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Session: CLIMATE

Using crop models to extend genomic prediction for genotype-specific evaluation of climate change impacts

by Livia Paleari | Alessandro Tondelli | Agostino Fricano | Luigi Cattivelli | Ernesto Igartua | Alan H. Schulman | Andrea Visioni | Roberto Confalonieri | Università degli Studi di Milano, ESP, Cassandra lab | CREA Centro di ricerca Genomica e bioinformatica | CREA Centro di ricerca Genomica e bioinformatica | CREA Centro di ricerca Genomica e bioinformatica | Spanish National Research Council (CSIC) | University of Helsinki; Production Systems, Natural Resources Institute Finland (LUKE) | International Center for Agricultural Research in the Dry Areas (ICARDA) | Università degli Studi di Milano, ESP, Cassandra lab

Abstract ID: 50
Topic: Climate
Presenter Name: Livia Paleari
Contribution: Oral

Biophysical crop models can explicitly account for G×E×M interactions while estimating crop response to climate change, by reproducing crop growth and development as a function of environmental (climate, soil), management, and genetic factors. As such, they represent a unique tool to support the definition of both short- (management-based) and long-term (breeding-based) adaptation strategies. However, their capability of capturing genotype-specific responses to climate has been limited by the lack of approaches for integrating genetic information in crop modelling frameworks. The objective of this study (ERA-NET project RecoBar) was the integration of genomics and crop modelling to allow climate change impact analyses explicitly accounting for the heterogeneity among genotypes. Days to flowering in spring barley was used as a case study, given the primary role of phenology for crop adaptation. Phenotypic and genomic (50K Illumina SNP array) data for 151 two-row, spring barley genotypes from the ClimBAR and ExBarDiv collections were used, which involved days to heading evaluated with multi-environment trials in 17 site × season combinations. A wide range of conditions was explored, with locations spread from the Mediterranean basin to Northern Europe, and sowings performed both in autumn and spring. A dedicated modelling solution for crop phenology was developed by using approaches from the models WARM and WOFOST. Accession-specific calibration of model parameters was carried out using optimization algorithms (mean R^2 equal to 0.97). To avoid equifinality, variance-based global sensitivity analysis (Sobol' method) was used before calibration, which focused on the two parameters with the highest relevance on the target output. Genome-wide association analysis (GWAS) and genomic prediction were carried out on calibrated model parameters with the R package rr-BLUP. Genomic-predicted model parameters were then used – together with the modelling solution – to simulate heading date thanks to the model capability to explicitly interpret G×E×M interactions. Prediction accuracy was evaluated through a ten-fold cross validation scheme, randomly selecting 10% of the genotypes as test set and the remaining 90% as training. In order to test the capability of crop models to extend the genomic prediction in untested environments (not included in the training), a leave-one site-out cross validation was also carried out. Results

were encouraging, with R^2 between observed and simulated heading date for validation sets ranging from 0.95 to 0.97. This highlighted the potential of crop models to successfully extend genomic prediction (normally based on statistical relationships between SNPs and performance traits, without any process-based logic between genetics and the phenotypic expression of traits) to unexplored conditions. This allowed to use genomic-predicted values of model parameters to simulate genotypes response under climate change scenarios (IPSL and MPI realizations of SSP1-2.6 and SSP3.7.0). The variability observed in genotype-specific response to future climate projections highlighted, on the one hand, the need of genotype-specific quantification of climate change impacts and, on the other hand, the key role of crop modelling in extending the potential of genomic prediction to drive breeding-based adaptation to climate change.

