy seen in garlic seeds should be broken, and germination should be encouraged. The aim of this research was to examine the effects of gibberellic acid, stratification, and stratification + gibberellic acid applications on the breaking of dormancy in garlic seeds. In this research, seeds obtained from two different garlic clones (G1 and G2 genotypes) were used, and applications were started immediately after the seeds were harvested. In stratification applications; the seeds were kept in moist sand at 4°C for different periods (0, 2, 4, 6 and 8 weeks). In gibberellic acid applications, seeds were kept in gibberellic acid solutions of different concentrations (distilled water, 500, 1000 and 1500 ppm) at 18°C for 48 hours. In stratification + gibberellic acid applications, seeds were kept in gibberellic acid solutions after stratification applications. After the applications, the seeds were taken for germination tests immediately. As a result of germination tests, normal germination rate (%) and average germination time (days) values were calculated. Significant differences were identified between the applications. The best results for breaking dormancy and

promoting germination in garlic seeds of G1 and G2 genotypes obtained from 4 weeks of stratification + 500 ppm GA3 applications.

Keywords: *Allium sativum* L., dormancy, GA3, mean germination time, normal germination rate

S02-PI-04

Effect of treatment with microalgae extracts on growth and development of tomato seedlings

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The research aimed to the evaluation of growth and development of tomato seedlings under the treatment with microalgae extracts. The experiment was started in July 2023 in polycarbonate greenhouse of the laboratory of Horticulture and Beekeeping of the Latvia University of Life Sciences and Technologies. Seeds of tomato hybrid cultivar 'Belle' F1 (Enza Zaden) were sown in plastic cassettes filled with peat (producer Laflora Ltd., pH KCl 5.5) at 1st July. At the stage of early growth, (18th July) seedlings were replanted in vegetation pots (1 L) filled with the same substrate. Since germination seedlings had been sprayed weekly with the solution of ethanol extractions of different microalgae species, e.g. Spirulina, Dunaliella, Chlorella, total 4 times: from 24th July to 14th August. Two concentrations of the extracts were compared with sprays with corresponding ethanol solution as a control. After sprays, the following parameters were measured: plant height, number of internodes, hypocotyl colour, stem collar diameter, number of leaves, length and colour of leaves on the middle node as well as pHKCl and content of soluble solids (°Brix). At the age of 35 days, seedlings were replanted in 25 L containers for next investigations and data about plant growth type, leaf type as well as number of leaves under first inflorescence were measured. It was observed, that influence of microalgae extract`s type on plant height, number of leaves, length of leaves on the middle node and content of soluble solids was significant ($p<0.05$). In the case of concentration, the significant influence ($p<0.05$) on such parameters as number and length of leaves as well as content of soluble solids was observed. For all indices, no negative effects of any microalgae extracts were noticed.

Keywords: tomatoes, seedlings, microalgae, biostimulants, plant development, quality parameters

S02-PI-05

Evaluating the efficiency of using biostimulants for sweet pepper seedlings production (*Capsicum annuum* L. var. *grossum*) in an organic system

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The overall production of vegetable seedlings in an ecological system represents an increasingly important aspect of sustainable agriculture. In this context, the present study evaluates the efficiency of utilizing two biostimulants, Etamin and Kerafol, newly introduced to the horticultural input market. Biostimulants, derived from natural sources, have gained recognition for their role in enhancing plant growth and development. In the ecological system, their application not only fosters healthy seedling growth but also aligns with environmentally friendly practices. This paper highlights the significance of biostimulant use in the production of `DarianaBac` pepper seedlings (Capsicum annuum L. var. grossum), emphasizing their potential to contribute to sustainable agriculture and the cultivation of high-quality, eco-friendly crops. The influence of the two biostimulants was assessed through various biometric parameters such as seedling height, root length, leaf count, collar diameter, root-to-shoot ratio, leaf surface area, leaf length, leaf width, leaf length-to-width ratio, as well as through some qualitative indices including total chlorophyll and anthocyanin content, total dry matter, and mineral content. The results highlight that the use of the two biostimulants positively influenced both the biometric and qualitative characteristics of pepper seedlings, with recorded enhancements ranging from 10% to 45% compared to the control variant. These positive outcomes suggest the two studied biostimulants ability to boost seedling growth, root development, leaf characteristics, and pigment content underscoring their potential for enhancing crop quality and yield in an environmentally friendly manner. Further research and experimentation in diverse ecological settings could provide valuable insights into optimizing the application of Etamin and Kerafol biostimulants for improved pepper seedling production.

Keywords: plant growth, chlorophyl content, antocianin content, leaf surface area, root-to-shoot ratio

S02-PI-06

Clonal micropropagation and hydroponic combined method for growing *Rosmarinus officinalis* L. for obtaining plant raw materials in Armenia

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The introduction and accelerated propagation of Rosmarinus officinalis L. (RO) with the combination of clonal micropropagation and hydroponics methods was investigated. Experiments were carried out using tissue culture and hydroponic methods, using the EBB&FLOW hydroponic system at the IHP experimental field in the Ararat Valley. The spectrophotometric method was used to study phenolic compounds and vitamins in the raw materials of RO. The possibility of clonal micropropagation, callogenesis, and morphogenesis of RO in an in vitro culture was studied. According to the results of the study, concentrations of 0.5mg/L α-NAA and 1.0mg/L BAP in Murashige Skoog (MS) media stimulated the formation of callus tissue and organogenesis with 5 - 6 adventitious shoots. Clonal micropropagation on MS medium with half the concentration of macro- and microelements and an IBA concentration of 0.3mg/L stimulated 80% rhizogenesis. In the spring, microplants were acclimatized and transplanted into outdoor hydroponic conditions, where the plant survival rate was 90%. In hydroponic raw materials of RO, the content of flavonoids, rutin, and quercetin exceeded that in soil plants by 1.5, 1.4,

and 1.2 times, respectively. In hydroponic and soil RO, phenolic acids formed the following descending range: chlorogenic > rosmarinic > gallic > caffeic, where chlorogenic acid exceeded rosmarinic, gallic, and caffeic acids by 1.4 and 1.5; 2.4 and 2.5; by 2.5 and 2.8 times, respectively. Soil plants were 1.3 times inferior in vitamin “C” content to hydroponic plants but did not differ significantly in β-carotene content. The essential oil content in fresh plant raw materials of hydroponic RO was 0.2%, 1.7 times higher than the soil control. Thus, this study has scientific and practical significance, since the combination of in vitro and hydroponic cultivation methods for rosemary can serve as a rich source for the production of antioxidant dietary supplements, spices, herbal teas, and essential oils.

The work was supported by basic funding from the Institute of Hydroponics Problems of NAS RA

Keywords: in vitro culture, microplants, EBB&FLOW system, phenols, phenolic acids, essential oil

S02-PI-07

Vegetable waste extracts as priming agents to enhance seed germination

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Plant-derived biostimulants (PBs) are natural substances that can have an impact on sustainable agriculture and bio-economy by promoting plant growth and stress resilience while reducing the input of synthetic fertilizers. Such sustainable agriculture practices aim to minimize the negative impact on the environment while ensuring long-term food production and economic stability. In addition, PBs are of paramount importance in facing climate change, as they not only mitigate environmental impact but also ensure resilient food systems. The economic value of agricultural residues and plant by-products can be harnessed through plant waste recycling and precision farming technologies. Seed priming, defined as technologies designed to improve germination performance, can contribute to building up dynamic and sustainable agriculture practices. In this work, vegetable waste has been used to produce PBs that are applied as seed priming agents to boost seed germination and stress resilience. Red chicory and cauliflower waste-derived extracts were obtained through an innovative and sustainable extraction process, and subsequently applied to treat different soybean and maize varieties, along with hydropriming and unprimed control. The germination efficiency was monitored under drought stress conditions. The germination performance was tracked and multiple parameters (e.g., percentage, speed, synchrony, uniformity, and radicle growth) were measured. The results evidence that the vegetable waste-derived biostimulant application improves seed germinability under drought. This work is part of the project NODES which has received funding from the MUR – M4C2 1.5 of PNRR funded by the European Union - NextGenerationEU (Grant agreement no. ECS00000036).

Keywords: biostimulants, vegetables, sustainability, bio-economy, seed priming, drought

S02-PI-08

Effects of frass in growth and weed occurrence in chamomile (*Matricaria chamomilla* L.)

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In recent years, the cultivation of Medicinal Aromatic Plants (MAPs) has grown relatively in Kosovo. The use of frass has recently been increasing for various agricultural crops in different countires, therefore application of insect frass for chamomile in organic agriculture will be introduced in Kosovo. The study focused on quantifying the impacts of the application of frass to organic chamomile in the open field. The experiment was arranged according to the randomized block design with four replications and the elementary plot size was 15 m2. In the experiment were eight treatments: A - frass 5 t/ha; B - frass 3 t/ha; C – frass 2 t/ha; D - 1 t/ha + NAG-27%-500 kg/ha; E - frass 1/t/ha + NPK 15:15:15-450 kg/ha; F- NPK 15:15:15-450 kg/ha; G - mulching (without fertilizers and frass) and H - Control (without fertilizer and frass). Consequently, the highest fresh biomass of chamomile is achieved with the combinations of frass 1 t/ha + NPK 15:15:15-450 kg/ha, while the lowest fresh biomass of chamomile is achieved by the control plot. The highest average height of plants was observed where frass was used combined with 1 t/ha + NPK 15:15:15-450 kg/ha. The dominant weed species were: *Capsella bursa-pastoris* (L.) Medik., *Plantago lanceolata* (L.), *Myosotis arvensis* (L.) Hill.and *Aphanes arvensis* (L.). According to the obtained results, regarding the fresh biomass and average height of chamomile, it is obvious that the frass used in higher doses and in combination with artificial fertilizers has a significant effect on fresh biomass and average height of chamomile. Thus, the use of frass can be an alternative to be used in the future for medicinal aromatic plants.

Keywords: Circular bio-economy, frass, medicinal aromatic plants, regenerative agriculture

S02-PI-09

Presentation of the PRIMA project: New low cost strategies of crop based on biodiversity and remote sensing to reduce the application of nitrogen fertilizers in the Mediterranean area

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Horticultural crops, in the Mediterranean area of Europe and Africa, are of great socio-economic importance both in terms of production and cultivated area. To achieve the agronomic performance of these crops and to obtain a quality harvest, it is necessary to

apply nitrogen fertilisers. However, in this geographical location there are areas vulnerable to nitrates. The excessive use of nitrogen fertilisers containing nitrates is polluting natural resources such as seas, lakes, coastal lagoons, aquifers, etc., leading to eutrophication of waters and thus degrading the environment. The PRIMA project aims to use plants and/or plant extracts that inhibit nitrification in agricultural systems to reduce nitrate pollution in soils and waters in agricultural areas. Nitrification inhibitors are natural organic compounds from plants that inhibit the conversion of ammonium to nitrate, reducing the presence of the latter form of nitrogen in the environment. The project is being carried out in four countries of the Mediterranean basin: Spain, Italy, Tunisia and Morocco. This communication will present what the project consists of, as it started in July 2023 and trials are currently underway. It will explain what nitrification inhibitors are, what their mode of action is, how they will be used in the experimental plots of horticultural crops such as watermelon, broccoli, pepper and tomato, and the technological tools for monitoring.

Keywords: horticultural crops, NBI plants, botanical extracts, nitrate pollution reduction

S02-PI-10

Possibilities of implementing the HACCP plan for a tomato crop

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Food safety plays an important role in the lives of end consumers, who want to purchase safe, quality, and safe products. In the category of the most consumed foods, vegetable products are obtained ecologically or conventionally (vegetables, fruits). On the top of consumer preferences, the most sought-after are organic plant products, obtained from ecologically certified farms that generally use natural fertilizers. In vegetable production, especially in an ecological system, a series of risk factors can be inventoried and defined within the technological flow. As in other food fields and in the field of organic vegetable growing, there are risks in the production of vegetable crops. This risk is represented by a phenomenon, process, or action from outside or inside a system that can disrupt the system. Knowing the risk factors is very important throughout the technological flow because in this way we can prevent the occurrence of dangers that can lead to crop compromise. In such a case, the role of this food safety system is to identify the danger and reduce it to a minimum. Cultivation technology generally uses natural resources (soil, climate), human resources, and financial resources. During the technology, both natural factors and anthropogenic factors can change from their values and mode of action, thus leading to damages, processes, facts, and unwanted events that affect the technological process and not ultimately the vegetable harvest.

Keywords: HACCP, risk, organic tomato products

S02-PI-11

Studies on path analysis and correlation of yield with growth and yield contributing traits in fenugreek (*Trigonella foenum-graecum* L.)

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India is one of the home of vast agro-ecological diversification. A good amount of information is available on correlation and path analysis in fenugreek for seed purpose. In India, wide range of genetic variation is found in fenugreek leaves, leaf size, number of root nodules, branching and flavour. Information related to correlation and direct and indirect effect of such characters to foliage yield and seed yield would added advantage in selection criteria of fenugreek. Genetic diversity of fenugreek in India provides a vast opportunity to exploit its potential. So, the present study was planned to reveal the nature and magnitude of correlation among different characters in fenugreek. Association studies in fenugreek revealed that fresh weight per plant had highly significant and positive relationship with all quantitative characters except number of branches per plant, dry weight per plant suggesting that major emphasis should be given on these characters for improving yield for leaf purpose. Path coefficient analysis in fenugreek at horticultural maturity revealed that root length had highest positive direct effect on fresh weight per plant followed by total chlorophyll content, plant height, number of root nodules per plant, dry weight per plant, average weight of root and leaf area. The association studies for various characters noted mutual relationship among the traits that contribute to leaf yield of fenugreek. It was suggested to consider these characters while selecting desirable assessions for improving high yielding variety of fenugreek.

Keywords Fenugreek, Path analysis, Correlation coefficient

S02-PI-12

Performance evaluation of cherry tomato genotypes grafted onto different rootstocks in protected cultivation

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The study investigated cherry tomato genotype performance when grafted onto various rootstocks under protected cultivation, aiming to assess morphological and yield parameters for production optimization. The experiment was conducted at the Centre of Excellence for Vegetables, Krishi Vigyan Kendra, Baramati, Pune, from August 2022 to February 2023. It followed a Factorial Completely Randomized Design (FCRD) with two replications, evaluating 14 scion and rootstock combinations using the splice grafting

method. Data were recorded on various morphological and yield parameters. Among the scion genotypes, hybrid Junita exhibited early grafting stage initiation (20.5 days), along with the earliest flowering (15.69 days), 50% flowering (15.45 days), and first harvesting (73.37 days). It also displayed the highest germination percentage (98.6%), maximum number of fruit pickings (6.97), number of fruits per cluster (15.73), fruit yield per plant (1034.27 g), and yield per square meter (3.41 Kg). Hybrid Junita recorded the highest lycopene content (1.2 mg/100g), juice content (56.48%), and pH (3.66). On the other hand, Phule Jayshree exhibited superiority in stem diameter above graft union (15.22 mm), at graft union (16.43 mm), and below graft union (15.09 mm), vine length (533.34 cm), number of branches (82.31), and total soluble solids (TSS) content (6.03). Non-grafted cherry tomato plants demonstrated the shortest duration for flower initiation (15.05 days), 50% flowering (14.63 days), and first harvest (71.75 days) compared to grafted plants. Rootstock 5-3 emerged as the superior rootstock, showing maximum number of fruits per cluster (19.45), average cluster weight (145.18 g), average weight of 10 fruits (65.36 g), number of pickings (7.05), crop duration (168.20 days), highest yield per plant (910.45 g), and yield per square meter (3 Kg/m2). Rootstock 5-2 exhibited the highest germination percentage (98%) and lycopene content (1.08 mg/100g). Furthermore, rootstock 5-4 demonstrated the maximum plant height (568.49 cm), while rootstock 5-1 displayed the highest number of branches (86.20). These findings underscore the significance of selecting appropriate scion-rootstock combinations to optimize cherry tomato production under protected cultivation. The results provide valuable insights for improving yield and quality traits in cherry tomato cultivation systems.

Keywords: Cherry Tomato, Grafting, Stock-Scion relationship, Lycopene, Protected cultivation

S02-PI-13

Comparative evaluation of hydroponic systems for growth, yield, and quality of iceberg lettuce (*Lactuca sativa* var. *capitata*)

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Hydroponics, heralding a paradigm shift from traditional soil-based farming, presents a promising alternative. By circumventing seasonal constraints, it enables year-round crop cultivation, overcoming the limitations imposed by unpredictable weather fluctuations, while also optimizing resource efficiency, minimizing water usage, and fostering sustainable agriculture practices. The research was conducted during the rabi season of the academic year 2022-23 which focused on evaluating the growth of iceberg lettuce in different cultivation systems. The experimental setup included ten treatments, namely Ebb and Flow (T_1), Wick System (T_2), Deep Water Culture (DWC) (T_3), Drip and Drain (also known as Dutch Bucket) (T_4), NFT Vertical (T_5), NFT Flatbed (T_6), NFT Slanting (T_7), Coco-slabs (T_8), pot cultivation (T_9) (control), and open field cultivation (T_{10}), each statistically designed in a Completely Randomized Design (CRD) with three replications. DWC exhibited superior vegetative growth, while vertical NFT excelled in biochemical, sensory, and quality aspects. Open field cultivation resulted in the highest yield, but

hydroponic systems, particularly DWC and vertical NFT, showcased competitive performance. DWC proved noteworthy with maximum leaf width, plant spread, and leaf area. Vertical NFT demonstrated superiority in sensory attributes like color, texture, and crispiness, as well as overall acceptability. Biochemical parameters, including nutrient content (N, P, K, Ca, Fe), protein, chlorophyll, TSS, Crude fibre, and Percentage dry matter consistently favored plants from vertical NFT. Notably, the wick system and coco-slab system performed poorly across all parameters, suggesting impracticality for commercial crop production. To sum up, vertical NFT emerges as a more practical hydroponic system for lettuce production, offering advantages in growth, yield, and quality. Despite the absence of head formation characteristic of iceberg lettuce in hydroponic systems, they present overall benefits, making hydroponics, especially vertical NFT, a viable alternative to open-field cultivation.

Keywords: lettuce, hydroponic, yield, quality

S02-PI-14

Hydroponic *Eleutherococcus senticosus* (Rupr. & Maxim) as a source of biologically active compounds and herbal tea

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The production of functional foods and herbal teas is a pressing issue in the world. In this regard, the introduction of the rare, adaptogenic and immunomodulatory medicinal plant Siberian ginseng - *Eleutherococcus senticosus* (Rupr. & Maxim) (ES) and the development of hydroponic technology for its cultivation are promising. This study aims to obtain herbal tea and biologically active compounds (BAC) from the leaves of ES using the hydroponic method. Experiments were carried out using the EBB & FLOW outdoor hydroponic system and soil culture in the experimental field of the Institute of Hydroponics Problems in Ararat Valley. The plants were fed 2 times a day with Davtyan's nutrient solution (N 200mg L^{-1}, P 65mg L^{-1}, K 350mg L^{-1}, pH 5.8-6.5, EC 1.2-1.3mS cm^{-1}). The content of major BAC (eleutherosides, flavonoids, phenolic acids, vitamin "C", carotenoids, chlorophyll a, b), and gross β-radioactivity in the leaves of ES were studied. According to the results, the content of total flavonoids and eleutherosides was 1.6 and 1.5 times higher, respectively, in hydroponic leaves than in soil plants during the fruiting phase. The content of phenolic acids in the leaves of hydroponic and soil plants formed the following descending range: chlorogenic > rosmarinic > gallic > caffeic acids. During the vegetation period in fresh leaves of ES, the content of vitamin "C" and chlorophyll (a+b) in hydroponic leaves was 1.2 times higher and the content of carotenoids was 1.3 times lower than in soil plants. The gross β-radioactivity of ES leaves in hydroponics and soil did not exceed 1.0 Bq g^{-1}, which can be considered radioecologically safe according to acceptable WHO standards. Thus, this study is of practical importance, as ES leaves grown by hydroponic and soil methods can serve as a rich source for antioxidant herbal teas, BAC, dietary supplements, etc.