A long-term experiment on mowing, fertilization and their combination to control Brachypodium rupestre in an abandoned grassland of the Alps

by Marco Pittarello | Alessandra Gorlier | Simone Ravetto Enri | Michele Lonati | Ginevra Nota | Giampiero Lombardi | Dept. Veterinary Sciences - University of Turin | School of Natural Resources and the Environment - University of Arizona | Dept. Agriculture, Forest and Food Sciences - University of Turin | Dept. Agriculture, Forest and Food Sciences - University of Turin | Dept. Agriculture, Forest and Food Sciences - University of Turin | Dept. Agriculture, Forest and Food Sciences - University of Turin

Abstract ID: 65
Topic: Climate
Presenter Name: Giampiero Lombardi
Contribution: Oral

In the Alps, grasslands have been the basis of mountain farming systems for centuries. However, agro-pastoral abandonment now poses a significant threat to their conservation. The cessation of grazing and mowing promotes the spread of coarse plants, such as the tall grass *Brachypodium rupestre*, which negatively affects grassland agroecosystem functions and leads to grassland degradation. Practices such as biomass removal, i.e. mowing, and nutrient addition, i.e. fertilization, have been successfully applied in various mountain environments to stop the degradation process and restore high-forage-quality and species-rich vegetation. However, to our knowledge, research that combines both practices is limited in alpine environments. An experiment was conducted in a *B. rupestre* semi-natural grassland, abandoned since the 1950s, located at the 'Gran Bosco di Salbertrand' Natural Park, at 1360 m a.s.l. We tested the effects of mowing, fertilization (120 kg/ha N, 80 kg/ha P2O5, 80 kg/ha K2O), and their combination over ten years, on 16 plots with four replicates of the three treatments and an untreated control. During the entire period, we evaluated the changes: in agronomic performances by computing the pastoral value and abundance of meso-eutrophic grassland species; in plant diversity, through species richness and effective number of species; in botanical composition. We used linear mixed effect models (LMM) to assess the effects of treatment, year, and their interaction on the above mentioned vegetation variables. Differences in single-plant species composition among treatments and throughout time were evaluated by performing multivariate analyses (PERMANOVA, PRC, tb-PCA). Mowing effectively reduced *B. rupestre* occurrence after five years while maintaining the initial cover of dry grassland species and overall species diversity. However, it did not increase the cover of meso-eutrophic grassland species or the pastoral value, which limits the use of this practice when aiming to improve attractiveness for grazing. Addition of fertilizer enhanced meso-eutrophic grassland species but did not affect either *B. rupestre* cover or the pastoral value. Instead, it slightly reduced the cover of dry grassland species, which are considered of conservation interest, and decreased plant diversity, which is not desirable with conservation purposes. Instead, the combination of mowing and fertilization resulted in a decrease of *B. rupestre* cover by 80% in the short term, increased

by 300% the meso-eutrophic grassland species cover, and improved the pastoral value by 6.5/100 points. Moreover the cover of dry grassland species and plant diversity were not negatively impacted. While dry grassland mowing is generally recommended by European and national policies for the protection of open habitats, and the use of fertilizers is frequently restricted as it can cause eutrophication and reduces species richness, according to our long-term study, combining biomass removal with nutrient addition is an effective strategy to secure either agronomic performance and habitat conservation targets. Land managers should attentively balance the agroecosystem inputs and outputs to achieve intermediate nutrient levels and maximize grassland forage quality (to meet farm needs) and plant diversity (to preserve grassland natural value).

Land surface phenology for the characterization of Mediterranean permanent grasslands

by Alberto Tanda | Antonio Pulina | Simonetta Bagella | Giovanni Rivieccio | Francesco Vuolo | Pier Paolo Roggero | Department of Agricultural Sciences, University of Sassari | Department of Agricultural Sciences, University of Sassari | Department of Chemical Physical Mathematical and Natural Sciences, University of Sassari | Department of Chemical Physical Mathematical and Natural Sciences, University of Sassari | Institute of Geomatics, University of Natural Resources and Life Sciences (BOKU) | Department of Agricultural Sciences, University of Sassari