Keywords: Siberian ginseng, EBB & FLOW system, eleutherosides, flavonoids, phenolic acids, chlorophyll (a, b), gross β-radioactivity

S02-PI-15

Dicamba drift on green onions and possibility for overcoming the herbicidal stress by subsequent plant biostimulant application

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Onion (*Allium cepa* L.) is a widespread vegetable crop with a high content on nutritional substances. One of the most commonly used weed control menthods in crops the herbicidal application. In certain cases, they can have a toxic effect on the crop. Herbicide phytotoxicity can occur as a consequence of herbicide drift on non-target plants or areas. This undesirable phenomenon can be observed in low-volume spraying with small droplet sizes, as well as in conditions of inappropriate wind speed and direction. The aim of the present study was to investigate the effect of different rates of dicamba-containing herbicide product on green onions and its potential to be overcome the herbicidal stress by medicative biostimulant treatmen t. In this regard, in 2022 and 2023, a trial with the green onion variety "Lyaskovski 90" was carried out at the Agricultural University of Plovdiv, Bulgaria. The trial was performed a herbicide drift of Dikash 48 SL (containing 480 g/l dicamba) in rates 0.10; 0.20; 0.30; 0.40; 0.50, and 0.60 l ha^{-1} in crop growth stage 6-8 leaves to be imitated. A comparison of the performance of the plants received different rates of the herbicide and the same rates followed by ameliorative biostimulant treatment was studied. The subsequent treatment with the biostimulant Amino Expert Balans in a rate of 1.00 l ha^{-1} three days after the imitation of the herbicide drift was done. The obtained results were compared with untreated control (without herbicidal drift or biostimulant treatment). The onion injury after herbicide application was evaluated, as well as the enhancement effect of the biostimulant. All studied Dicash 48 SL rates caused crop injury resulting in chlorosis and leaf twisting. The damage levels increased with increasing the herbicidal rate sprayed, but enhancement of the plants when the biostimilant for medicative treatment was distributed.

Keywords: green onions, herbicide injury, biostimulant

S02-PI-16

Optimizing the chemical weed control in tomatoes

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Tomatoes are vegetable crop grown in a great number of countries around the globe including Bulgaria. Weeds are one of the factors that limit the normal growth and development of the crop. The aim of the present study is to optimize the chemical control of weeds in tomatoes. In this regard, in 2021 and 2022 a field experiment with tomatoes, variety "Kasey" F1, was carried out in the experimental field of the Agricultural University - Plovdiv, Bulgaria. The experiment includes the following variants: 1. Untreated control (no weed management applied); 2. Economic control (removal of weeds by hoeing without herbicidal treatments); 3. Smerch 24 EC (240 g/l oxyfluorfen) - 1.00 l ha^{-1}; 4. Dual

Gold 960 EC (960 g/l s- metolachlor) - 1.20 l ha^{-1}; 5. Smerch 24 EC + Dual Gold 960 EC in rates 0.50 l ha^{-1} + 0.60 l ha^{-1} (applied in tank mixture); 6. Temsa SC (100 g/l mesotrione) - 1.50 l ha^{-1}. The tested herbicides were applied to the soil before transplanting the tomatoes (BBCH 00). The efficacy of the studied herbicides was evaluated by the 10-score scale of EWRS. The selectivity was evaluated by the 9-score visual scale of EWRS. The highest herbicidal efficacy against the weeds Portulaca oleracea L., Amaranthus retroflexus L., Solanum nigrum and Setaria viridis (L.) P. Beauv. after alone application of Smerch 24 EC in rate 1.00 l ha^{-1} and the combine application of Smerch 24 EC + Dual Gold 960 EC in rates 0.50 l ha^{-1} + 0.60 l ha^{-1} in tank mixture was recorded. Under the conditions of the experiment, on the 14th and 28th day after the alone application of Temsa SC in the rate of 1.50 l ha^{-1}, phytotoxicity with score of 4 was reported on tomatoes. The highest yield of tomatoes, was reported at the Economic control, followed by Smerch 24 EC - 1.00 l ha^{-1} and the tank mixture of Smerch 24 EC + Dual Gold 960 EC.

Keywords: Tomatoes; weeds; efficacy; yield

S02-PI-17

Assessing the allelopathic potential of white clover (*Trifolium repens*) for weed control in organic agriculture on long pepper (*Capsicum annuum* convar. *longum*) crop

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The aim of the present work was to evaluate the allelopathic influence of white clover (*Trifolium repens*) on weed control. A single experimental variant was investigated, represented by the intercropping of white clover and birdsfoot trefoil (*Lotus corniculatus*) with long pepper (*Capsicum annuum* convar. *longum*). The control represented by pepper crop without allelopathic species which was tillaged three times manually. The allelopathic species were sown 52 days prior to pepper planting. Weed infestation was evaluated using the metric frame. The number of weeds and their fresh matter per m2 were assessed. The main weed species identified in pepper crop were: red-root amaranth (*Amaranthus retroflexus*), cockspur (*Echinochloa crus-galli*), perennial sow thistle (*Sonchus arvensis*), groundsel (*Senecio vulgaris*), pale knotweed (*Persicaria lapathifolia*), purslane (Portulaca oleracea), guasca (*Galinsoga parviflora*), Canada thistle (*Cirsium arvense*), bindweed (*Convolvulus arvensis*), flower-of-an-hour (*Hibiscus trionum*), crabgrass (*Digitaria sanguinalis*), shepherds purse (*Capsella bursa pastoris*) and petty spurge (*Euphorbia peplus*). The results indicated that the intercropping of white clover with pepper significantly reduced the number of weeds in the field compared to the control treatment without allelopathic species. This study highlights the potential of white clover as an effective allelopathic species for weed management.

Keywords: chemical interaction, associated plants, suppressive effects, secondary metabolites

S02-PI-18

Integrated pest management model to control whitefly (*Bemisia tabaci*) and increase the quality of the processing tomato products

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The goal of this study was to provide simple and easy-to-use tools and solutions for risk assessment and decision-making process, aiming at crop protection and production sustainability. The risk assessment plan proposed yellow adhesive traps for monitoring adults and weekly visual observations on a sample of 25 plants, considering leaflets at different positions in the plant. The results revealed that the first records of adult whiteflies in the yellow adhesive traps occurred about a week before the first attack on the crop, which was the basis for the decision-making process. The monitoring results combined with the technical profile and characteristics of the plots` reinforced the need for prior evaluation and intervention time. In addition, the work developed by a focus group with farmers, technicians and researchers indicated that these risk assessment strategies will be even more effective if networking and knowledge sharing are permanent on a co-creation basis. The treatments with insecticides, the timing and the active ingredient selection, in the final phase of the crop, combined with the use of cultivars with high content of lycopene, suggested an increase in the quality of the final product.

Keywords: Risk assessment; decision-making; IPM; co-creation solutions; tomato quality

S02-PI-19

Protection of the organically produced potato crop against the Colorado beetle

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As an alternative to synthetic insecticides, some of the current combat concepts (especially in the field of organic culture) refer to the use of insecticides extracted from different plants and microorganisms. The purpose of the research in this work was to test some alternatives to the chemical method by using some metabolic extracts from plants and some bioinsecticides.
The effectiveness of metabolic extracts when performing two treatments was over 80% for the extract obtained from *Athyrium filix-femina*, followed by the combination obtained from *Tanacetum vulgare* + *Arthemisia absinthium*, over 70% efficacy.
Even if these "insecticides" obtained from plants are not very effective, some of them induce the inhibition of feeding because the damage to the leaf surface is only in a very small percentage (up to 10%).

Keywords: organic potato, bioinsecticides, control, efficacy

S02-PI-20

Pest management using predators in cucurbits crops in high tunnels

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The *Cucurbitaceae* family has economically important species including cucumber, melon, watermelon, calabash, squash and pumpkin, cucumber being one of the most important cultivated greenhouse crops. Biological pest control can be achieved through both biological treatments and parasite and predator releases. This experiment aimed to study the efficacy of predators against pests like mites (*Tetranychus urticae*), thrips and aphids. For the control of the red spider mite were tested the efficacy of Amblyseius andersoni predator (25.000 individuals/ 500 sq m), for thrips, Orius laevigatus (100 individuals/ 500 sq m) and Transeius montdirensis (50.000 individuals/ 500 sq m) predators and for aphids it was released a parasitic wasp, Aphidius colemani 1000 individuals/ 500 sq m. The O. laevigatus and T. montdirensis recorded an effectiveness in controlling thrips between 88.35 and 94.68% in cucumber crops and in squash crops it was between 82.21 and 86.27%, which denotes that they can achieve effective control of the pest. The A. colemani predator had an effectiveness between 65.31 and 75.26% in cucumber crops and between 62.00 and 77.37% in squash crops. In cucumber crops, the A. andersoni predator had an efficacy for the egg stage of the pest between 73.93 and 79.95%, for the nymph stage an efficacy between 73.76 and 85.77%, and for the of adults between 81.84 and 90.07%.

Keywords: aphids, cucumber, predators, pests, squash, *Tetranychus urticae*

S02-PI-21

Hot and Spicy - understanding molecular basis of pungency in *Capsicum* spp

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Widely cultivated all over the world, peppers are loved and used in a variety of forms. Fresh for a healthy diet, powder as a condiment, or in industry for colors or for pharmaceutical needs, peppers have a wide domain of use. Although the peppers' pungency is highly appreciated for health reasons and in gastronomy, people' appreciation of pepper taste is unique, and what is mild for somebody can be very spicy for somebody else. Capsaicin fruit content is the main reason for pepper pungency.

Understanding the biochemical capsaicinoid biosynthesis pathways and discovering the genes responsible for controlling the biosynthesis process are some of the major goals in Capsicum research. These kind of studies deliver new data to pepper breeders, making it easy to select pepper genitors with the desired amount of spiciness. This review integrates the latest information about capsaicin biosynthesis, capsaicin biosynthesis genes, transcription factors controlling the biosynthesis process, and molecular markers responsible for pungency in pepper fruits.

Keywords: hot peppers; pungent; capsaicinoids; pungency genetic factors

S02-PI-22

Clonal micropropagation of *Eleutherococcus senticosus* (Rupr. & Maxim.)

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Significant progress and development in the field of science agriculture and technology in many countries around the world has stimulated the use of in vitro tissue culture technology. This agrobiotechnology promotes the introduction of new exotic, agricultural, and pharmacologically valuable species, as well as the propagation, reproduction, and increase in plant productivity. Plant tissue culture should not be used in all cases, but it offers clear advantages when species are difficult to propagate traditionally. This will be the case, e.g. with rarely or never flowering species, low seed germination or variable seed quality, and slow-growing taxa such as woody and shrubby plants such as Eleutherococcus senticosus (ES) (Rupr. & Maxim.). ES is one of the valuable adaptogen plants, which herbs are used particularly in the food, pharmaceutical, and cosmetic industries. The aims of the study are the possibility of introducing into in vitro culture, clonal micropropagation, and obtaining healthy planting material for ES.

Experiments were carried out using tissue culture methods. Micro-cuttings and micro-shoots were passaged and cultivated on Murashige and Skoog (MS) nutrient media with various modifications of the concentration of micro- and macro-elements, growth regulators, sucrose, etc.

According to the results of the study, it was found that in isolated culture, the sterilization efficiency of ES explants (bud, shoot, leaf) isolated from hydroponic plants was 86%. Under in vitro conditions in 0.5MS nutrient medium, a concentration of 0.5 mg/L GA3 contributed to the elongation of the internodal segments of micro-cuttings and micro-shoots to 1.5 – 2.0cm. Micro shoots were passaged on 0.5MS nutrient medium without nitrogen, with 1 mg/L IBA, where 80% was observed rhizogenesis. Concentrations of 2.0 mg/L BAP, 0.5 mg/L IBA, and 0.5 mg/L GA3 in 0.5MS nutrient media contributed to the formation of 4 to 6 adventitious micro-shoots on micro-cuttings.

Thus, this study has scientific and practical significance, since clonal micropropagation contributes to the accelerated propagation of slow-growing ES and the production of homogeneous planting material, which can serve as a source for the production of herbal teas and medicinal raw materials.

Acknowledgments: The work was supported by the Science Committee of RA, in the frames of the research project №21T- 4D205.

Keywords: in vitro, tissue culture, micro-plants, MS nutrient media, growth regulators, GA3

S02-PI-23

Variability of morphological and production characters in some basil genotypes from Romania

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Basil plants of the genus *Ocimum* are aromatic plants widely cultivated in tropical and temperate regions. They are used in traditional medicine in our country, as culinary and medicinal plants and as a source of flavoring principles. The essential oils obtained from the aerial parts are rich in volatile organic substances, compounds with high market demand for the food and pharmaceutical industries. In this study, the variability of the main morphological and production characteristics of 10 Romanian basil genotypes grown in the field was followed, in order to assess the biomass yield performance. Their morphological determinations showed a high level of variability of the recorded characters. Thus, 7 of the 10 genotypes had an average height of over 60 cm, height which in 7 of the 10 genotypes also correlates with the diameter of the bush which was over 45 cm. Observations on production characters revealed four genotypes with productions of more than 30 t/ha of green biomass and 7 genotypes with productions of more than 5t/ha of dry biomass, which can serve as genetic sources for the improvement of basil culture.

Keywords: *Ocimum basilicum*, basil, cultivars, germoplasm resourse

S02-PI-24

The effect of cultivar type on the production of *Spinacia oleracea* L.

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The aim of the research is to study the best performing varieties in relation of growth, yield and quality of spinach production. The research was carried out in a private vegetable farm. Four spinach varieties - Clipper F1 (C); Mercat F1; Matador and Victoria were studied to determine the growth, development and yield. For spinach, the aerial part of the plant is an important parameter that characterizes the degree of plant development and the optimal harvesting time. The period from sowing to emergence, on average over the years of experience, did not vary greatly depending on the variety, being within the limits of 9-10 days. Since the experience was established in the greenhouse, all the variants had optimal germination conditions, which favored the acceleration of seed germination and uniform plant emergence. The total number of

leaves per plant depending on the variety - was 9,2 - V4 Victoria up to 13,0–12,5 leaves (V1 Clipper and V3 Matador). During the vegetation period, the varieties studied formed a height of the rosette that varied within the limit of 15.2–19.8 cm. We found that plants with a wider and longer leaf, form a higher rosette height, and plants that form a long petiole - a semi-spreading rosette of leaves. It is difficult to identify all the existing spinach varieties, that differ a lot according to the shape of the rosette, the color and the way the leaves are spread, the length, width and shape of the leaf. Determination of leaf area it was realized with the Portable Leaf Area Meter. On the total leaf area per plant directly influenced the measured leaf traits: leaf blade width, leaf blade length, as well as the number of leaves per plant. The largest leaf area was recorded at the hybrid Clipper F1 being 102 cm^2.

Keywords: varieties, leaves, spinach, growth, aerial part, vegetation period, yield

S02-PI-25

The behavior of the Romec 554j tomato variety (*Lycopersicon esculentum* Mill.) on the sandy soils of SCDCPN Dăbuleni

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Tomato (*Lycopersicon esculentum* Mill.) is one of the most important vegetable species, due to its particularly high nutritional value. The nutritional value of tomato fruits is given by the content of carotenoids, polyphenols, sugars, organic acids, minerals and vitamins. Worldwide, tomatoes are grown on an area of approximately 4.85 million hectares (Faostat, 2019), and in Romania on an area of approximately 40,000 hectares, especially in the counties of Olt, Galați, Dolj, Giurgiu, Buzău (FAO, 2018). The success of tomato cultivation is conditioned by many factors, but the cultivar (variety/hybrid) has an essential role. In this sense, at the Research-Development Station for Plant Culture on Sands Dăbuleni, in the period 2021-2023, research was carried out on the variability of the main quantitative characters in the tomato genotype Romec 554j. Fruit weight (g), fruit diameter (cm), pericarp thickness (mm) and soluble dry matter (S.U.S%) were analyzed. The results obtained differed according to the climatic conditions of each year of the study. The registered biometric data were statistically processed, calculating for each analyzed character the mean ($\bar{x}$), the standard deviation (s), the coefficient of variability (s%), the range of variability ($k = \bar{x} \pm s$). The calculation and analysis of the variability revealed, on average, during the three years of the study, a small variability for fruit diameter (s% = 7.38;) and medium for fruit weight (s% = 14.95); pericarp thickness (s% =13.34); soluble dry matter (s% = 12.64). Although the tomato variety Romec 554j is a stable variety, the current climatic conditions increasingly leave their mark on the quantitative characteristics of the tomatoes grown in the southwestern area of Romania, the improvement of this species gaining particular importance. The variety Romec 554j still represents a valuable material in the improvement process.

Keywords: tomato, genotype, quantitative characteristics, sandy soils

S02-PI-26

Evaluation of antioxidant activity and compounds in the fruits of some tomato cultivars

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Tomatoes are the most consumed vegetable globally and a valuable source of antioxidants. The consumption of tomatoes (appropriate cultivars) can significantly improve the human diet. In an experimental study conducted at the University of Craiova, six tomato cultivars (*Lycopersicon esculentum* var. *cerasiforme*): 'Camelia F1', 'Italian', 'Yellow Pear', 'Italian Ice F1', 'Red Lightning F1', and 'Honey Delight F1' were evaluated. Average fruit weight, fruit color, and shape were assessed, together with quality parameters such as soluble solid content, reducing sugars, vitamin C, total polyphenols, total flavonoids, carotenoids (lycopene and β-carotene), and antioxidant activity (DPPH and ABTS). 'Camelia F1' and 'Italian' presented high values in vitamin C, total polyphenols, flavonoids, lycopene, and beta-carotene, while 'Red Lightning F1' recorded high values of antioxidant capacity (DPPH and ABTS). This study aimed to investigate the content of the main bioactive compounds in cultivars with red and yellow fruits, of various shades belonging to the cerasiforme variety.

Keywords: *Lycopersicon esculentum*, reducing sugars, vitamin c, polyphenols, flavonoids, total antioxidant capacity

S02-PI-27

Technological perspectives on the effect of some technological factors on the productivity of *Phaseolus coccineus* L.

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Runner beans (*Phaseolus coccineus*) are preferred by consumers for the main characteristic that differentiates them from common beans, i.e. the larger bean size, MMB ranging from 900 to 3000 g, and their nutritional properties are very similar to those of P. vulgaris. The main risk factors of this species are pedological drought, atmospheric drought, and +25°C temperatures. Therefore, a study was necessary to adapt the technological factors to the requirements of the plant under Romanian environmental conditions in order to high yields. Thus, in the year 2022, a polyfactor experiment was set up in the experimental field of the Vegetable Growing Department at Iasi University of Life Sciences: Factor A - Support system with two graduations (pyramid and trellis); B - Local population, with three graduations, Cozia 1, Cozia 2 and Cozia 3; C - Irrigation norm, with two graduations (300 m3/ha and 400 m3/ha) and D - Fertilization type, with three graduations (unfertilized, organic fertilized, chemically fertilized). Following analysis of the production results, the variant that stood out was Trellis x Cozia3 x 300 m3/ha x Chemically fertilized.

Keywords: runner beans, agricultural productivity/yield, support system, plant nutrition, variety

S02-PI-28

Interaction effect of planting time, mulching and fertilization on perennial wall-rocket

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Arugula, also known as rocket, indeed encompasses various species, two of which are commonly cultivated: Eruca sativa, for which the name annual rocket is preferred and Diplotaxis tenuifolia, for which the name perennial wall-rocket is preferred. Perennial wall-rocket is a leafy vegetable of the Brassicaceae family, specific to the Mediterranean area, which has recently been taken over from wild flora. The aim of study was to evaluate the good practices of planting time, mulching and fertilization on perennial wall-rocket. In this study we evaluate the behaviour of the cultivar Seledor, under the influence of three technological factors: 1) planting time with three graduations (28.03 = Epoch 1; 7.04 = Epoch 2 and 17.04 = Epoch 3); 2) mulching, with three graduations, non-mulched (NM), mulched with white polyethylene film (WLDPE) and mulched with black polyethylene film (BLDPE) 3) fertilization, with three graduations, non-fertilized (NF), organically fertilized (O) and chemical fertilization (Ch). The experiment was carried out in an unheated plot during the winter-summer cropping cycle in a split-plot design with three replications. The highest yield for the planting time was obtained for the Epoch 1, 51.58 t·ha-1, for mulching factor by the white polyethylene film variant, 52.5 t·ha-1, and for the fertilization factor, by the organically variant, 49.80 t·ha-1. Regarding the combined influence of the three factors the higher yield was obtained by Seledor planting on 28 March, un-mulched and chemically fertilized, respectively 63.4 t·ha-1. These results show that perennial wall rocket can be grown successfully according to the farming practices applied.

Keywords: *Diplotaxis tenuifolia*, planting time, mulching, fertilization, yields

S02-PI-29

Evaluation of the Soil-Plant system of a pepper crop (*Capsicum annuum* L.) using hydromulching

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The aim of this work is to evaluate the use of hydromulching as a methodology to be considered in the reduction of inorganic fertilizers application in pepper crop through the study of the nutritional composition of the soil solution. Pepper plants were grown outdoors without mulching (S), mulched with linear low-density polyethylene (Pe) or with different types of organic hydromulch composed of residues of other crops, namely: straw (C), pepper (P), tomato (T), artichoke (A), olive mill waste (ALP), almond shell (ALM), mixture of tomato and rapeseed (TCO) and mixture of straw and rapeseed (CCO). The ionic composition of the soil solution of each mulching treatment was analyzed. Soil respiration was also evaluated as well as vegetative growth variables: leaf and stem biomass, stem diameter and plant length. In general, the concentration of the macroelements analyzed in the solution of hydromulched soils was higher than in the non-mulched soil and in those mulched with polyethylene, with increases on K, Mg and SO4-2 concentration. Soil respiration was also higher in the mulched treatments than in the uncovered soil. On the other hand, vegetative parameters were positively affected by the use of the hydromulching condition. Taken together, these results highlight the potential applicability of hydromulching towards a more sustainable and circular agricultural model.

Keywords: Fertilization, sustainable agricultura, circular economy, organic mulch, pepper

S02-PI-30

The use of new ecological hydromulching materials improve the productivity of pepper (*Capsicum annuum* L.) crops under Mediterranean climate condition

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In this work, the effect on productivity of the use of different types of hydromulches on pepper plants (*Capsicum annuum* L.) was studied. Pepper plants were grown outdoors without mulching (S), mulched with linear low density polyethylene (Pe) or with different types of ecological hydromulches composed by residues from other crops, namely: straw (C), pepper (P), tomato (T), artichoke (A), olive mill waste (ALP) and almond shell (ALM). The parameters studied were commercial yield and number of commercial fruits, leaf and stem biomass, stem diameter, plant length, gas exchange parameters (photosynthesis, stomatal conductance, transpiration and water use efficiency), as well as SPAD unit content and fluorometry (Fv/Fm). Regarding photosynthetic parameters, no significant differences were observed between the different mulching treatments. However, vegetative development parameters were affected by the use of mulch, which were superior in plants covered by Pe, C and ALP in comparison to the uncovered ones. Commercial yield in the hydromulched plants were significantly higher than in the uncovered soil, especially in plants covered with P. These results represent advances in the use of the hydromulching technique in crops of substantial economic importance such as pepper in Mediterranean environments.

Keywords: Sustainability, circular economy, productivity, *Capsicum annuum* L., organic mulches

S02-PI-31

Circular fertilisers for soilless systems: evaluation methodology applied to phosphorus

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Recirculating soilless systems in greenhouses are extremely nutrient-efficient, but their reliance on minerals from finite natural reserves is a long-term sustainability concern. This is part of the impetus behind the transition away from a 'linear' economy to a 'circular' one. Moving away from conventional fertilisers to circular alternatives brings questions: where should nutrients come from? How applicable are recovered nutrient products? How can the risk of contaminants be mitigated? Questions like these have been (and are still being) investigated. Particularly for open-field agriculture, this has also resulted in new guidelines for contaminant levels such as the EU Fertilising Products Regulation (FPR) 2019/1009. However, in greenhouse horticulture, especially soilless systems in which nutrients are delivered via fertigation and drain water is recaptured, many of these questions remain. In our research, we propose a methodology specific to soilless systems (and their unique properties) with which circular fertilisers can be evaluated in terms of availability, affordability and quality. We apply the developed methodology on the use case of phosphorus in soilless cultivation systems, using parameters from Dutch tomato greenhouses. Using simulated chemistry analysis, we find that alternative phosphorus compounds like struvite can be applied to soilless systems if dissolved in acid on-site in a 'C tank' (in addition to the conventional 'A-' and 'B' tanks used) and investigate the impact of this on nutrient recipes. For inorganic contaminants (e.g. heavy metals), we propose a 'safety by design' approach to quantifying their risk of accumulation. With it, we calculate contaminant limits for soilless systems for phosphorus and compare them to existing products and the EU FPR, concluding that soilless systems are orders of magnitude more sensitive than limits prescribed by legislation. This methodology can be applied to other nutrients and products, helping secure confidence for the transition to circular fertilisers for soilless systems.

Keywords: fertilisers, circularity, soilless systems, phosphorus, food safety, contaminants

SESSION III- NEW CULTIVARS AND PERSPECTIVE CROPS

S02-OIII-26

Effects of water deficit on some local tomato genotypes grown in soil under greenhouse conditions

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This study was carried out to determine the effects of different irrigation levels on some local tomato genotypes under unheated soil greenhouse conditions. In this framework, a total of 13 genotypes including 12 local genotypes (*S. lycopersicum*) and 1 F1 variety (Lapçin F1) as control genotype were included in the experiment. In the study, which was carried out with 2 replications according to the split-plot experimental design in randomized blocks, irrigation treatments were included in the main plots and plant genotypes were included in the sub-plots. The main plots were cultivated under full irrigation and two different water deficit treatments. In the full irrigation treatment, 20% of the available water capacity of the plant root zone was allowed to be consumed and irrigation was applied to bring the deficient soil moisture to the field capacity, while 70% and 40% of the water applied to the full irrigation was applied to the deficit irrigation treatments, respectively. During and after the experiment, measurements and analyzes related to yield values, irrigation values and leaf element contents were carried out and statistical evaluations were made. As a result of the evaluations, total yield decreased by 30.7% and 65.2% in deficit 1 and deficit 2 compared to full irrigation, respectively, and total fruit number and average fruit weight also decreased with increasing water deficit. When the yield-dependent water use efficiency and irrigation water use efficiency values were examined, the highest results were obtained in full irrigation, while a decrease was observed with the increase of deficit, however response of genotypes showed differences. Leaf element contents of the genotypes, decreased with increasing water deficit.

Keywords: *Solanum lycopersicum*, Drought, Stress, Yield, WUE

S02-OIII-27

Biostimulant effects of algae species, arbuscular mycorrhizal fungi and their combinations on yield and quality of yellow tomato landrace

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Recent agricultural research has prioritized the development of environmentally friendly management strategies to ensure food security, among which the application of biostimulants such as brown algae extracts, arbuscular mycorrhizal fungi (AMF) and their combination. Biostimulants, derived from bioactive materials and microorganisms found in organic matter, enhance plant tolerance to abiotic stress. The experimental protocol was based on the comparison between seven biostimulant treatments (three brown algae species, Cystoseria spp. - C.T., Fucus Vesiculosus - F.V., Padina Pavonica - P.P.; Arbuscular mycorrhizal fungi – AMF; C.T. + AMF; F.V. + A.M.F.; P.P. + AMF) plus an untreated control, in terms of effects on tomato yield, fruit quality, antioxidant properties, and biochemical activities. Plants treated with P.P. brown algae extracts produced a significantly higher number of fruits (20 per plant), compared to the untreated control. The highest tomato yield was recorded in plants treated with the P.P. and F.V. extracts (5.8.t ha-1 and 5.5 t ha-1, respectively). The combination of algae extract and AMF also improved yield (51.7 t ha-1), compared to the untreated control. Significant increase was recorded in the antioxidant capacity of tomato fruits following the application of biostimulants. The P.P. extract led to a notable increase in TAA levels (226.6 mg g-1 f.w), as well as the AMF+P.P. combination showed an improvement in antioxidant activity. Phenol content increased in tomato fruits treated with P.P. extract. Significant variation in catalase activity was noted in tomato fruits, particularly with the M+C and M+P combinations, indicating enhanced enzymatic antioxidant mechanisms. Overall, our study highlights the potential of biostimulants, particularly brown algae extracts and their combination with AMF, to improve tomato yield, antioxidant properties and biochemical activities.

Keywords: Sustainable agriculture, Brown algae, Arbuscular mycorrhizal fungi (AMF), Biostimulants, Abiotic stress, Algal extracts, Catalase activity, Plant response

S02-OIII-28

Zombi pea: a neglected potential crop

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Zombi pea (*Vigna vexillata*), an underexploited tuberous legume with edible tubers and pods, has the potential of sustainable food production being a climate smart crop. Compared to conventional tuber foods like cassava and sweet potatoes, it has a higher protein level. Hence, the zombi pea is a potential future wonder crop to ensure food and nutritional security in the era of climate change. The zombi pea is one of the domesticated Vigna species that has received the least attention in terms of study on its genetic makeup and potential for production, particularly in the Indian subcontinent. In this regard, during the 2021–2022 crop season, an experiment was carried out at the research farm of the Central Tuber Crop Research Institute (CTCRI), regional center, Bhubaneshwar. The experiment was laid out in the randomized block design with eight treatments (consisting of four levels of spacings combined with and without deblossoming) and three replications. The findings showed that the highest plant height, fresh weight of the leaf and stem, number of tubers per plant, weight of the tubers, length, girth, and yield of tubers per plant were all achieved with the widest spacing. The significantly highest green pod yield and tuber yield (150.85 q/ha) were recorded at the closest spacing. Deblossoming conditions encouraged more vegetative growth with the highest tuber yield per hectare (120 q/ha). The crop phenotype expressed fully in the wider spacing, while maximum total yield was experienced with narrow plant spacing. Retaining the flowers resulted in a significant pod yield, but removing the flowers increased the tuber yield. Understanding the potential of zombi pea for food and nutritional security in the face of climate change is made possible by the current work.

Keywords: Deblossoming, Food security, Phenotypic traits, Phenology, Yield traits, Zombi pea

SESSION IV - PROTECTED CULTIVATION SYSTEMS

S02-OIV-29

Production of selenium biofortified mizuna migrogreens

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In recent years, there has been an increasing interest in microgreens as consumers have gained more awareness about their nutritional benefits. Microgreens contain higher levels of phytonutrients and secondary metabolites than their mature-leaf counterparts. The short growing cycle (7–21 days), minimal space requirement (vertical farming), and high nutritional value make microgreens the crop of choice grown within an urban and peri urban farming framework and individual households, providing nutrients for urban dwellers while minimising food miles.
Brassica vegetables have received considerable attention as a result of their chemopreventive properties, which are mainly attributed to glucosinolate degradation products. The nutraceutical value of microgreens may be further enhanced through biofortification with micronutrients. Selenium (Se) applications have been shown to have the dual effect of both enriching food with an essential microelement and increasing the overall content of bioactive compounds in microgreens. However, the effect of Se on glucosinolate content depends on several factors, including species, varieties, Se dose, and method of application. This project aims to illustrate Se accumulation in mizuna (Brassica rapa var. japonica) and identify the Se dose that enhances the nutraceutical characteristics of the product in terms of the phenolic and glucosinolate compounds, without deleterious effects on yield. Mizuna was chosen since it is gaining popularity among consumers for its health-related benefits. More importantly, mizuna belongs to the Brassicaceae family, a family of natural Se bioaccumulators, exhibiting great potential to uptake Se and tolerate high Se environmental conditions. We will assess the nutritional value of hydroponically grown Mizuna with different nutrient solutions by using a Nutrient Quality Score that includes the relative dietetic contribution of some macro- and micro-nutrients.

Keywords: selenium, *Brassica rapa* var. *japonica*, glucosinolate, phenolics

S02-OIV-30

Adoption of European technologies for greenhouse production by the Colombian horticultural sector

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Greenhouse production, originated in Europe, has been widely adapted and replicated worldwide. In South America, and specifically in Colombia, more than 15,000 hectares are cultivated under greenhouse conditions. Due to the remarkable growth in the use of protected growing environments, an assessment of the degree of adoption of technologies and the current challenges facing this sector is required. This analysis aims to identify research needs for the coming years. The main objective of this work is to analyze the adoption of European technologies in greenhouse production within the Colombian horticultural sector. The analysis was carried out through a combination of systematic literature review and analysis of government data. The literature review was carried out in December 2023, using databases such as ScienceDirect, Springer Link, Scopus, Scielo and Google Scholar, using boolean operators that matched the terms relevant to the interest topic. The search was limited to a time interval from 1990 to the present date. Official data were obtained from the Ministry of Agriculture. The information and data analyzed indicate that in Colombia research has been conducted by a small group of organizations. The main research topics include the use of computational fluid

dynamics (CFD), the accurate and uniform supply of water and nutrients and environmental performance for crops grown under greenhouse. However, the appropriation by the productive sector remains to be assessed yet. Moreover, when examining the findings based on plant species, it becomes evident that ornamental plants and vegetables like tomatoes and lettuce have garnered the most focus. Furthermore, research efforts have been directed towards medicinal species such as cannabis. We conclude that there is no evidence in the literature of a wide adoption of technologies, and on the contrary, there is an interest in local developments in aspects such as the design of greenhouses and the search for local materials that can be used as substrates in the face of a growing interest in hydroponic systems. In brief, in Colombia the adoption of European technologies remains low, and the preference for local developments with considerably low levels of standardization stands out.

Keywords: Greenhouse, Horticulture, Hydroponics

S02-OIV-31

Simple model to predict yield and dry matter production of cucumber (*Cucumis sativus* L.) under Japanese greenhouse condition

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In recent years, large-scale production has been increasing in Japanese greenhouse horticulture. In the condition, predicting annual yields is essential for labor management and marketing strategy. Therefore, the simple model was developed to predict the total and weekly fresh weight of cucumber (*Cucumis sativus* L.) fruits in Japanese greenhouse. The model consists of some parameters for greenhouse climate condition (light and CO2 level), leaf area index (LAI), light extinction coefficient, assimilate partitioning to fruits and fruit dry matter content. The input data of calculations are the average outdoor daily integrated light intensity for the past 10 years, the predicted or measured CO2 level, and LAI. Model output are weekly fruit fresh weight and dry matter production. The model was validated by comparing predicted results with observed production data in 2018 - 2019(August - March) and in 2020 - 2021 (October – June). Even when only the three data (light, CO2, LAI) were used as input to the model, the model was able to predict the weekly and total fresh weight of fruits and total dry weight of plant with high accuracy.

Keywords: dry matter production, LAI, predition, simulation

S02-OIV-32

Effect of plant densities on glasswort growth and yield in floating system

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Salinity is one of the most important problems threatening global food security and environmental sustainability. Halophytes are considered to be one of the best salt-tolerant plants. In this study, *Salicornia perennis* Mill. which belongs to the Amaranthaceae family, has been selected as promising food crop and tested in floating culture to determine the effect of plant densities on growth and yield of glasswort. To keep the plants afloat, a 20 mm thick styrofoam with holes for pots was used on the solution. Perforated pots were placed at a distance of 15 cm between rows and 20 cm on the row. The experiment was set up with the number of seedlings as 1 (22.12 plants m-2), 2 (44.24 plants m-2), 4 (88.48 plants m-2) and 6 (132.72 plants m-2) in each pot. The solution EC was adjusted by adding sodium chloride to Hoagland nutrient solution. The highest plant height, root length, root fresh weight and stem diameter were 33.5 cm plant-1 (22.12 plant m-2), 81.83 cm pot-1 (88.48 plant m-2), 72.57 g (132.72 plant m-2) and 8.16 mm plant-1 (22.12 plants m-2), respectively. L*, b* and C* values of shoots were found to be statistically significant while ho and a* were not found to be significant. Glasswort fresh biomass was 4907.23 g m-2 obtained from 132.72 plants m-2. It was concluded that higher plant density increases the yield as fresh biomass, however plant growth parameters shows differences due to the plant density.

Keywords: Soilless culture, hydroponics, halophyte, Hoagland and Arnon, *Salicornia perennis* Mill.

S02-OIV-33

Effect of insect-proof nets on the greenhouse climate and the productivity of a soilless tomato crop

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Greenhouse vegetable production must minimize the use of chemicals such as insecticides as much as possible. A solution is the installation of insect-proof nets at the openings of the greenhouse. These nets limit the intrusion of insects into the greenhouse but they are also likely to modify the climate inside the greenhouse and consequently the profitability of production. The present research aimed to study the effect of such insect-proof nets on the productivity of a soilless tomato crop. The impact on the climate in the greenhouse was studied as well as the development of the plants. Two greenhouses, one equipped with nets and the other without nets, of 360m2 each were used as part of this experiment. The experiment was repeated in 2022 and 2023. The grape tomato variety studied was “Foundation” grafted onto the “DRO141” rootstock, this combination being widely cultivated in professional Swiss greenhouses. The results showed a slight reduction in yields in the presence of nets, around 6% (50kg/m2 against 53kg/m2). The climatic parameters have been monitored. The 24-hour average temperature was similar in the presence or absence of nets. However, the water deficit (Dx) ranges were different. Nevertheless, monitoring showed that the average daily values remained within an acceptable range for tomatoes, between 3 g/kg and 10 g/kg. The presence of netting has sometimes tended to make the plants a little too vegetative.

In addition, we were also able to show that in our continental climate with a southern tendency, the presence of nets made it possible to avoid having an atmosphere that could be sometimes too dry during the summer period. Installing insect-proof nets on greenhouses is therefore a sustainable solution to limit insect attacks and limit phytosanitary treatments. However, the grower must learn to work with this new equipment which changes the greenhouse climate and potentially the health and productivity of the plants.