Abstract ID: 122
Topic: Climate
Presenter Name: Alberto Tanda
Contribution: Oral

Mediterranean permanent grasslands play a key role in biodiversity conservation and offer a range of ecosystem services. However, they are under threat in southern Europe due to abandonment and environmental pressures. In this study, we explored the hypothesis that a set of Land Surface Phenology (LSP) parameters derived by medium-high spatial and temporal resolution Copernicus Sentinel-2 satellite data, can provide a fine characterization and long-term monitoring of a variety of vegetation and management systems of permanent grasslands, to support the design of conservation and agronomic improvement programs. We focused on LSP parameters against ground proofs based on vegetation and agronomic surveys, to obtain useful information from agronomic and ecological perspectives. Forty-nine polygons, representing eleven sites characterized by different grassland vegetation, soil, climate, and management types, were selected in Sardinia (Italy). Six years Sentinel-2 satellite images were processed to derive NDVI, and LSP parameters were obtained using TIMESAT 3.3 software after Savitzky–Golay filtering. The results showed a clear correspondence between LSP parameters and a set of indicators relevant from the agronomic and environmental points of view, including: 1) managed vs. abandoned grasslands, 2) specific management practices (mown vs. not mown); 3) wooded vs. open grasslands, 4) grassland vegetation, as described by a principal component analysis and 4) climatic gradients (elevation). In conclusion, LSP provides a promising proxy to characterize agronomic features and relevant vegetation of Mediterranean permanent grasslands, useful to support conservation and improvement programs, as well as the monitoring of grassland-related habitats threatened by management or environmental pressures.

Modelling estimation of crop and soil variables in agrivoltaic systems in marginal areas

by Alessia Perego | Marco Botta | Mara Gabbrielli | Giorgio Ragaglini | Marco Acutis | Albino Maggio | Claudio Russo | Valerio Cirillo | Elena Cervelli | Stefania Pindozzi | Pier Francesco Recchi | Antonio Mileti | Fabio Terribile | Department of Agricultural and Environmental Sciences, Università degli Studi di Milano | Department of Agricultural and Environmental Sciences, Università degli Studi di Milano | Department of Agricultural and Environmental Sciences, Università degli Studi di Milano | Department of Agricultural and Environmental Sciences, Università degli Studi di Milano | Department of Agricultural and Environmental Sciences, Università degli Studi di Milano | Department of Agricultural Sciences, Università degli Studi di Napoli Federico II | Department of Agricultural Sciences, Università degli Studi di Napoli Federico II | Department of Agricultural Sciences, Università degli Studi di Napoli Federico II | Department of Agricultural Sciences, Università degli Studi di Napoli Federico II | Department of Agricultural Sciences, Università degli Studi di Napoli Federico II | Department of Agricultural Sciences, Università degli Studi di Napoli Federico II | Department of Agricultural Sciences, Università degli Studi di Napoli Federico II | Department of Agricultural Sciences, Università degli Studi di Napoli Federico II

Abstract ID: 78
Topic: Climate
Presenter Name: Mara Gabbrielli
Contribution: Pitch

The present study aims to present a preliminary estimation of crop productivity in a wide range of shading conditions in agrivoltaic systems in Italian marginal lands.
The first objective of this study was the identification of marginal areas of Italy potentially suitable for agrivoltaic systems, as a baseline for technical and economic viability. Two procedures were applied, e.g. deterministic and probabilistic approaches. The deterministic approach considered the constraints which allowed us to exclude entire portions of the study area according to our purpose. Such conditions are linked to: - Physical aspects: elevation and slope - Socioeconomic aspects: land-use/land-cover (LULC) - Environmental aspects: areas of natural interest. The probabilistic approach is based on the deterministic one to which a Multiple-Criteria Decision Analysis (MCDA) was added (Cervelli et al., 2024). In this work, the choice of criteria was strictly related to land marginality aimed at finding the best land allocation in terms of sustainability of energy supply, with a special reference to agrivoltaic systems. A double set of criteria was taken into account:1) Land marginality: factors determining land marginality in terms of geomorphology (elevation, slope, etc.), environmental risk (soil erosion), socioeconomic context (land use); 2) Profitability: factors determining the maximum return of investments in the agrivoltaic systems (solar radiation, elevation, slope, aspect, proximity to the electricity grid). The second objective was to build a harmonized database of yield and other crop-related data in shading conditions, considering three crop functional groups, i.e cereals, grass ley, and non-food oleaginous crops, to identify the most suitable species for cultivation at different levels of shading. Among the food crops, the most promising are fodder crops, limited to shading conditions of around 40%. The yields of Ricinus are highest when cultivated at shading levels of 50%, due to its apparent tolerance to shading. The collected data were used to calibrate the crop