Keywords: insect-proof nets, tomato, greenhouse, climate management

SESSION V- DISEASE AND PEST CONTROL

S02-OV-34

Effect of the essential oils of the species *Menta* and *Occimum* on the growth of the species *Sclerotinia sclerotiorum*

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Effective protection of agricultural vegetation against pathogenic microorganisms requires constant attention. Producers as well as consumers increasingly realize the risks related to excessive use of pesticides. Therefore, it is necessary to continuously develop the current knowledge in the field of alternative ways of protection of agricultural crops. The research reflects these facts. The aim of the research was to verify antifungal activity of the essential oils of the species *Occimum tenuiflorum* ´Tulsi´ a *Mentha x piperita* ´Danica´ towards pathogenic microorganism *Sclerotinia sclerotiorum*. This microorganism harms various vegetable species, such as *Daucus carota*, *Aphium graveolens*, *Brassica oleracea* var. *capitata*, *Brassica oleracea* var. *botrytis*, *Lactuca sativa*, *Cichorium inthibus* and others. It causes a disease commonly called white mold. The cultures of the pathogen were obtained from the gene bank of the Slovak University of Agriculture in Nitra, Slovakia. They were cultivated on Potato dextrose agar. The particular plant species were selected based on the previous studies, in which the stated species were characterized by the highest content of essential oils from dried matter (OT 5.73% EO, MP10.69% EO) grown in the university demonstration garden. The essential oils were extracted by hydrodistillation according to the standardized methodology. With the aim of finding the lowest lethal dose, they were diluted with distilled water with the addition of 1µl DMSO (Dimethyl Sulfoxide). We have specifically applied dilution with the following ratios: 1:29999, 1:19999, 1:4999, 1:2490, 1:999, 1:499, 1:249, 1:124, 1:74, 1:29, 1:14, 1:6.5 a 1:0. For the verification of the antifungal activity we used contact disc method. The discs with the diameter of 10 mm which contained the aforementioned dilutions were placed on colonized Petri dishes with Sclerotinia sclerotiorum. 24 hours later, the discs were removed, and swabs were taken from the places of contact zone of the disc and the culture. The swabs were applied on new sterile Petri dishes and incubated with the aim of verifying their vitality. Experiment results have shown that the

essential oil of the species *Mentha x piperita* ´Danica‘completely inhibited the growth of the pathogen S. Sclerotiorum in the dilution 1:6.5, 1:14 a 1:29. In the case of *Occimum tenuiflorum* ´Tulsí´ there was a complete inhibition solely in the variant without dilution. In the dilution of 1:6.5 the variant proved 83% inhibition success. These results may be of significant interest in the field of preventive protection of vegetation with repeated application. We assume that the specific way of application may, in the field conditions, markedly inhibit or completely eliminate the aforementioned pathogen as well as other pathogenic fungi. This study was supported by the budget of the projects KEGA 004SPU-4/2022 Interactive Classroom for Horticulture study program in the Context of Innovation of the Current Student's Teaching Process and VEGA 1/0517/21 Utilization of antifungal properties of essential oils to elimination of post-harvest decay of fruits and vegetables and their influence on sensory properties of these commodities.

Keywords: *Sclerotinia*, pathogen, *Mentha*, *Occimum*, essential oils, protection

S02-OV-35

CMV and CPMMoV impact in open field Ibarra chili pepper and its prevalence in wild flora around the crop in the Basque Country (Northern Spain)

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During the 2018 and 2019 crop cycles, an outbreak of mild leaf mosaics, fruit thickening and reduction in yield quality was observed in several open field Ibarra chilli pepper growing plots in the Basque Country (Northern Spain). DAS-ELISA analyses and subsequent confirmation by RT-PCR pointed out the presence of a tobamovirus, displaying a high nucleotide identity (>99.1%) with chilli pepper mild mottle virus (CPMMoV, GenBank: MN164455), representing the first detection of this newly identified Tobamovirus in Europe. The predominant variety in this region, "Ibarroria," lacks resistance to the group of Tobamovirus and also to other aphid-transmitted viruses like cucumber mosaic virus (CMV). Furthermore, weeds may contribute to the spread of plant virus epidemics by acting as reservoirs of viruses or/and their vectors. To understand the incidence of these viruses in open field cultivation, random samplings were conducted in the crop and surrounding weeds during the 2021 and 2022 crop cycles. At the end of the 2021 crop cycle, CMV was detected in 50% of the crop plants and CPMMoV in the 52.2%. At the end of 2022, CMV was detected in 100% of the crop plants and CPMMoV in 16.7%. Additionally, in a 2022 survey of 397 weeds at the plot edges, only one plant, Cerastium glomeatum was CPMMoV-positive, and three CMV-positive plants were identified as Capsella bursa-pastoris, Cardamine flexuosa, and Stellaria media. This study illustrates the considerable incidence and potentially deleterious impact of Tobamovirus and CMV on Ibarra chilli pepper crops in the Basque Country, emphasizing

the urgency for developing effective control measures and resistant varieties to mitigate losses and preserve crop yield quality.

Keywords: virus epidemics, plant virus reservoir, *Capsella bursa-pastoris*, *Cardamine flexuosa*, *Stellaria media*, *Cerastium glomeatum*, *Capsicum annuum*

S02-OV-36

Enhancing tomato tolerance against water stress and *Fusarium oxysporum* f. sp. *Lycopersici* through the artificial application of PGR and biocontrol agents

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Tomato (*Solanum lycopersicum*) is an edible berry that belongs to the family solanaceae and contributes significance to human health. Given its immense health potential, researchers are actively engaged in cultivation poses challenges due to its sensitivity and specific growth requirements. The plant demands consistent moisture throughout its growing season, making it susceptible to diseases under high moisture conditions. This study aims to assess the growth of different tomato cultivars exposed to drought stress and fungal wilt caused by Fusarium oxysporum f. sp. Lycopersici, with stressed plants treated with biocontrol agents and Plant Growth Regulators (PGRs). To achieve this, a total of eleven distinct treatments were implemented under controlled conditions, and the results were evaluated after 120 hours of treatment. The evaluation was encompassing enzymatic activities (including CAT, SOD, POD, and PPO), physiological parameters, as well as growth and morphological parameters (root length, shoot length). This study employed a factorial design using Completely Randomized Design (CRD) to analyze the effects of different treatments on tomatoes under stress conditions. The findings of this research endeavour hold promise for understanding the potential of biological control agents and PGRs in mitigating the detrimental impacts of drought stress and fungal wilt on tomato plants, thereby offering insights into potential strategies for enhancing tomato cultivation.

Keywords: Tomato, water stress, *Fusarium oxysporum* f. sp. *lycopersici*

S02-OV-37

Insights into the occurrence and race distribution of *Fulvia fulva* (syn. *Cladosporium fulvum*) in Germany

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Fulvia fulva (syn. *Cladosporium fulvum*, *Mycosphaerellaceae*), a dematiaceous fungus, is the causal agent of tomato leaf mold, a devastating disease with significant implications for tomato cultivation especially in organic farming. As resistance, breakthroughs are increasingly occurring in widely grown commercial tomato cultivars that were previously resistant to *Fulvia fulva* infection can lead to defoliation, resulting in

substantial economic losses. The regulation of *F. fulva* is a great challenge especially because new races of the pathogen are constantly developing. However, limited knowledge exists on *F. fulva* races associated with tomato production in Germany. In this comprehensive study, we collected 62 isolates of *F. fulva* from 32 locations across Germany. To verify the pathogenicity of these isolates and the correlation with the observed disease symptoms, we have conducted a series of pathogenicity tests. Subsequently, we performed race determination experiments, revealing a diverse set of races, including race 0, race 1, race 2, race 3, race 5, race 6, and race 9. Furthermore, genetic analysis focused on four previously described effector genes Avr2, Avr4, and Avr9, revealing the presence of polymorphisms, with Avr2 exhibiting the highest variability. Our findings suggest dynamic changes in the genetic makeup of *F. fulva* populations, both across different regions and over time. Our findings of distinct race patterns, shedding light on the potential impact of tomato breeding concepts for organic farming. The examination of our isolates revealed remarkable diversity, emphasizing the need to consider population diversity as a crucial factor in the development of effective disease management strategies.

Keywords: avirulance genes, genotype, pathotype determination, resistance genes, *Solanum lycopersicum*, tomato leaf mold

S02-OV-38

Distribution and flight activity of the asparagus moth, *Parahypopta caestrum*, in Southern Italy as monitored by pheromone traps

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The asparagus moth, *Parahypopta caestrum* (Hübner) (*Lepidoptera*, *Cossidae*), is among the most damaging pests of *Asparagus* spp. in many Mediterranean areas. Adults lay eggs in the soil near the shoots and larvae bore the roots causing the destruction of asparagus plantations in a few years. Due to the cryptic nature of immature stages, control of this pest is very difficult. The recent identification of the female sex pheromone of *P. caestrum* can contribute to develop effective monitoring and control means. In this study, sex pheromone traps were employed to define the presence, distribution, and the flight period of *P. caestrum* adults in the main Italian area of green asparagus production. Funnel traps (Novatrap, Novapher, Italy) baited with green rubber septum dispensers loaded with a multicomponent sex-pheromone blend were positioned in green asparagus production sites located in Foggia and Campobasso provinces (southern Italy) during May and June 2021-2023. P. caestrum adults showed one period of flight activity per year. Adult emergence occurred from the third decade of May to the second decade of June, on 2021 and 2022, whereas it lasted until the end of June on 2023 due to higher precipitation levels and lower soil temperatures during April to June. Overall, the monitoring activity highlighted differences among areas and years in terms of pest abundance and pattern of flight activity, indicating high accuracy and sensitivity of sex-pheromone traps as a very useful monitoring tool in the Integrated Pest Managment of *P. caestrum*.

Keywords: *Lepidoptera*, *Cossidae*, *Asparagus*, sex-pheromone, pest monitoring, Integrated Pest Management, sustainable control

S02-OV-39

Bioprotection and grafting strategies to suppress pest pressure and improve yield of hydroponically grown organic tomato

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The infestation of major greenhouse pests such as whitefly, leafminer, and thrips, coupled with hot and humid conditions, poses significant challenges in controlled environment horticulture, particularly in organic tomato production. Low tomato productivity is attributed to pest pressure and the inadequate stress tolerance of existing cultivars, hindering their ability to optimize fruit set and yield. While the individual impacts of bioprotection and grafting strategies have been extensively studied in conventional production systems, their combined effects in controlled environments remain less explored. This study aimed to assess the efficacy of grafting (‘Maxifort’ × ‘Valdeon RZ’) and bioprotection strategies (Yellow sticky traps, Spinosad, and Bacillus thuringiensis) in mitigating greenhouse pest infestation and enhancing the yield of organically grown hydroponic tomatoes in adverse environmental conditions in Qatar. The experimental design employed a strip plot, with grafted ‘Valdeon RZ’ and non-grafted ‘Valdeon RZ’ as the main plot treatments, and Yellow sticky traps, Spinosad, and Bacillus thuringiensis randomly assigned to the subplots. Tomato cultivar ‘Valdeon RZ’ grafted on ‘Maxifort’ exhibited superior seedling quality, as evidenced by increased stem diameter and improved root attributes. Grafted ‘Valdeon RZ’ plants treated with Spinosad demonstrated enhanced net assimilation rate (23%), stomatal conductance (17%), and membrane stability index (14%), along with reduced transpiration loss (20%) and electrolyte leakage (18%), while maintaining intercellular CO2 concentration. Flowering occurred four days earlier in grafted ‘Valdeon RZ’ plants treated with Spinosad compared to untreated and non-grafted counterparts. Among the bioprotection strategies, Spinosad exhibited superior pest control efficiency, followed by Bacillus thuringiensis and Yellow sticky traps. Spinosad-treated plants showed a 37.5% reduction in leafminer and a 25% decrease in whitefly incidence compared to untreated control plants by eleven weeks after transplanting. Our findings can lead to practical strategies aimed at minimizing greenhouse pest infestations while improving tomato yield in an organic hydroponic system within a protected environment.

Keywords: Yellow sticky traps, Spinosad, *Bacillus thuringiensis*, ‘Valdeon RZ’, Protected environments

S02-OV-40

Biological soil health parameters increase as a consequence of land management change from conventionalized organic production to market gardening

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Market gardening is a low-tech, small-scale production system with an emphasis on diversity, ecological balance and community engagement. The basis of market gardening is a combination of agroecological principles and organic production. Through employment of management practices that minimizes soil disruption, and promotes the use of composts, cover crops, and mulches to increase soil organic matter content, this type of production system is suggested to lead to long-term sustainability. In the current project, a newly established market gardening system was compared to conventionalized organic field production over a period of one year in which soil samples were collected at four time points. With a focus on biological soil health indicators, analyses were made on soil organic matter, soil protein content, soil respiration, microbial activity, active carbon, total organic carbon, and nutrient availability. The results showed significant enhancements in soil health parameters in the market gardening system compared to the conventionalized organic production. This study thus underscores the potential of market gardening as a production system with high potential to improve soil health and increase sustainability in food production.

Keywords: sustainable food production, soil health, market gardening, agroecology, conservation agriculture, CASH protocol

S02-OV-41

Developing new techniques to integrate in the IPM strategy of the cabbage root fly *Delia radicum* L.

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Cabbage root fly (*Delia radicum* L.) can cause high yield losses in Brassica crops, and current control relies mainly on insecticides. The efficacy of three different methods against cabbage root fly as alternative control strategies was assessed. (1) Intercropping with flower strips constituted of buckwheat, cornflower or dill could increase the abundance of above ground natural enemies, but could not increase the abundance of soil-dwelling predators or improve egg predation. (2) The first test with a pneumatic control device dislocating cabbage root fly eggs from the cauliflower stem showed similar control as a standard insecticide drench treatment. (3) Yellow and green McPhail traps

in combination with a strong attractant showed, compared to other tested trap types, the highest catch rate and the highest selectivity and are promising trap types for mass trapping of cabbage root fly.

Keywords: natural enemies, intercropping, egg predation, pneumatic insect control, trap type, mass trapping

S02-OV-42

Virtual Greenhouse Simulator – an open, modular platform for analyzing greenhouse resource use efficiency

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Greenhouse climate and crop models are an important tool for analyzing and improving the production and resource use efficiency of greenhouse vegetable production. Such models can help us understand how choices regarding the greenhouse design, climate control, and crop attributes influence the performance of the greenhouse, including crop production, heating demand, lighting demand, energy use and water use. Throughout the history of greenhouse modelling, the development of models has generally been very isolated: research groups have rarely built upon other groups' work, and instead developed new models "from scratch", creating considerable repetition and redundancy. Virtual Greenhouse Simulator is a new, open-source, modular greenhouse modelling platform which aims at creating a common basis for greenhouse modelling. The platform allows to easily model various greenhouses – with different designs, equipment, control strategies, and crops – in order to predict how each greenhouse will perform in terms of production and resource use. The platform is open and easy to use by researchers and practitioners working in various locations and conditions. By creating this shared platform, researchers are able to collaborate, compare, and share their results. Some questions that can be answered by the platform are: how does the physiology of a vegetable crop influence greenhouse climate and resource use? What is the influence of strategies for the control of biotic and abiotic stress factors? And which greenhouse attributes have the most potential for reducing the resource use of the system? By using this platform in a collaborative way, it helps uncover practices and innovations that reduce the environmental impact of greenhouse vegetable production.

Keywords: Protected cultivation systems, Vegetable production, Resource use efficiency, Energy use, Water use, Greenhouse modelling, Crop modelling, Open source modelling

POSTER SESSION II

S02-PII-32

Biological pest control using predators in cucurbits crops in greenhouses

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The *Cucurbitaceae* family has economically important species including cucumber, melon, watermelon, calabash, squash and pumpkin, cucumber being one of the most important cultivated greenhouse crops. Biological pest control can be achieved through both biological treatments and parasite and predator releases. This experiment aimed to study the efficacy of predators against pests like mites (*Tetranychus urticae*), thrips and aphids. For the control of the red spider mite were tested the efficacy of Amblyseius andersoni predator (25.000 individuals/ 500 sq m), for thrips, Orius laevigatus (100 individuals/ 500 sq m) and Transeius montdorensis (50.000 individuals/ 500 sq m) predators and for aphids it was released a parasitic wasp, Aphidius colemani 1000 individuals/ 500 sq m. The O. laevigatus and T. montdirensis recorded an effectiveness in controlling thrips between 88.35 and 94.68% in cucumber crops and in squash crops it was between 82.21 and 86.27%, which denotes that they can achieve effective control of the pest. The A. colemani predator had an effectiveness between 65.31 and 75.26% in cucumber crops and between 62.00 and 77.37% in squash crops. In cucumber crops, the A. andersoni predator had an efficacy for the egg stage of the pest between 73.93 and 79.95%, for the nymph stage an efficacy between 73.76 and 85.77%, and for the adult stage between 81.84 and 90.07%.

Keywords: aphids, cucumber, predators, pests, squash, *Tetranychus urticae*

S02-PII-33

Biological and conventional control of *Sphaerotheca fuliginea* and *Tetranychus urticae* on cucumber crops in greenhouses

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The cultivation of cucumbers in greenhouses occupies an important area in Romania. The main foliar diseases and pests on cucumbers have a negative impact on fruit yield and quality. This experiment aimed to study the efficacy of biological and conventional control of powdery mildew (Sphaerotheca fuliginea) and mites (*Tetranychus urticae*) on cucumber crops in greenhouse. There are used conventional fungicides (Topas 500EC 0.5l ha-1, Amistar 1 l ha-1, Cidely Top 1 l ha-1, Dagonis 0.6 l ha-1) and biological products (Fytosave 2 l ha-1, Funres 3 l ha-1, Mimoten 3 l ha-1, Canelys 3 l ha-1) for controlling powdery mildew. Biological products for the control of the pathogen *Sphaerotheca fuliginea* had a much lower efficacy compared to chemical control products used in the conventional system. Between conventional (Nissorun 10 WP 0.08%, Floramite 240 SC 0.04%, Voliam Targo 0.06%, Vertab 0.05%) and biological (*Amblyseius andersoni*) control of mites there are no significant differences.

Keywords: pathogen, mite, powdery mildew, *Tetranychus urticae*, *Sphaerotheca fuliginea*

S02-PII-34

Sclerotium rolfsii survival after autumn biodisinfestation in Southeastern Spain

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The effect of biodisinfestation (soil amended with organic matter and tarped with a transparent plastic film) with mild temperatures was evaluated in Sclerotium rolfsii survival in a pepper greenhouse located in Murcia (Southeastern Spain). The treatments tested were: T1: Wheat Kernel Shell + Fresh Sheep Manure (WKS+FSM) 3.5 kg m-2; T2: Sunflower Seed Cake + Fresh Sheep Manure (SSC+FSM) 3.5 kg m-2; T3: Fresh Sheep Manure (FSM) 3.5 kg m-2; and T4: control without amendment and without plastic. The biodisinfestation was initiated in October and treatments were carried out for 6 weeks. Treatments were randomized in a complete block design with three replicates. The soil temperature and soil oxygen content were measured during the application of biodisinfestation treatments. Viability of sclerotia of Sclerotium rolfsii, buried at 15 and 30 cm soil depth, was determined before and after the application of treatments. Sclerotia viability was determined by sowing them in a selective agar medium followed by subsequent observation of sclerotia germination with a stereoscopic microscope (X 60 magnification). Soil temperature did not exceed 38ºC during the biodisinfestation treatment. Soil oxygen content was below 2% in the biodisinfestation treatments while in the control treatment was always close to 16%. Anaerobiosis was longer in the biodisinfestated soil with the SSC+FSM amendment (oxygen <2% up to 28 days) than with the WKS+FSM amendment (oxygen <2% up to 16 days). All biodisinfestation treatments reduced sclerotia viability when compared to the non-treated control. The order of amendments effectiveness was T2 (SSC+FSM) > T1 (WKS+FSM) > T3 (EFO). The above mentioned amendments reduced inoculum survival (expressed as germinated sclerotia) with respect to the control treatment 54-59%, 52-55% and 40-54% at 15-30 cm soil depth, respectively.

Keywords: southern blight, sclerotia, organic amendment, anaerobic soil disinfestation, soil biosolarization, *Capsicum annuum*

S02-PII-35

Foliar application of fungal culture filtrates enhances fruit yield of tomato plants under suboptimal irrigation conditions

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One of the major issues of present global concern is the climate change due to rising atmospheric CO2 concentration, which causes global warming and drought. Drought is by far the leading environmental stress factor in agriculture that limits the global productivity of major crops. Therefore, it is mandatory to stablish strategies for a sustainable and eco-friendly agriculture aimed at enhancing crop yield, drought tolerance and water and nutrient use efficiency, while reducing the negative impact of agrochemicals on the environment; potential solutions may be fostered by the use of microbial-based biostimulants (Morcillo et al. 2022). Soil application of cell-free culture filtrates (CFs) of microorganisms promotes growth and enhances the yield of horticultural crops (Baroja-Fernández et al. 2021). The objective of this work was to evaluate the extent to which foliar application of fungal CFs may improve yield of tomato plants subjected to water scarcity, and decipher the mechanisms therein involved. To do it, we characterized the fruit yield and the leaf metabolic responses of tomato plants (cv. Macizo F1) cultured under optimal irrigation conditions and water reduction (60% irrigation of the optimal condition) to foliar application of fungal CFs. In plants subjected to water stress conditions, the CF treatment improved number and commercial fruit yield, and enhanced organic acid content in fruits. This treatment also enhanced the levels of stress-responsive amino acids closely related to the GABA shunt (e.g. aspartate, glutamate, GABA and alanine) some of which are known to protect cell membranes against oxidative damage. Furthermore, it promoted the accumulation of jasmonic acid, salicylic acid and active cytokinins in leaves, and prevented the accumulation of soluble sugars such as glucose and fructose. The overall data strongly indicated that foliar application of fungal CFs enhances fruit yield and drought tolerance through mechanisms involving hormone and sugar signalling and prevention of oxidative stress.

Keywords: Microbial-based biostimulants; water stress tolerance; plant-microbe interaction

S02-PII-36

Streptomyces strain applied as tomato seed coatings to improve plant performance

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Streptomyces showed a remarkable ability to modulate plant response and colonize plant tissues as endophytes. As soil inhabitants they are also good rhizosphere colonizers and play a crucial role in the plant microbiome shaping and making them good candidates as microbial biostimulants. A Streptomyces spp. strain (DEF17) was tested on tomato plants grown under water deficit to assess its effectiveness in modulating plant

growth by seed coating application. Seed colonization tests confirmed the ability of this strain to colonize the emerging root of plant after seed treatment. Preliminary studies on the growth-induced effect of DEF17 treated plants showed an increased height of tomato plants at three weeks post seeding indicating its ability in modulating the plant growth. The aim of the experiment was to evaluate the effect of this Streptomyces strain in tomato plants grown under water shortage. The focus has been paid on physiological parameters, stress indices, and quality of the production. Interestingly, the presence of DEF17 induced different effects on tomato plants, affecting the concentration of chlorophylls and carotenoids, carbohydrates, and nitrates. At the same time the application of the strain induced a significant decrease in proline concentration in tomato leaves grown under non-stressful condition. Further studies on the production of metabolites and mechanisms of action of DEF17 strain are warranted to deepen its activities and potential use ad biostimulant product in agriculture.

Keywords: *Solanum lycopersicum* L., *Streptomyces*, PGPB, water deficit

S02-PII-37

The impact of planting density on yield and nutritional value of Glycine max (L) Merr. under outdoor hydroponics in Armenia

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The aim of the research is to investigate the influence of planting density on the yield and nutritional value of soybean seeds under conventional agricultural and controlled hydroponics conditions of Ararat Valley. The obtained data will later serve as a basis for organizing the industrial production of soybean in Armenia. The influence of different planting density (30, 50, 70, and 90 plants m-2) on the seeds yield and on the accumulation of most important metabolites (protein, fat, fiber, carbohydrates, etc.) was evaluated in outdoor hydroponics. The experiments were carried out in automatically nourished hydroponic equipment with 2.0 m2 surface area, using an EBB & Flow hydroponic system. Plants were nourished 1-2 times a day with the Davtyan nutrient solution. Soil culture was a control variant with 30 plants m-2 planting density. It has been shown that the planting density had significant influence on the yield and biochemical indices of soybean. Under hydroponic conditions the soybean seeds yield from per plant with the lowest planting density exceeded the densest one by 4.5 times. At the same planting density (30 plants m-2), the yield of hydroponic soybean seeds were 1.9 times superior to that of the soil ones. Also, soil plants were distinguished by the highest fat and lowest protein accumulation (1.3 times) compared to the hydroponic plants. The obtained results established the effectiveness of soybean cultivation in Armenia. It turned out that a planting density of 30 plants m-2 is the most optimal in regard to financial matters. The regulated hydroponic method ensures obtaining about 1162 g of soybean seeds, 366 g of protein and 256 g of fat per m2. For soil culture the above-mentioned indices are 596, 141 and 173 g, accordingly.

Keywords: soybean, soilless culture, soil, yield, protein, fat, fiber, carbohydrates, ash, moisture

S02-PII-38

Comparative characteristics of several biochemical indicators of *Ocimum tenuiflorum* L. in hydroponic and soil conditions

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Currently, more attention in the world is being paid to adaptogenic plants, which have a positive effect on the human body, help to adapt to external factors, work capacity and, most importantly, regulate the level of chronic stress. Among such plants is Ocimum tenuiflorum L., which is widely known in the traditional and folk medicine of a number of Southeast Asian countries. O. tenuiflorum gives tea a unique taste. It helps to manage stressful situations and depression, promotes memory and sleep recovery and stimulates brain function. The plant is also used for the treatment of infectious and viral, skin, liver, cardiovascular system diseases, pneumonia, asthma, atherosclerosis and a number of other diseases. The plant extract is reducing blood glucose levels. The beneficial properties of O. tenuiflorum are mainly due to the presence of essential oil in the leaves, the main components of which are linalool, cineole, camphor, eugenol and methyleugenol. It has an antibacterial effect, due to the content of phytoncides. The leaves of O. tenuiflorum also contain ursolic acid and flavonoids including apigenin, luteolin, orientin. The plant has a weak analgesic and antioxidant effect, due to the content of vitamin C, vitamin E, rosmarinic acid, and flavonoids (orientin and vicetin). It prevents the development of several types of malignant tumors, including those of the breast, colon and pancreas. The aim of the work is to study the efficiency of the plant and the change of several biochemical indicators under outdoor hydroponics and soil conditions. The results showed that growing media did not have any significant influence on accumulation of fresh and dry biomass of holy basil. It was found that a high content of vitamin C (2.9 times) in the fresh plant raw material was observed in the soil plants. The difference in the content of β-carotene, extractives and flavonoids was not significant. However, hydroponic plants exceeded the soil one in the content of the most important indicator - essential oil by 1.7 and in the content of phenolic acids by 1.2 times. Therefore, the cultivation of holy basil in both soil and soilless conditions of Ararat Valley is effective, and the resulting plant raw material can be used for the treatment of several chronic diseases, due to the high content of essential oil, extractives, flavonoids, and phenolic acids.

Keywords: soilless culture, holy basil, essential oil, flavonoids, phenolic acids

S02-PII-39

Electrophysiology indicates a role for iodine in fast response of *Capsicum* plants to interrupted irrigation and high temperature

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Iodine (I) is a mineral nutrient with beneficial effects on crop growth and fertility. How iodine evokes these effects is still poorly understood. It has been shown that iodine application has an impact on gene expression and modulates calcium-dependent signalling. In an attempt to record modulation of ion-dependent signalling, we applied a novel electrophysiological tool (Vivent biosensors) that measures electrical signals over long distance in plant stems. We used Capsicum pepper plants as these have been shown to positively respond to iodine applications. Plants were grown in the presence (3-4 micromole L-1) and absence (0.02 micromole L-1) of I in two consecutive periods of 6-8 weeks in a greenhouse during summer, on stone wool. The difference between the treatments was established by using either potassium nitrate without I or potassium nitrate containing 0.1% I in the nutrient solution recipe. The electrophysiological response to the ambient climate and interrupted irrigation was recorded using Vivent biosensors. Plants grown in the nutrient solution with I grew thicker stems, compared to plants grown without. The biosensors on plants with adequate I, detected an optimal plant balance index more often and detected a distinct response to interrupted irrigation. The difference in electrophysiological response between the two treatments was amplified during periods with temperature > 27 ^{o}C in sweet pepper (Capsicum), confirming the role of I in resilience to heat stress. These results further support the beneficial impact on crop growth and underscore that this is achieved via modulation of ion conductivity within stem tissue.

Keywords: Sweet pepper, resilience, abiotic stress, micronutrients, fertigation, hydroponics

S02-PII-40

Agri-Photovoltaic in greenhouse: optimization of sunlight

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Greenhouses' high energy consumptions results in 2 issues: cost of energy and carbon footprint. Photovoltaic (PV) solutions integrated on greenhouse surfaces tackle both of these issues. However, existing agrivoltaics solutions capture parts of the sun's incidence and transform it into electricity, which causes partial shading. This is incompatible with the large majority of greenhouse produces, as it reduces agricultural yield. The spectral splitting photovoltaic system of Voltiris is an innovative solution for energy production in greenhouses without affecting food production. Practically, the system filters spectrally sunlight: the light components required by plants to grow, i.e. the 'useful' colours, are left untouched and transmitted to the plants, whilst the other 'wasted' colours are focalized on a photovoltaic module to generate electricity. In this way, the entire light spectrum is utilised. Installed on existing greenhouse structures, the technology causes less than 10% partial shading. Moreover, with a continuous and dynamic tracking of the Sun, electricity production is optimised. In this study, a first prototype was installed at Agroscope in Conthey (CH) and analysed during the growing season 2022. The impact of the solution have been quantified in terms of plants' growth, development and yields of the different crops tested: tomato, pepper-bell, basil and

salad. On all crops, no significant impact have been observed for plant growth, yield and fruit quality. In addition, electrical measurements were realized to quantify the expected energy production and showed that the power output was two times higher than standard PV panel oriented south. Additional studies at larger scale need to be performed in order validated these preliminary results. Greenhouse production must also undertake a transition to 'greener' energies. This innovative technology contributes to the achievement of the target of carbon-neutral greenhouses in Switzerland by 2050, namely by promoting the effective production of renewable energy.

Keywords: Agriphotovoltaic, greenhouse, tomato, basil, spectral filtering

S02-PII-41

The influence of some technological measures on long pepper seed crop *Capsicum Annuum* L. var. *longum*

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Through this scientific work, it was aimed to make a modest contribution to the development of knowledge in the field of research in vegetable cultivation and especially that of the conservation of local varieties through own research on the production of seeds in different conditions of density and fertilization, these partial results are the subject of the present works.An experience will be organized according to three factors:The biological material used to establish the experiments was seed from the biological category S.A. (author's seed) Capsicum annuum L.Var.Longum variety Oranj. This cultivar is part of the collection of the Iernut Vegetable Research and Development Station.From the combination of experimental factors, 8 experimental variants resulted, placed in blocks subdivided into three repetitions, the surface of the experimental plot being 12.6 m2 and the entire experience 302.4 m2. Presenting the significance of the differences of the eight variants resulting from the interaction fertilization x decime x fruit load it can be said that the highest production is recorded in the variant with chemical fertilization, decime of 45 thousand, all fruits with a production of 2.81 kg/m2 and a production increase of 6% compared to the distinctly significant control variant. Regarding the organic fertilization of 45 thousand, all the fruits reach a production increase of 0.74% compared to the same significant control. Regarding plant development and the biometric results obtained, we can say that they were influenced by chemical fertilization, and regarding desime, they had the best results with 30 thousand plants.

Keywords: density, experiences, fertilization, production, plant

S02-PII-43

Effect of cultivar and plant density on plant growth, pods yield and green grains yield of broad bean (*Vicia faba* L.)

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Cultivar and plant density are two main factors known for greatly influence both pod and seed yield as well as the economic profitability of broad bean crop. The aim of this research is to evaluate the effect of three plant density (150.000, 200.000 and 250.000 plants/ha) on some plant characteristics, pods and grains yield of two broad bean cultivars, Karmazin and De Monica, in climatic conditions of NE Romania. In this experiment, the studied growth and yield related characteristics were plant hight, number of stems per plant, number of internodes per stem, number of pods per plant, number of seed per pod, while quantitative traits were pods weight, grains weight per pod, pod yield and grains yield. Regarding cultivar influence on analysed characteristics, the Karmazin cultivar showed the highest values in terms of plant height (83.51 cm), number of stems per plant (2.76) and number of seeds per pod (4.25), pods (16995.37 kg/ha) and grains (6680.86 kg/ha) yield, while De Monica cultivar obtained the highest values in terms of number of internodes per stem (15.99) and number of seeds per pod (4.44), pod weight (27.10 g) and green grain weight per pod (8.46 g). Relating to plant density influence on analysed characteristics, it was observed that the plant hight increases with the increasing in plant density (from 74.00 cm to 76.72 cm), while the number of stems per plant (from 2.39 to 2.79), number of internodes per stem (from 15.49 to 16.04) and number of pods per plant (from 3.16 to 3.88) increases with the decreasing in plant density. Pod yield (from 13517.50 to 17627.78 kg/ha) and green grain yield (from 4728.37 to 6354.96 kg/ha) increases, according to plant density. Regarding cultivar x plant density influence on analysed characteristics, it was observed a significant increase of plant hight (84.58 cm), pod yield (19125.00 kg/ha) and green grain yield (7614.45 kg/ha) at Karmazin x 250.000 plants, a significant increase in number of stem per plant (3.00), number of internodes per stem (16.51) and a number of pods per plant (4.77) at Karmazin x 150.000 plants and a significant increase in pod weight (27.66 g) and seeds weight per pod (8.71 g) at De Monica x 250.000 plants.

Keywords: number of pods per plant, plant hight, seeds weight per pod

S02-PII-44

Effects of civil reclaimed wastewater for the irrigation of lettuce (*Lactuca sativa* L.) and zucchini (*Cucurbita pepo* L.) in open field

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As consequence of the global warming the scarcity of water availability for agricultural purpose is now a reality and a critical point especially for the Mediterranean countries. New water resources and strategies to optimize the available water resources are therefore needed. Within the framework of sustainable water resource management and the promotion of eco-friendly agriculture, this study aims to assess the effectiveness of civil reclaimed wastewater from a constructed wetland for the irrigation of horticultural crops. The reclaimed wastewater (RW) were applied for the irrigation of zucchini (Cucurbita pepo L.) cv “Sayonara” and lettuce (Lactuca sativa L.) cv “Flavius”. Divided into two sections: one irrigated with conventional water and the other with constructed wetland treated wastewater The plants were characterized at maturity for several agronomic characteristics. The results showed a significant impact of irrigation water type on crop yield and fruit weight. Plants irrigated with constructed wetland treated

wastewater demonstrated higher productivity compared to those irrigated with conventional water for both crops. Particularly, a significant increase in fruit weight was observed in zucchini irrigated with constructed wetland treated wastewater. Regarding lettuce, besides increased yield, a higher number of leaves were recorded in plants irrigated with constructed wetland treated wastewater. These findings indicate that constructed wetland treated wastewater represents a valuable and sustainable resource for agricultural irrigation, contributing to water resource conservation and promotion of eco-friendly agricultural practices. The utilization of such water sources could constitute an effective strategy in addressing challenges related to water availability and food production, with potential long-term environmental and economic benefits.

Keywords: Wastewater, Sustainability, production, *Cucurbita pepo* L., *Lactuca sativa* L.

S02-PII-45

Enhancing *Brassica oleracea* L. production in deficit irrigation regime utilizing elicitors

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This study aimed to investigate the effects of solar radiation on the growth and biochemical variations of two genotypes of commercial rocket, namely Eruca sativa Mill. var. darkita and Eruca sativa Mill. var. lobata (RC1 and RC2, respectively), as well as Sicilian Black sprouting broccoli (Brassica oleraceavar. italica Plenck, Broccolo nero, BR). Black shade nets with different reduction of solar radiation (SR100, SR60, SR40) were employed in this experimental trial. The experimental design adopted was split plot and the main experimental factor was represented by solar radiation (SR100, SR60, SR40), the sencundary one represented by the growth stage (sprouts, microgreens and baby-leaves), and the third one by the genotype (BR, RC1 and RC2). The harvested plants were characterized for the main morphometric traits. A comprehensive assessment of various biochemical parameters, such as total glucosinolates content, sucrose, fructose, fructooligosaccharides (FOS), and total sugars, was conducted. Light use efficiency (LUE) determination revealed variations in biomass production and sugar profiles under different solar radiation (SR) conditions. Our findings shed light on the impact of solar radiation on the growth and biochemical profile of sprouts, microgreens, and baby leaves across both species. Notably, the total glucosinolates content exhibited a significant interaction between genotype and plant growth stage, ranging from 6.96 to 5.56 g TGLSs g -1d.w.for BR and RC2 genotypes, respectively. A significant finding concerns the sugars composition, which is predominantly influenced by solar radiation. The glucose and sucrose amount generally increased from sprouts to baby leaves for all evaluated genotypes, while the fructose amount increased from sprouts to baby leaves for BR but decreased during plant growth for RC1 and RC2. Additionally, FOS decreased under reduced solar radiation conditions during the baby leaves stage, with an increase in small sugars such as sucrose, glucose, and fructose compared to the sprout stage.

Keywords: vegetables, rocket, broccoli, plant growth stage, sugars, glucosinolates

S02-PII-46

Enhancing the water use efficiency of tomato crop in cold greenhouse by using grafted plants

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Sustainable production of vegetable crops is mainly focused on water economy and conservation techniques due to the reduction of access to fresh water for agriculture day after day. Grafting on vegetable crops, such as tomatoes, is likely an interesting technique for tolerating water shortage regimes. In this study, we evaluate the Water Use Efficiency (WUE) of four commercial tomato rootstocks on traditional tomato plants under water stress (WS) conditions carried out in cold greenhouse. Combined with three scions: two accessions of the Sicilian landrace 'Pizzutello' and a breeding line'101'from MVS s.l.r., in a split-plotdesign by two irrigation regimes: full irrigation (100%)and induced WS of 40%(60%irrigation). Diversity was observed among scions mainly: fruit size and number per truss, date to flowering and maturity; “Pizzutello di Paceco” having the lowest fruit size (31mm x 28mm) but the highest number of fruits per truss (14 fruit), “101” bigger fruit size (60mm x 34mm) and 12 fruits by truss. “Pizzutello grande” showed the lateness flower set and fruit maturity with an average fruit size of 45mm x 36mm with only 6 fruits per truss on average. At the physiological level, the water retention in leaves showed a reduced capacity of water stocking in stressed plants in all grafted and non-grafted combinations. Rootstocks showed diversity at the level of plant vigour on different cultivars under WS. “KS4” rootstock showed to induce lateness in fruit maturity under WS compared to other rootstocks and controls. “OptfortF1” allowed to reach the same yield under both irrigation regimes with a light earliness for the plants grown under WS. Our study showed an interesting potential for grafted tomato plants to be used under deficit irrigation regimes by the selection of the adequate rootstock to increase the WUE of tomato crops.