parameters of the ARMOSA simulation model (Perego et al., 2013). The third objective was the development of a module that was integrated into the modular model ARMOSA to simulate a wide range of agrivoltaic plans characteristics (fix of solar tracking panels, height, panel width, radiation porosity, panel density, distance between panels) to reproduce the condition that is mainly characterized by the reduction of the radiation and evapotranspiration. In three sites identified in the marginal lands of southern Italy (probabilistic approach), the yield reduction of durum wheat, barley, alfalfa, Ricinus, safflower, and camelina was simulated in 15 agrivoltaic configurations in interaction with varying aspects and slopes. Evapotranspiration, nitrogen uptake, nitrogen losses and soil organic carbon sequestration were also estimated in each scenario. The average yield reduction was 10% to 40%, in agreement with the literature data. The newly implemented is a promising tool to simulate yield driven by shading and field management with a flexible model that can be set by the user.

Life Cycle Assessment of Wheat Production in Sicily: Conventional vs. Organic Approaches

by Monica Auteri | Giuseppe Di Miceli | Mario Licata | Rose Nangah Mankaa | Simona Prestigiacomo | Marzia Traverso | Department of Agricultural, Food and Forest Sciences, University of Palermo | Department of Agricultural, Food and Forest Sciences, University of Palermo | Department of Agricultural, Food and Forest Sciences, University of Palermo | Institute of Sustainability in Civil Engineering, RWTH Aachen University | Department of Agricultural, Food and Forest Sciences, University of Palermo | Institute of Sustainability in Civil Engineering, RWTH Aachen University

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Topic: Climate
Presenter Name: Monica Auteri
Contribution: Pitch

Food systems have profoundly impacted many facets of human life, by influencing dietary habits, health outcomes, economic stability, and socio-cultural structures. Wheat production is one of the most important agricultural systems, with an estimated global area of about 219 million hectares. It has been shown that agricultural systems and the cereal industry as part of this, may potentially threaten biodiversity and ecosystem functions. This highlights the necessity to optimise the production of wheat grain in an environmentally sustainable way. The aim of this study was to evaluate and compare the environmental impacts of conventional and organic wheat grain production systems in Sicily using the Life Cycle Assessment (LCA) method. The analysis was conducted using data from 21 farms (14 conventional and 7 organic) based in Sicily in 2021 and 2022. A "cradle to gate" system boundary was specified. All wheat cultivation activities from sowing to harvest, fuel consumption and its production, water consumption for pesticides dilution and waste treatment were considered. The production of fertilisers, seeds and pesticides, which includes packaging and delivery to farmers, was also included in the analysis. Farm infrastructure, machinery production, human labour and maintenance were excluded. In this study, yield (t ha^{-1}) was used as the functional unit (FU). In the life cycle inventory stage, primary data was collected from above-mentioned farms through questionnaires. Secondary data from Ecoinvent v.3.0 were used in instances where the necessary primary information was unavailable. The analysis was carried out using SimaPro 9.5.0.1. The CML-IA baseline impact assessment method was used, considering 11 categories. The results showed that for almost all impact categories, conventional farming had higher environmental impacts than organic farming. Normalized results suggested that, for both systems, marine aquatic ecotoxicity was the most affected impact category, with calculated values ranging from 1,30E+05 to 1,05E+06 kg 1,4-DB eq. For the conventional system, most of the impact categories were mainly influenced by transport of all products and by pesticide production, especially for ozone layer depletion and abiotic depletion. The only exception was terrestrial ecotoxicity, which was mainly affected by seed production. Only eutrophication was primarily affected by the cultivation step. The production of packaging, lubricating oil and waste treatments had no significant impact. Overall, the impacts were lower for the organic farms, which can be explained by the fact that fertilisers and pesticides were not used in this system. In this case, in almost all categories, the most significant impacts were related to the production and use of diesel. Furthermore, there were no differences between self-produced seeds vs. seeds that were sourced from local producers. The findings of this study are useful in assessing solutions to reduce the environmental impacts related to wheat production, for example reducing the use of pesticides and sourcing products such as fertilisers, pesticides or buy it from local producers in order to reduce transport related to impacts.