Keywords: *Solanum lycopersicon*, rootstock, water stress, physiological modifications, Sustainability

S02-PII-47

Improving light use efficiency of *brassicacaceae* crops for growing novel foods

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This study aimed to investigate the effects of solar radiation on the growth and biochemical variations of two genotypes of commercial rocket, namely Eruca sativa Mill. var. darkita and Eruca sativa Mill. var. lobata (RC1 and RC2, respectively), as well as Sicilian Black sprouting broccoli (Brassica oleraceavar. italica Plenck, Broccolo nero,

BR). Black shade nets with different reduction of solar radiation (SR100, SR60, SR40) were employed in this experimental trial. The experimental design adopted was split plot and the main experimental factor was represented by solar radiation (SR100, SR60, SR40), the sencundary one represented by the growth stage (sprouts, microgreens and baby-leaves), and the third one by the genotype (BR, RC1 and RC2). The harvested plants were characterized for the main morphometric traits. A comprehensive assessment of various biochemical parameters, such as total glucosinolates content, sucrose, fructose, fructooligosaccharides (FOS), and total sugars, was conducted. Light use efficiency (LUE) determination revealed variations in biomass production and sugar profiles under different solar radiation (SR) conditions. Our findings shed light on the impact of solar radiation on the growth and biochemical profile of sprouts, microgreens, and baby leaves across both species. Notably, the total glucosinolates content exhibited a significant interaction between genotype and plant growth stage, ranging from 6.96 to 5.56 g TGLSs g -1d.w.for BR and RC2 genotypes, respectively. A significant finding concerns the sugars composition, which is predominantly influenced by solar radiation. The glucose and sucrose amount generally increased from sprouts to baby leaves for all evaluated genotypes, while the fructose amount increased from sprouts to baby leaves for BR but decreased during plant growth for RC1 and RC2. Additionally, FOS decreased under reduced solar radiation conditions during the baby leaves stage, with an increase in small sugars such as sucrose, glucose, and fructose compared to the sprout stage.

Keywords: vegetables, rocket, broccoli, plant growth stage, sugars, glucosinolates

S02-PII-48

Yield-increasing effect of foliar silicon application in early potato production

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Silicon, previously considered a non-essential element for plant, has an important role in alleviating environmental stresses in plants by regulating physiological and biochemical processes. In recent years, the use of silicon to increase crop productivity under abiotic stresses caused by climate change has been increasing. The effect of silicon (sodium metasilicate) foliar application on plant growth, tuber yield and quality of early crop potato was determined. The field experiment was carried out in east-central Poland, during three growing season, on a sandy loam soil (Haplic Luvisol). Silicon was applied at dosages of 23.25 g Si ha-1 or 46.50 g Si ha-1 (0.25 L ha-1 or 0.50 L ha-1 of Optysil) once at the leaf development stage or at the tuber initiation stage, and twice, at the leaf development and tuber initiation stages. Potatoes were harvested 75 days after planting (the end of June). Foliar-applied silicon improved plant growth and increased early crop potato yield under a water deficit conditions. Silicon caused an increase in above-ground plant biomas, enlarged leaf area and chlorophyll content, and, as a result, increased tuber number and tuber weight per plant. The yield-increasing effect of silicon depended on a water deficit during potato growth. Under periodic water deficits during tuber bulting, silicon increased marketable tuber yield (diametr > 30 mm) by an average of 6.9 t ha-1 (50%) and under drought conditions during the potato growth period by 0.7 t ha-1 (9%). Under periodic water deficits during tuber bulking, the marketable yield was greatest after applying 46.50 g Si ha-1 (0.50 L ha-1 of Optysil) in the tuber initiation stage. Under drought conditions, the most practical were two silicon applications at 23.25 g Si ha-1

(0.25 L ha-1 of Optysil) in each treatment. Silicon slightly affected the nutritional value and sensory quality of new potatoes.

Keywords: sodium metasilicate, plant growth, tuber yield, tuber quality

S02-PII-49

Ammonium to total nitrogen ratio affects the *Portulaca oleracea* L. growth, nutritional, and antioxidant status

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Purslane (*Portulaca oleracea* L.) is a widespread weed, which is greatly appreciated for its high nutritional value. The present work evaluated the effect of different ammonium/total nitrogen ratios (NH_4/Total N: Nr 0.01-0.15) on growth, physiological and biochemical parameters, and nutrient accumulation in different plant parts of hydroponically grown purslane during autumn. Young seedlings of purslane were transferred to a Nutrient Film Technique (NFT) system and they were exposed to different Nr levels. The pH and the electrical conductivity of the nutrient solution were kept constant at 5.8 and 2.3 mS cm^{-1}, respectively. After the end of the cultivation period, a series of assessments took place (growth parameters, mineral content in different plant organs, antioxidant status of the plant, etc.). Plant height, leaf number, root fresh weight and plant biomass revealed decreased trends at the higher NH4/total N ratios. Total phenols, flavonoids and antioxidant capacity appeared increased at Nr ≤ 0.10, revealing higher nitrogen accumulation rates and increased water and nutrient use efficiency. Purslane plants grown in Nr 0.05-0.10 revealed a less intense oxidative stress, with decreased lipid peroxidation levels that was the result of the activation of both enzymatic (superoxide dismutase, catalase and peroxidase) and non-enzymatic (ascorbic acid) antioxidant capacity of the plant. Increased Nr resulted in the accumulation of potassium, while calcium, phosphorus and magnesium levels in leaves were decreased. Additionally, the greater water use efficiency was measured for plants grown under Nr 0.01-0.05. Therefore, the recommended ammonium/total nitrogen ratio for purslane production of increased yield, improved nutritional value and efficient use of water and nitrogen sources is to employ Nr of 0.05.

Keywords: ammonium to total nitrogen ratio; antioxidants; mineral fertilizer; purslane; soilless culture

S02-PII-50

Abiotic stress effect on quinoa species (*Chenopodium quinoa* Willd.) under fertilization management

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It is well known that, all over the world, food alternatives are being sought, driven by climate change, which forces humanity to look for new solutions, especially among plants that can withstand difficult environmental conditions. The aim of the research is to evaluate the influence of chemical and biological fertilization on the growth and development of two quinoa varieties (Vikinga and Puno), in order to optimize the development of the vegetative mass, which represents the edible part of the plant. Quinoa (*Chenopodium quinoa* sp.) is a pseudo-cereal native to Latin America, known mainly for seeds. The latest studies and research have begun to be done on leaves, as it is known that in the area of origin, some local populations used as vegetables. The experience was organized in vegetation pots, in 42 variants, in the greenhouse. The obtained results show that the species is suitable for cultivation in protected areas, under the influence of factors: variety, fertilization and irrigation. The highest amount of leafy mass was obtained by Vikinga variety under biological fertilization and irrigation. Vikinga is the cultivar that performs the best results.

Keywords: quinoa, fertilization, irrigation, variety

S02-PII-51

Dynamics of growth and development in celery under the influence of organic fertilizers

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The study analyzed the dynamics of growth and development of celery plants, 'Rex' cultivar, under the influence of organic fertilizers. Fertilizers Naturamin Plus, 25 ml/10 L water (V2), Naturvital Plus, 25 ml/10 L water (V3), and Naturcomplet G, 300 g/100 m2 (V4) were used. For comparison, a control variant (V1) was considered. For seedlings production, the sowing date (Ds) was January 15. The seedlings planting date (Pd) was March 22. Plant determinations were made on May 25 (Dd1), on June 13 (Dd2) and on July 13 (Dd3). The dynamic variation of the parameters Lw (leaf weight), Rw (root weight) and Tpw (total plant weight) was described by polynomial equations of the 2nd degree under statistical safety conditions ($R2 = 0.827$, $p = 0.00036$, $RMSE = 0.04501$ in the case of Lw; $R2 = 0.941$, $F = 71.24714$, $p < 0.001$, $RMSE = 0.10369$ in the case of Rw; $R2 = 0.934$, $F = 63.39694$, $p < 0.001$, $RMSE = 0.12268$ in the case of Tpw). The growth rate (D) in root weight in the interval Dp – Dd3 (DRw) varied between DRw = 0.0075 kg day-1 in the case of the V1 variant, and DRw = 0.0118 kg day-1 in the case of the V4 variant. Differentiated variations of the growth rate (D) were recorded on the determination intervals, respectively DRw1 = 0.0012 – 0.0023 kg plt-1 day-1 (Dp – Dd1); DRw2 = 0.0148 – 0.0163 kg plt-1 day-1 (Dd1 – Dd2); DRw3 = 0.0166 – 0.0303 kg plt-1 day-1 (Dd2 – Dd3). The regression analysis resulted in models in the form of equations and graphic models (3D, isoquants) that described the variation of Tpw in relation to Lw and Rw ($R2 = 0.999$, $p < 0.001$, $RMSE = 0.00315$). According to PCA, PC1 explained 77.006% of variance, and PC2 explained 22.993% of variance.

Keywords: celery, growth rate, models, organic fertilizers, PCA, response curves

S02-PII-52

Do higher fertilization doses guarantee higher vegetable yield?

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Currently in regards to Green Deal policy the main challenge in the vegetable cultivation is to ensure high yield and quality using sustainable farming methods. Appropriate use of fertilizers in vegetable growing reduces production costs simultaneously increasing the nutrient content available in the soil to a level that optimally ensure plant growth and development. Thus, appropriate fertilizers doses and the use of green manure should be promoted in vegetable cultivation. In order to address the aforementioned challenges, in 2021, a study on vegetable fertilization efficiency was started in the frame of the project "Optimizing the fertilization of more widely grown field vegetables in Latvia to ensure sustainable growing technologies" financed by the Ministry of Agriculture of Latvia Republic. The field trials were established in LatHort and in 10 farms widely spaced through Latvia, representing both integrated and organic growing systems. Four most widely grown field vegetables are included in the trials: cabbage, carrot, onion and red beet. The agrochemical nutrients content of soil and plants was determined, yield and plant biomass was measured in order to calculate nutrient balances. The amount of applied fertilizers was registered in order to calculate nutrient balance. The results obtained until now show the huge influence of soil and meteorological conditions of particular year on the yield outcome and nutrient balance. However, in many cases there is not observed clear positive correlation between the amount of fertilizers applied and yield outcome. Trials are continued to come up with clear recommendations for sustainable fertilization strategies for field vegetable production in agro-ecological conditions of Latvia.

Keywords: cabbage, carrot, onion, red beet, sustainable, integrated growing

S02-PII-53

Unlocking the potential of underutilized crops: evaluation of wild leafy greens in low-input organic fertigation systems

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Underutilized crops, characterized by their high nutritional value and adaptability to diverse abiotic stresses, offer a promising avenue for mitigating agriculture risks and

enhancing food security in the face of climate change. Despite their potential, the lack of cultivation protocols and limited background on their antinutritional factors hinder their integration into modern agricultural systems. This study aimed to evaluate the performance of select underutilized crops, particularly suited to mild winter climates, under low-input organic fertigation regimes. Specifically, we investigated the growth of bristly oxtongue (*Helminthotheca echioides* (L.) Holub), wild mustard (*Sinapis arvensis* L.) and corn salad (*Valerianella locusta*) in open field conditions using both organic and conventional fertigation methods over two consecutive winter cultivation periods. Results indicate that organic fertilization restricted the yield and yield parameters of the tested leafy greens, albeit with varying degrees of severity among species. Notably, bristly oxtongue exhibited lesser yield restrictions (25%) compared to the other species (40-50%). Additionally, organic fertilization led to reduced nitrate accumulation in fresh leaf tissues, with nitrate levels remaining within safe thresholds for human consumption in both cultivation systems. Overall, our findings suggest bristly oxtongue as a promising candidate for achieving higher yields of wild leafy greens under low organic inputs. However, further optimization of cultivation protocols is necessary to maximize productivity in this system. This preliminary study underscores the potential of underutilized crops in sustainable agriculture but highlights the importance of continued research to refine cultivation practices and unlock their full potential.

Keywords: responsible production, sustainability, bristly oxtongue, wild mustard, corn salad

S02-PII-54

Physiological and agronomic response of traditional pepper varieties to reduced fertilization and microbial biostimulants

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Pepper traditional varieties are good candidates for growth under sustainable conditions. In this study, the effects of fertilization dose reduction (100%, 75% and 50%) and the use of microbial biostimulants, Bactogreen® (N-fixing bacteria + K and P solubilizing bacteria) and Agromic® (endomycorrhizal mycorrhizal fungi), on physiological parameters and yield were evaluated. The varieties consisted of one traditional variety (Najerano) and a hybrid (H1) resulting from the cross between Najerano with a source of resistance to TSWV. In addition, a commercial variety, Herminio, was used as a control. The net photosynthetic rate (An) of the three varieties was not affected by decreasing fertilizer dose, and only in the commercial variety Herminio did the intrinsic water use efficiency (WUEi) decrease by decreasing the F dose in treatments without B. There was also no effect of B application on An, except in Najerano where an increase in AN was observed in the 100%F + B treatment. In general, B increased WUEi, although in the case of the commercial variety no increase was observed at 100% F. Regarding leaf chlorophylls, a 50% decrease in fertilizer dose decreased the amount of chlorophyll in C and N, and in the commercial variety this decrease occurred at both 75% F and 50% F. In contrast, biostimulants significantly increased the amount of chlorophyll in H

regardless of the F dose. Finally, the total yield of the varieties tested was not affected by the fertilization treatments, whereas in the traditional variety N, although the yield did not vary, an increase in the number of fruits and a reduction in the average weight were observed in the treatments with lower fertilization doses. The effect of biostimulants on N and H was significant, producing an increase in total production as a consequence of an increase in the number of fruits.

Keywords: Biodiversity, Sustainability, Gas exchange, *Capsicum annum*, Landrace

S02-PII-55

Using silicon-based biostimulant and phosphorus application as a possible solution for beetroot (*Beta vulgaris* L.) grown under multi-stress in South Africa: A short review

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Adverse environmental stressors such as moisture deficit, soil acidity and nutrient deficiency, particularly phosphorus (P) due to climate change as single and combined multistress are gradually threatening food security globally. Therefore, modern agriculture is facing pressing challenges where novel strategies must be developed for sustainable food production and security, particularly in developing countries like South Africa. The authors conducted a desktop review focusing on various vegetables and other commercial crops globally. At most, the authors maintained fifteen years of research material, constituting research articles, reviews, book chapters, thesis, research short communications, and industrial short communications. Abiotic stress as a leading stress factor tends to occur alone or simultaneously, causing severe consequences for plant growth, and the quality of horticultural species such as beetroot (*Beta vulgaris* L.), and this has been recorded more in South Africa recently, where multistress factors are a problem to emerging farmers. Beetroot is well-known as the second most important sugar-producing crop after sugarcane (*Saccharum officinarum* L.), contributing to about 40% of world sugar production. However, successful production of beetroot has been recorded widely to depend on many agronomic and environmental factors such as moisture deficit and P-deficiency, which are considered critical limiting factors reducing the beetroot yield from 5 to 30% globally. In South Africa, it has been further observed that a combination of soil moisture stress and P assimilation are contributing significantly to the losses in the production yields of beetroot in agricultural farming, particularly in Highveld areas such as the Mpumalanga Province; thus, multistress remain a challenge for emerging and subsistence farmers in South Africa. Therefore, this review focuses on the development of the mitigating strategy using a combination of silicon-based biostimulant and the P application to improve the P assimilation, growth, and yield of beetroot grown under adverse multi-stress in South Africa.

Keywords: environmental stress factors, horticulture, phosphate, plant stress, vegetables

S02-PII-56

Potential use of seaweed-and silicon-based biostimulants to alleviate the multistresses on tomato (*Solanum lycopersicum* L.) in South Africa: A short review

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The globe is home to 7.7 billion people, with an annual increase of 83 million people at a pace of 1.09%. Therefore, ensuring food security for a growing population is one of contemporary agriculture's most essential goals. However, environmental stress factors such as climate change, wounding because of severe pruning, hail damage and natural pests, and the soil and water quality remain the most important determinants of the success of agricultural productivity. The effects of climate change on agricultural productivity can be well comprehended by studying the effects of individual components contributing to climate change on plants and crops, i.e. changes in soil and water quality for agricultural use and extreme climatic hazards. A conclusion and recommendation could be reached using the pool of research material, which constituted research articles, reviews, book chapters, thesis, research short communications and industrial short communications from at least fifteen years ago. From the results, it could be deduced that the soil salinization removes 1.5 million ha of cropland from production each year and reduces the potential for output by up to 46 million ha annually, resulting in annual losses in agricultural production of US$31 million. Along with the chloride, sulphate, and carbonate salts of calcium, magnesium, and sodium, sodium chloride is the most frequently found in salty soils and waters. To date, salinity has been recorded to damage plant germination, development, and reproduction, and lower agricultural yield. On the other hand, plant wounding such as severe and incorrect pruning techniques is another detrimental factor reducing plant growth and yield. In the pool of research, several studies reported widely on the assessment of the effectiveness of biostimulants in promoting plant development under single stress in South Africa; however, only a few studies reported the recovery responses of combined, and multistress alleviated using biostimulants. This review provides insight into the potential use of seaweed- and silicon-based biostimulants to alleviate various multistresses on tomatoes (*Solanum lycopersicum* L.) in South Africa.

Keywords: moisture stress, plant growth stimulants, salinity, stress factors

S02-PII-57

The optimal nitrate/ ammonium- ratio as a suitable strategy to enhance the componentes nutricionales y bioactivos de la lechuga throughout global warming

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Lettuce (*Lactuca sativa* L.) has outstanding content in phytonutrients which are highly beneficial health, such as minerals and antioxidant compounds. The content of these health-promoting compounds is increased in baby versions. Which is why the intake of baby-leaf lettuces is increasing. Unfortunately, a large amount of nitrates are also accumulated in lettuce. Although nitrates per se are relatively non-toxic, their metabolic products can be very harmful. Many studies have reported that the biosynthesis and accumulation of the healthy compounds is highly affected by the growing conditions, environmental factors, and fertilization. Although in nature it is very rare for a climate effect to occur in isolation, there is scarce literature on how the combination of several of these factors can affect on morphological, physiological and biochemical parameters. This work provides information on how two different levels of CO2 (400 and 1000 ppm of CO2), four different NO3-/ NH4+ ratios (100/0 (T-I), 100/0 before applying short-term heat stress and finally without NO3- (T-II), 80/20 (T-III) and 50/50 (T-IV)) in the nutrient solution, and a short-term heat stress (25 and 43 °C) affect the biomass and nutritional quality of baby-leaf lettuce cv Derbi. Similarly, a comparison of that combined effect of all these parameters between the inner and outer leaves was also carried out. Results indicated that the strategy used led to a bigger and healthier baby-leaf lettuces. So, the resulting lettuces showed higher biomass and content of phenolic compounds, an enhanced antioxidant activity and a significantly reduced nitrate content. This work also showed that although the biosynthesis of antioxidant compounds was more favored in the inner leaves, the outer leaves were also rich in these bioactive compounds. Moreover, in outer leaves was favored the biosynthesis and/ or accumulation of nitrate content, which was drastically reduced after the application of this new strategy.

Keywords: sustainable strategy, baby-leaf lettuce, climate change, antioxidant activity, reduction of nitrate

S02-PII-58

Productivity and quality of swiss chard (*Beta vulgaris* var. *cicla*) in aquaponics: fertilization strategies

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Aquaponics (multi-trophic system that combines hydroponics and aquaculture) promotes economic and sustainable agricultural production as avoid soil degradation and increase

water and nutrient use efficiency. In recirculating aquaculture systems (RAS) effluents can be used as a valuable fertilizer source. Our experiment with RAS produced Nile tilapia (Oreochromis niloticus), and the water and nutrients (NO3- using aerobic bacteria genera Nitrobacter spp. and Nitrosomonas spp.). Swiss chard (leaf stalks white) was planted in 1.2 m long bags filled with coconut fiber contained three plants and 3 drippers. Three irrigation treatments were used in this study: 100% synthetic fertilizers (control), mixed water (50% fish effluent/50% drainage water-50F/50D) (reused drainage water from the aquaponics plant cultivation system), and the mixed water combined with the control water which was applied every two days (50/100). Results showed that irrigation treatments affected fresh weight of Swiss chard thus the 50F/50D solution showed an increase of 38% compared with the control. Additionally, the total phenolic content of the leaf extracts was augmented with that irrigation treatment. This study provides an optimal irrigation management to maximize the benefits of the tilapia effluents for Swiss chard.

Keywords: Leafy vegetables, nutrient efficiency, tilapia, recirculating aquaculture system, aquaponics, Swiss chard

S02-PII-59

Treatments application frequency of calcium nitrate used in combination with seaweed-based biostimulants on the seed quantity and quality in round pepper

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The purpose of this scientific work is to establish the optimal interval between the treatments applied with calcium nitrate and a bioactive product based on Ascophyllum nodosum (L.) Le Jolis., on the seed production of round pepper, using the cultivar 'Asteroid 204'. The experiment was carried out at Research and Development Institute for Vegetable and Flower Growing Vidra, Ilfov county, Romania. Foliar treatments with calcium nitrate combined with the bioactive product Auxi 4C were applied to the round pepper plants, at different time intervals. The studied time intervals were seven days between treatments, 10 days and, respectively, 14 days between treatments. The treatments applied at intervals of seven days determined the most important increases in the amount of seed. Regarding the quality of the seeds, the weight of 1000 seeds, the final germination percentage and the germination per days, the germination speed index of seeds, the vigor of the seedlings 14 days after sowing and the seed vigor index were calculated. Treatments applied to peppers at an interval of seven days increase the quantity and quality of the seeds.

Keywords: seed, calcium nitrate, biostimulants, round pepper

S02-PII-60

Future perspectives of organic and conventional fertilizers on the morphological and yield parameters of tomato

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In Romania over the last two decades, many tomato varieties have been introduced which have not met the requirements of growers, mainly due to the climatic conditions in the country. Not in the least, both organic and conventional nutrition technology has evolved a lot, input companies have constantly diversified their offer, which has led to finding answers to the problems faced by farmers. Tomato have always occupied an important place in the food strategy, due to nutritional considerations and health benefits. The aim of this research was to evaluate morphologically and productively the use of differentiated nutrition in some new tomato varieties. The research carried out in a greenhouse of 200 square meters. The values for morphological characters of tomatoes varied on the varieties and nutrition regime. The fertilizers had a positive influence on the morphological characters studied, the highest values of fruit weight being recorded with conventional fertilization, and among the cultivars the Pinkid cultivar responded well in terms of productivity.

Keywords: tomato varieties, nutrition regime, morphological and yield characteristics

S02-PII-61

Variability of quantitative characters in the tomato variety Romec 554j (*Lycopersicon esculentum* Mill.) in pedo-climatic conditions from SCDCPN Dăbuleni

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Tomato (Lycopersicon esculentum Mill.) is one of the most important vegetable species, due to its particularly high nutritional value. The nutritional value of tomato fruits is given by the content of carotenoids, polyphenols, sugars, organic acids, minerals and vitamins. Worldwide, tomatoes are grown on an area of approximately 4.85 million hectares (Faostat, 2019), and in Romania on an area of approximately 40,000 hectares, especially in the counties of Olt, Galați, Dolj, Giurgiu, Buzău (FAO, 2018). The success of tomato cultivation is conditioned by many factors, but the cultivar (variety/hybrid) has an essential role. In this sense, at the Research-Development Station for Plant Culture on Sands Dăbuleni, in the period 2021-2023, research was carried out on the variability of the main quantitative characters in the tomato genotype Romec 554j. Fruit weight (g), fruit diameter (cm), pericarp thickness (mm) and soluble dry matter (TSS) were analyzed. The results obtained differed according to the climatic conditions of each year of the study. The registered biometric data were statistically processed, calculating for each analyzed character the mean ($\bar{x}$), the standard deviation (s), the coefficient of variability (s%), the range of variability ($k = \bar{x} \pm s$). The calculation and analysis of the variability revealed, on average, during the three years of the study, a small variability for fruit diameter (s% = 7.38;) and medium for fruit weight (s% = 14.95); pericarp thickness (s% =13.34); soluble dry matter (s% = 12.64). Although the tomato variety Romec 554j is a stable variety, the current climatic conditions increasingly leave their mark on the

quantitative characteristics of the tomatoes grown in the southwestern area of Romania, the improvement of this species gaining particular importance. The variety Romec 554j still represents a valuable material in the improvement process.

Keywords: tomato, variety, quantitative characteristics, sandy soils

S02-PII-62

Enhancing tomato tolerance against water stress and *Fusarium oxysporum* f. sp. *Lycopersici* through the artificial application of PGR and biocontrol agents

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Tomato (*Solanum lycopersicum*) is an edible berry that belongs to the family solanaceae and contributes significance to human health. Given its immense health potential, researchers are actively engaged in cultivation poses challenges due to its sensitivity and specific growth requirements. The plant demands consistent moisture throughout its growing season, making it susceptible to diseases under high moisture conditions. This study aims to assess the growth of different tomato cultivars exposed to drought stress and fungal wilt caused by *Fusarium oxysporum* f. sp. *Lycopersici*, with stressed plants treated with biocontrol agents and Plant Growth Regulators (PGRs). To achieve this, a total of eleven distinct treatments were implemented under controlled conditions, and the results were evaluated after 120 hours of treatment. The evaluation was encompassing enzymatic activities (including CAT, SOD, POD, and PPO), physiological parameters, as well as growth and morphological parameters (root length, shoot length). This study employed a factorial design using Completely Randomized Design (CRD) to analyze the effects of different treatments on tomatoes under stress conditions. The findings of this research endeavour hold promise for understanding the potential of biological control agents and PGRs in mitigating the detrimental impacts of drought stress and fungal wilt on tomato plants, thereby offering insights into potential strategies for enhancing tomato cultivation.

Keywords: Tomato, water stress, *Fusarium oxysporum* f. sp. *lycopersici*

SESSION VI STRATEGIES FOR CONTROL OF ABIOTIC AND BIOTIC STRESS FACTORS

S02-OVI-43

Assessing the effects of strigolactone on the drought tolerance of underutilised tomato landraces in farmer conditions

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Underutilised landraces of major crops are an untapped source of resilience in the face of climate change, and may be an important resource for biodiversity. Strigolactones are phytohormones with a positive effect on tomato performance under drought. Thus, in our work, underutilised and stress-resilient tomato varieties selected during previous EU projects were tested for water deficit stress responses after being mock treated or treated with the strigolactone analogue GR24. The experiment was performed during the 2023 spring/summer vegetation period in farm settings under a high tunnel using a randomised block experimental design. Plants of three tomato landraces (T27, T43, T271) were divided into two blocks each (I-II), two stress levels (Stressed-Unstressed), and hormone treatments (Treated-Untreated). Plants were spray-treated at the start of flowering with a 5 µM solution of the strigolactone analogue GR24, while stress was administered by halving irrigation times starting with blossoming and ending with the first harvest. Stomatal conductance (mmol m−2 s−1), commercial yield per plant (g), number of fruits, single fruit weight (g/fruit), total acidity (mg/L), Brix (%), and firmness (kg) were all measured in the study. Each variety had a different stomatal conductance response: for T27, it went down under stress conditions; for T271, it went up; and for T43, it stood stable. Regarding the commercial fruit yield, T271 demonstrated the most stable performance under stress conditions. The total number of fruits per plant did not show a significant variation in any varieties, except for T271, where the number of fruits in treated plants under unstressed conditions was significantly lower than in all other cases. No other measured parameters had statistically significant differences upon GR24 treatment and across all conditions, except for acidity. Nonetheless, stressed and GR24-treated plants showed a consistent trend towards higher stomatal conductance and commercial yield when compared to stressed and untreated; regarding fruits, they were more numerous, firmer, with higher total acidity content, and Brix than untreated plants under stress conditions. This work was supported by the European Union's Horizon 2020 research and innovation programme through the project: Realising Dynamic Value Chains for Underutilised Crops" (RADIANT). Grant agreement No. 101000622.

Keywords: fruit quality, drought stress resilience, strigolactones, tomato, underutilized crops

S02-OVI-44

Yield and growth of different multiple-parent advanced generation inter-cross (MAGIC) amaranth genotypes under varying water regimes

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Traditional vegetables are piloted as champion species for sub-Saharan Africa, a region experiencing high nutritional food insecurity and water scarcity. Amaranth is one of the traditional vegetables that has excellent potential to be commercialized in South Africa. The study's main objective was to assess the effect of different water regimes on six amaranth genotypes that was used to generate a MAGIC population as well as two

reference genotypes. An experiment was conducted under rain shelters at ARC-VIMP, Roodeplaat Pretoria, Gauteng, during the 2020/2021 and 2021/2022 summer seasons. The experiment was laid out in a 3 x 4 factorial treatment in a completely randomized design with amaranth genotypes (VI060472, VI061494, VI044371, VI062433, VI061487, VI050446, Arusha and Anna,) and water levels (20-25%, 60-65%, and 80-85%), replicated three times using two rain shelters. Data collected included total fresh and dry biomass, fresh and dry edible biomass, fresh and dry stem mass, leaf number, fresh and dry leaf mass in grams per plant and initial and final plant height. The study's findings showed that there was highly significant difference (P<.0001) as well as interaction effect for water levels and genotypes for the selected variables. There was a significant difference (P ≤ 0.05) for leaf number. In contrast, there was no significant difference for initial plant height. Total dry biomass ranged from 32.93 to 61.36 t ha-1, dry stem mass ranged from 24.43 to 37.97 t ha-1, and dry leaf per plant from 6.43 g to 18.35 g. Higher productivity was observed from the VI061494 genotype. Therefore, this genotype can be recommended to farmers who want to commercialize Amaranth; they will attain higher productivity, assuming that agronomic management is the same.

Keywords: Biomass, Crop productivity, Genotypes, Traditional vegetables, Water levels

S02-OVI-45

Ionomic and metabolomic profile in Solanum lycopersicum L. 'Micro-Tom' under Nickel stress

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The crop production can no longer be sustained by rainfall due to climate change and irrigation strategies must be applied. In this contest, wastewater is an important water supply, but it could contain heavy metals that may affect both plant health and product quality and safety. Nickel (Ni) is one of 23 metal pollutants that could be a risk to the ecosystem and human health. According to the Italian Ministerial Decree, the limit value of Ni concentration in wastewater is 0.2 mg L-1. Tomatoes are one of the most consumed vegetables and have a high nutritional value. Tomato plants are sensitive to heavy metal pollution and accumulate these elements in their organs, including fruits. According to FAO/WHO Codex, the maximum permissible value of Ni in vegetable samples is 10 mg kg-1. This study aims to understand whether the levels of Ni allowed in irrigation water can be harmful to tomato plants and consumers. Solanum lycopersicum L. 'Micro-Tom' plants were watered for 52 days until fruit maturation with four treatments: 0 (control), 0.1, 0.2, and 0.4 mg L-1 of Ni. At harvest, all fruits (n=6) were sampled. Dried samples were digested in 65% HNO3, using the COOLPEX Smart Microwave Reaction System. The ionomic profile, which included Ni, Cu, Mn, Zn, Fe, Mg, Ca, and K was analyzed using a Microwave Plasma Atomic Emission Spectrometer (4210 MP-AES, Agilent Technologies). Polyphenols were extracted from tomatoes' fresh material using 80:20 (v/v, methanol/MilliQ) before performing UHPLC-MS/MS analysis. The data revealed a dose-dependent increase in Ni levels in the fruit, which, however, remained below permitted limits, ensuring consumer safety. Additionally, the Ni treatment had no discernible effect on the concentration of other mineral elements in the fruits. On the contrary, a significant alteration of plant polyphenols metabolic pathway was observed.

Keywords: wastewater, irrigation, heavy metals, tomato, human health

S02-OVI-46

Effect of ambient light enrichment with different LED light spectra on the agronomic characteristics and phenolic profile of lettuce

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The light spectrum is a factor that positively influences plant growth and development and the accumulation of bioactive compounds. The objective of this study was to evaluate the effect of ambient light enrichment with different LED light spectra on the agronomic characteristics and phenolic profile of 'Levistro' baby lettuce plants grown in greenhouses. The ambient light was enriched with 12 h of blue, white, blue-red, and red light, which resulted in the following blue:green:red: far-red spectra 60:16:16:8; 28:42:22:8; 31:20:40:9 and 15:20:57:8 with a PPFD of 350 µmol m^{-2} s^{-1}. The ambient greenhouse light (26:30:30:14) was used as a control (average PPFD = 750 µmol m-2 s-1). At harvest, 14 days after transplanting, plants grown under light enrichment showed fresh weight, dry weight percentage, leaf number and morphology similar to the control. While chlorogenic acid concentration was exacerbated under blue-red and blue light enrichment compared to the control. The quercetin concentration increased under blue-red and white light compared to the control. In view of the results, it is inferred that a PPFD half obtained in ambient light was sufficient to achieve normal growth and development of 'Levistro' lettuce plants, suggesting a more efficient use of light energy under the enrichment treatments in baby lettuce plants. On the other hand, the combined blue-red light promotes the accumulation of phenolic acids and flavonoids in the leaves of young plants.

Keywords: *Lactuca sativa* L., wavelength; chlorogenic acid; quercetin

S02-OVI-47

Comparative analysis of 'plant stress-reducing ventilation' strategies using plant sensors and decision trees across different tomato greenhouses

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In spring and summer, tomato plants cultivated in greenhouses can be exposed to environmental stress due to increased levels of irradiation and vapor pressure deficit during the day. On such days, the increased transpiration rates deplete the plant's internal water storage pools (i.e., living cells), leading to elevated daily stress with the risk of irreversible damage to plants and its fruits. To prevent this, Belgian and Dutch greenhouse farmers apply a specific ventilation strategy, which we dubbed the 'plant stress-reducing ventilation' strategy. This scientifically understudied strategy, currently lacking established guidelines, is approached differently by individual greenhouse growers. A comparative analysis was conducted involving two different Belgian tomato growers. For both growers, tomato plants (Solanum lycopersicum L.) were equipped with sap flow and stem diameter variation sensors to continuously measure the plant response during the application of the ventilation strategy. The plant response was classified and combined with data from the greenhouse climate computer to analyze the employed strategy based on machine learning techniques. The combination of decision tree algorithms and plant sensors proved essential in unraveling the plant stress-reducing ventilation strategy in practical applications. Additionally, it facilitated the comparative analysis of the different approaches employed by the greenhouse growers.

Keywords: tomato, greenhouse climate control, machine learning, plant sensors, sap flow, stem diameter variation, plant stress-reducing ventilation strategy, solar radiation, vapor pressure deficit, plant stress

S02-OVI-48

Nutrient management in closed-loop soilless culture systems using ion selective electrodes and DSS NUTRISENSE

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Dealing with the unknown mineral composition of the recycled drainage solution (DS) is a major challenge in closed-loop soilless culture systems (CLS). Currently, this issue is tackled through periodic laboratory analysis of DS followed by readjustment of the nutrient solution (NS). An attractive alternative approach involves using ion selective electrodes (ISEs) for direct measurement of macronutrient levels in the DS. However, to properly utilise the measurements obtained from the ISEs, suitable models based on mass balance and applied through an online operating decision support system (DSS) are needed. NUTRISENSE is a DSS operating online, which was designed specifically for managing nutrition in soilless culture systems. The main function of NUTRISENSE is the readjustment of the supplied nutrient solution (NS) based on the composition of the DS. If an ISE system is used, NUTRISENSE can recalculate daily the composition of the supplied NS based on the data obtained from ISEs to improve the accuracy of nutrient management. Furthermore, NUTRISENSE automatically transmits the corresponding

fertiliser injection rates to a fertigation system that utilizes individual fertiliser stock solutions to implement in real time the new NS composition. To evaluate the nutrient management efficiency of NUTRISENSE when connected online with ISE, an experiment was conducted with cucumber plants grown in two CLS. The LAQUAtwin sensors (Horiba, Kyoto, Japan) were employed to measure the NO3-, K+, Ca2+, and Na+ concentrations. In the control CLS, a standard NS composition was supplied, with EC and pH maintained close to the target levels. In the second CLS (ISE treatment), EC, pH, NO3-, K+, Ca2+, and Na+ levels were daily measured using ISEs, while Mg2+ levels were calculated from EC values and the other cation concentrations based on the anion to cation balance principle. The data obtained from these measurements were subsequently introduced into NUTRISENSE to calculate the readjusted NS compositions and injection rates for each fertiliser. The LAQUAtwin ISEs proved to be highly accurate and the EC, pH, NO3-, K+, Ca2+ and Mg2+ values measured in the DS were maintained close to the corresponding target values. The results showed that the algorithm deployed by NUTRISENSE to daily readjust the composition of the supplied NS using data from ISE measurements, is efficient and scalable for commercial application.

Keywords: *Cucumber*, fertigation, hydroponics, nutrient recirculation, nutrient management

SESSION VII BIO-ECONOMY, REUSE AND RECYCLE APPROACHES IN THE SYSTEM

S02-OVI-49

How does production of organic vegetable meet the market demand in Germany?

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Organic vegetable production in Germany has increased significantly in the past ten years and reached about 15 % of total vegetable area in 2023. This is a much higher share than for organic arable farming with only 6,5 % of total acreage. Yet, organic vegetable production is still far behind the targets set for organic production on national and EU-level. The aim of this study is to analyse the development of production and the trends in the demand for organic vegetables in Germany in order to identify growth potential and constraints for organic vegetable production in Germany. National agricultural production statistics, market data and international trade statistics are the data sources used in this study. Results show that there are large differences in the organic share of area under cultivation between different crops. While more than 20 % of production area of carrots or beet roots are cultivated organically, this proportion is significantly lower for most cabbage and lettuce varieties. Reasons can be found in agronomic challenges and market structures. The higher proportion of organic production also corresponds with higher demand for the respective vegetable products. This indicates the consumers' preferences for local or regional production. However, purchasing behaviour and demand for organic vegetables are changing over time. Over the past years, food retail companies have gained shares of the fresh organic vegetable market. At the same time, price premiums for organic vegetables have decreased. Also,

the demand for vegetables with high import shares, such as tomatoes, cucumbers and peppers, is also increasing. The analysis of data on developments in cultivation, demand, imports and price trends shows that there is still growth potential for organic vegetable production in Germany. Need for research and public support is seen in the further development of organic production systems and value chains.

Keywords: organic vegetables, market structure, value chains, vegetable demand and supply

S02-OVI-50

Community supported agriculture in terms of a closed system of one enterprise on the example of WUELS as a way to achieve sustainable practices in the supply of horticultural products

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Growing fruit and vegetables at the university's research and teaching stations brings measurable yields. Most of them are safe for human consumption. In order to manage these products, shorten the "from farm to fork" distance and provide a holistic, sustainable approach to food production and consumption, a social farming system was introduced at WUELS. Employees pay a certain rate (approx. EUR 8/week) for a package of fruit and vegetables that meets the nutritional needs of one person. During the first two years of the program, approximately 120 University employees took advantage of the offer. Among the biggest problems that emerged during the implementation of the program, the need to educate recipients about the quality of internal and external production should be noted. The recipients were surprised by the various sizes of the products before sorting and the irregular shape of the vegetables. Among the most satisfactory, respondents indicated the opportunity to try less known or new varieties and species. In total, over 30 parcels were delivered in each season from April to December, exceeding 100 kg of fruit and 100 kg of vegetables per person.

Keywords: sustainable, horticultural products, community, health

S02-OVI-51

Environmental impacts of growing media raw materials: average values from the European growing media industry

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Reducing the environmental impact of the horticultural sector is increasingly important in Europe and gloablly. The impact of growing media (soilless media), in particular the use of horticultural peat, has received considerable attention in recent years. However, surprisingly little is known about the relative impacts of different growing media raw materials, with much of our current understanding relying on studies looking raw materials in isolation or with too narrow of a geographic scope. This therefore does not reflect the reality of current growing media production and does not allow for meaningful comparisons between materials. To address this, Growing Media Europe published a growing media environmental footprint guidelines 2019 and an accompanying LCA tool in 2023, allowing growing media producers to measure the environmental impact of raw materials and mixes across 19 impact categories (e.g. climate change, water use, land use), as well as a combined score with factors weighted per EU guidelines. For this study, we collected data from growing media producers across Europe and used the LCA guidelines to create average environmental footprint values for the major major growing media raw materials, including horticultural peat, coir, wood fibre, compost and rockwool. We show that each raw material has varying environmental impacts across the 19 categories, and when comparing combined scores, no materials are clear outliers. Our results can not only be used to make comparisons between media, but can also be used as a benchmark for growing media producers to reduce footprints below these reported values. As growing media is only one part of the horticultural production chain, future studies must consider how the properties and quality of growing media, which may have a greater effect on the overall production footprint (e.g. through yield) than the impacts of the media themselves.

Keywords: Soilless culture systems, life-cycle analysis, environmental impacts, substrate, greenhouse, vegetable production, ornamental production

POSTER SESSION III

S02-PIII-63

Exploring the influence of growth-related phytohormones on lettuce: photosynthetic response and antioxidant activity

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This research investigates the impact of growth-related phytohormones on lettuce (*Lactuca sativa* L.) cultivation under controlled greenhouse conditions. Two distinct approaches were employed to assess the influence of phytohormonal treatments on lettuce growth and development. In the first approach, individual growth-related phytohormones, namely kinetin, indole acetic acid, and gibberellic acid, were applied at various concentrations as single treatments during the critical BBCH growth stages 12-14. This experimental setup allowed us to discern the specific effects of each

phytohormone on lettuce plants. In the second approach, we explored the effects of phytohormonal combinations of two phytohormones by applying mixtures of kinetin, indole acetic acid, and gibberellic acid, each at an equal rate of 30 mg/L, at the same BBCH stage. Throughout the study, we monitored photosynthetic, antioxidant and biometric parameters related to lettuce growth. In the case of single phytohormone treatments, we observed trend wherein lower concentrations of kinetin, indole acetic acid, and gibberellic acid elicited stronger responses in lettuce growth and development. This suggests that, at lower concentrations, these individponual phytohormones play pivotal roles in stimulating various aspects of lettuce physiology, including morphological changes, root and shoot development, and overall plant vitality. Conversely, the phytohormone mixture application exhibited a different set of results. Here, we observed a robust photosynthetic response characterized by increased photosynthesis. However, this heightened photosynthetic activity was accompanied by a lower antioxidant response. Results indicates that the combinations of two phytohormones leds to a synergistic or antagonistic relationship, enhancing photosynthetic efficiency while potentially reducing the need for antioxidant defense mechanisms.

Keywords: Biostimulants, exogenous phytohormones, lettuce, cytokinin, auxin, gibberellic acid, productivity

S02-PIII-64

Soil application of acetic acid increases fruit yield through mechanisms involving enhancement of water use efficiency in tomato plants

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One of the environmental stress factors that limits global productivity of major crops is water scarcity. It is mandatory to stablish strategies for a sustainable and eco-friendly agriculture aimed at enhancing crop yield while reducing water necessities and the negative impact of agrochemicals on the environment. Potential solutions may be fostered using microbial-based biostimulants. Acetic acid, a volatile organic molecule emitted by several microorganisms, has emerged as a compound with high biostimulant potential in agriculture. Its application has improved drought tolerance in Arabidopsis thaliana and different crops like cassava, cotton, rice and apple plants. The objective of this work was to evaluate the effects of soil application of acetic acid on tomato plants cultured under reduced water irrigation conditions. To do it, we characterized the response to soil application of 20 mM acetic acid of vegetative biomass, photosynthesis, water potential and fruit yield of hybrid tomato plants cultured under optimal irrigation (OI) and water reduction (60% of OI, WR60) conditions. Under WR60 conditions, plants

treated with acetic acid showed higher root weight, photosynthetic activity, water potential and fruit yield than non-treated plants. Collectively, these data indicate that soil application of acetic acid increases fruit yield through mechanisms involving enhancement of water use efficiency in tomato plants. The molecular mechanisms therein involved are currently being investigated.

Keywords: Biostimulation, tomato, acetic acid, water reduction, tolerance, photosynthesis, water potential

S02-PIII-65

Effects of exogenous application of melatonin in sweet pepper submitted to heat stress

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Heat stress is one of the most limiting factors that affect crop production. Melatonin plays a multifunctional role on the regulatory of metabolic pathways in plants that may enhance the adaptation to extreme temperatures. This study was conducted for the purpose of identifying the physiological and biochemical effects of exogenous application of melatonin (100µM, twice a week for two weeks) on the growth and defense strategies of pepper plants (Capsicum annuum L. cv. Espinosa F1), in combination with three levels of nitrate concentration in the nutrient solution (5, 12 and 30 mM), and under optimum (26 ºC) and heat stress (43 ºC) conditions. Leaf gas exchange measurements and leaf carbohydrates concentration were analyzed. The results show heat stress induced reductions in the net CO2 assimilation and the intrinsic water use efficiency. Otherwise, transpiration rate increased with heat shock, being significantly lower as the nitrate concentration increased in the irrigation solution. Additionally, stomatal conductance was significantly affected with the 5 mM NO3- concentration. The carbohydrates concentrations were, in general, significantly affected by heat stress. Glucose content was higher with increasing temperature, but melatonin reduced this carbohydrate with the three different nitrate concentrations. Similarly, fructose content had the same effect, but it was not as pronounced as glucose. Besides, when temperature and nitrate concentration increased, sucrose content augmented.

Keywords: pepper plants, melatonin, heat stress, N concentration

S02-PIII-66

Recovery response mechanisms of horticultural plants to multi-stress: Plant-based biostimulants as a potential alternative strategy for lettuce (*Lactuca sativa* L.) in South Africa

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Plants are subjected to severe abiotic and biotic stresses worldwide. Global warming and climate change are increasing water scarcity and water-saving strategies, especially in coastal agricultural lands and arid and semi-arid regions, including South Africa. A wide range of horticultural crops encounter single or combined environmental stresses such as water deficit, substrate bulk density, potting size, and wounding stress throughout the production cycle, resulting in significant yield losses. Under these abiotic stress conditions plant physiology and biochemical regulations are governed by a complex network of interactions in hormonal pathways crosstalk between the different phytohormones. Plant-based biostimulants have been widely reported to sustainably improve nutrient use efficiency, seed germination rate, crop performance, yield, plant nutritional quality, fresh produce shelf life, and tolerance against multiple environmental stresses. Therefore, this short review explores the effects of these adverse multi-stress conditions on horticultural plants, as well as the recovery responses to the use of plant-based biostimulants as an alternative strategy. Lastly, this review also provides scientific morphophysiological responses of lettuce (*Lactuca sativa* L.) to the use of plant-based biostimulants as a potential strategy.

Keywords: abiotic stress, horticultural crops, pot size, water deficit, wounding, bulk density

S02-PIII-67

Physiological and agronomic response of traditional tomato varieties grown under water stress

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Muchamiel and Flor de Baladre are traditional tomato varieties from south-eastern Spain, where water stress has been one of the main problems in agriculture and could therefore be adapted to drought and be an alternative for sustainable production. However, the main disadvantage of the recovery of traditional varieties is their sensitivity to viruses. For this reason, the UMH has developed F1 hybrids carrying virus resistance genes, while maintaining the characteristics of the traditional variety. The objective is evaluate

the effect of three irrigation doses (100%, 75% and 50%) on physiological, agronomic and fruit morphology traits in the traditional varieties Flor de Baladre (C) and Muchamiel (E), the virus resistant hybrids developed from them (D and F, respectively) and a commercial control, Pasadena. Regarding physiological parameters, irrigation reduction did not affect chlorophyll content in any of the cultivars studied, regardless of the irrigation dose. Plant biomass decreased in the case of C and F when the most drastic irrigation reduction was applied (50%) and in the commercial variety in both treatments, indicating a higher sensitivity of Pasadena to water stress. Concerning agronomic performance, irrigation reduction to 75% only negatively affected the average weight of cultivar F and Pasadena, but yield was not affected in either case. However, the reduction of irrigation to 50% affected the total yield of all the varieties studied, due to a reduction in the average fruit weight and in the case of the commercial variety, also to the lower number of fruits. This may indicate a higher water demand of the commercial variety compared to the other cultivars. Moreover, the most severe irrigation deficit was accompanied by a reduction in the equatorial diameter in all the cultivars studied and also in the longitudinal diameter in the two experimental hybrids (D and F), and in the commercial variety.

Keywords: landraces; yield; irrigation; sustainability; *Solanum lycopersicum*

S02-PIII-68

Assessment of perennial wall-rocket (*Diplotaxis tenuifolia*) growth under Pb(II) stress. Preliminary studies

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Heavy metal pollution in agricultural soils has become an important issue due to the variety of sources, their persistence in the environment, and their ability to accumulate throughout the food chain. Lead is one of the heavy metals that affects many physiological, morphological and biochemical parameters of plants and has been reported to induce growth disorders, affecting normal root development and causing

growth retardation, impaired photosynthesis, decreased root and stem biomass and altered mineral nutrition and enzyme activity. Consequently, this paper presents the lead-induced effects on morphology, physiology and biochemistry of perennial wall-rocket (Diplotaxis tenuifolia) grown under greenhouse conditions in Kekkila peat substrate contaminated with 20, 50 and 100 mg/kg Pb(II). The effects induced by Pb(II) in the chosen concentration range, were assessed by measuring multiple parameters, such as: leaf area, leaf number, dry biomass, photosynthetic pigments content, protein, total lipids content, ascorbic acid, and others. Analysis of the experimental data from a statistical point of view showed that Pb(II) in the set concentration range had no significant influence on leaf area, leaf number, dry biomass, chlorophyll content, protein or dietetic fibers contents in leaves of plants grown at 100 mg/kg soil lead concentration and control sample. For example, the protein level detected in plants grown at 100 mg/kg Pb(II) was 7.70 g/100 g d.w. and in control was 7.72 g/100 g d.w. The dietetic fibers content was 17.46 g/100 g d.w. in the control sample and 17.47 g/100 g d.w. at 100 mg/kg Pb(II). Significant differences were found in total lipid content, which decreased from 3.44 to 3.32 g/100 g d.w. Overall, the results of this study showed that perennial wall-rocket has a high tolerance to Pb(II), but special attention should be paid to the accumulation of this metal in the leaves, to avoid its consumption by people.

Keywords: deleterious effects, soil contamination, Pb(II) stress, plant growth, perennial wall-rocket

S02-PIII-69

The effects of salinity stress on growth parameters and chlorophyll fluorescence of three cultivars of basil

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Known in the world as a medicinal, ornamental, melliferous, aromatic plant, basil has been less included in research studies in Romania. The objective of the study was to establish the effect of different salinity levels on basil growth indicators and variables related to the salinity tolerance of this species. Three cultivars of basil were tested: Ocimum basilicum var. citriodorum; Ocimum basilicum var. piperitum; Ocimum basilicum var. bulatum, at different levels of salinity: 1g/l; 2 g/l; 4 g/l and were compared with the control variant that remained untreated. The germination process was monitored and measurements were made regarding the average height of the seedlings (cm) as well as determinations of the main indicators of chlorophyll fluorescence. All cultivars analyzed showed lower rates than the control, both in terms of germination processes and in the case of biometric indicators, the differences being significant. The concentration of 2 g/l positively influenced the height growth of seedlings for all cultivars, the highest average height of 4.3 cm was recorded for Ocimum basilicum var. bulatum, followed by Ocimum basilicum var. piperitum with 4 cm and Ocimum basilicum var. citriodorus by 3.8 cm, compared to the control (3.4 cm). There were changes in fluorescence variables at different salinity thresholds. At 4 g/l salinity concentration, all

varieties presented a lower Fm compared to the other salinity levels, the differences between them being significant. The values of the Fv/Fm measurements were between 0.7749 when applying 1 g/l to the Ocimum basilicum var. piperitum cultivar and 0.6901 when applying the concentration of 4 g/l to Ocimum basilicum var. bulatum, the decrease in the ratio value indicating the presence of stress conditions and a fluorescence quenching mechanism.

Keywords: basil, salinity stress, chlorophyll fluorescence, biometric indicators cultivars

S02-PIII-70

Impact of heat and drought stress on the response of the photosynthetic apparatus of potato plants (*Solanum tuberosum* L.)

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The aim of our study was to screen the tolerance of the photosynthetic apparatus of selection lines of potatoes to abiotic stress factors (high temperature and drought) by analyzing the parameters of chlorophyll fluorescence and searching for gene carriers of resistance to these stress factors for the purposes of selection. The pot experiments were carried out in a greenhouse during 2018-2021. Plants were subjected to stress factors during the reproductive period (bud formation and flowering phases), which is considered particularly critical for potato plants. The influence of drought and high temperature on the condition and functional activity of the photosynthetic apparatus was studied by analyzing the chlorophyll fluorescence characteristics of the photosystem II and the content of total chlorophyll in the potato leaves. The cultivars were subjected to two water levels (75%–80% and 45%–50%), which represented the well-watered and moderate drought stress conditions. A comparative test was conducted to determine the sensitivity of the photosynthetic apparatus (PSA) to abiotic stress factors (high temperature and drought) in seven potato selection lines belonging to different maturity groups. From the early maturity group, lines C 617, E 606, and E 1809 were included in the study; from the mid-early group, lines C 591 and D 348; and from the mid-late group, lines C 716 and C 749. The obtained results show that the applied stress during the budding-flowering phenophases has a negative impact on the activity of the photosynthetic apparatus (PSA) of potatoes, as expressed by the changes in the chlorophyll fluorescence values. A genotypic differentiation was found in studies of a set of potato samples regarding their response to the abiotic stress factors of high temperature and drought.

Keywords: potato, breeding, abiotic stress, photosynthetic apparatus, chlorophyll fluorescence

S02-PIII-71

A comparative study of strawberry (*Fragaria* sp.) yield and growth parameters in indoor controlled environment agriculture

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Strawberries Fragaria sp. are nourishing soft fruits grown globally. Technology and capacity determine strawberry production systems' - low under open-field conditions, medium in tunnels or greenhouses, or highly productive high-tech vertical farms. As the availability of arable soils diminishes, the climate changes, but human population grows, and there is an increasing demand for vertical farming. When cultivating strawberries in a controlled environment, it is crucial to assess the suitability of the cultivars, as not all varieties that demonstrate their efficacy as successful commercial cultivars when grown in open-air circumstances or tunnels maintain their desirable attributes when cultivated indoors. In this trial, the whole growing cycle indoors was tested. Strawberry plantlets were propagated by plant tissue culture methods and grown in indoor conditions; the first crop of runners and then the berry crop were obtained. Three cultivars 'Albion', 'Charlote', and 'Sonata' were grown. The experiment assesses the growth and development of runners, the mother plant's growth, flowering, and yield of berries. Yield, growth factors, and propagation capacity were analyzed using ANOVA and correlation. The growth and yield of 'Albion', 'Charlote', and 'Sonata' strawberries were compared. 'Albion' had a good yield of fruits and runners, 'Charlote' had high sugar levels in fruits but a lot of physiological flower distortions and moderate growth. 'Sonata' had larger yields. For all cultivars, the number of runners had little effect on fruit output. With this technology, we can collect two yields from strawberry farms: the production of plants for the next crop rotation and the berry yield, to ensure continuous production. In our case variety 'Charlote' has shown unsuitability for cultivation in indoor farm environmental conditions. Although 'Charlote' shows high sugar levels and a good taste, further findings about favorable growing parameters are necessary. While 'Sonata' has promising results and could be grown indoors. By forcing part of the indoor farm's plants produce runners, is possible to provide urban farm with planting material to continue to harvest berries.

Keywords: Strawberry, CEA, indoor farming, propagation

S02-PIII-72

Agriculture side-stream emergence and circular bio-economy: challenges and opportunities

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The challenges posed by the efficient utilization of organic resources in light of environmental considerations driven by the forces of globalization and consumerism are fueling worldwide interest in the concept of a circular bio-economy. Agriculture side-

streams refer to the secondary outputs generated during and/or after the harvest of organic fruits or vegetables that are not suitable for sale. This study aimed to analyze the agriculture side-stream production of tomatoes, peppers, potato, watermelons, melon, and apples in Kosovar agriculture and to explore the feasibility of using them as feed for the production of insects. The geographical scope of the study included two main regions for agricultural production in Kosovo (Dukagjini and Kosovo Plain). The samples were randomly selected: 108, 69, 284, 77, 136, and 90, for watermelon, melons, apple, tomatoes, peppers, and potatoes, respectively. Data collection methods varied, including sampling from 2 x 2 m surfaces for paper, tomatoes, and potatoes, 2 x 5 for watermelon and melon, and every 10 th plant in the line for apples. The results of this study indicate that the agriculture side stream production after harvesting can vary significantly depending on the specific crop or agricultural activity, the tomato plants (16.5 t/ha), followed by paper (5.6 t/ha), watermelon (2.5 t/ha), apples (2.3 t/ha), potato (2.0 t/ha), and melon (1.5 t/ha), respectively. Utilizing agriculture side-stream to feed insects effectively contributes to a circular bio-economy by reducing waste, recycling nutrients, creating value-added products, and promoting sustainability across various sectors.

Keywords: Agriculture side-stream, circular bio-economy, insects, sustainability

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