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Time-lapse Image-Based Monitoring of Pasture Growth in Agrivoltaic Environment Using Green Indices Extraction: A Proximal Sensing Approach

by Michele Moretta | Riccardo Rossi | Marco Moriondo | Marco Bindi | Enrico Palchetti | Gloria Padovan | DAGRI- Università degli Studi di Firenze | DAGRI- Università degli Studi di Firenze | CNR-IBE | DAGRI- Università degli Studi di Firenze | DAGRI- Università degli Studi di Firenze | DAGRI- Università degli Studi di Firenze

Abstract ID: 181
Topic: Climate
Presenter Name: Michele Moretta
Contribution: Pitch

Agrivoltaic systems (AV), which integrate agriculture with photovoltaic panels for electricity production, must include a monitoring system to verify the impact of the panels on crops, as required by the Ministry of Environment and Energy Safety guidelines (MiTe, 2022). Image-based monitoring using greenness analyses has proven effective both at the landscape level (Brown et al., 2016) and for specific species (Beamish et al., 2016). These studies emphasize the capability of image-based monitoring to reduce fieldwork demands while enhancing data resolution. Nevertheless, these methods often necessitate considerable manual effort to extract ecologically relevant data, which constrains their scalability (Mann, H et al., 2022).

In light of these challenges, we propose an innovative approach to monitor pasture growth in an AV environment, using time-lapse imagery and extracting green index. This methodology serves as a proximal sensing technique, offering a ground-based solution for monitoring pasture growth in areas where other types of remote sensing are limited by the presence of panels. The experimental investigation was conducted in a 70-hectare AV grassland in Ravenna throughout the 2023 growing season. At the start of the season, 1 time-lapse camera (Scout Guard BG590-K2-45mHD, Scubla) was installed on 1.5 m north-facing poles at 60 ◦, capturing an 18 m 2 angle area from the horizontal, in each frame. Images were recorded hourly during daylight, according to the cameras' automatic mode, from 28 December 2022 to 22 November 2023. Here, we focused on the annual meadow grass growth period, including spring (16 June) and summer mowing (28 August). 4′020 images stored in jpg format (1280 × 1040 pixels) were considered in the study. Furthermore, to assess the influence on grassland productivity, systematic mowing was performed within designated 0.5 m x 0.5 m square plots for each area and FPAR measured with a ceptometer. The main objective of this study was the extraction of green indices from time-lapse images to estimate the plants' photosynthetically intercepted radiation (fPAR). Various green indices were calculated from the images using image processing techniques. These indices served as proxies for vegetation health and allowed for the assessment of pasture growth trends. The results of our investigation revealed significant correlations between some extracted green indices and fPAR measured. The temporal variations of the green indices also closely mirror the biomass variations observed through field sampling, demonstrating the effectiveness of the proposed methodology for monitoring pasture growth in the AV system. In conclusion, by exploiting green indices extracted from high-resolution images, this approach offers a reliable and cost-effective solution for assessing vegetation dynamics and biomass accumulation in an agri-voltaic environment.

How Hairy Vetch (Vicia villosa Roth.) Residue Management Affect soil Carbon dioxide emissions and processing tomato (Solanum Lycopersicon L.) yield

by Quintarelli Valentina | Borgatti Daniele | Ben Hassine Mortadha | Baretta Mattia | Radicetti Emanuele | Mancinelli Roberto | University of Ferrara | University of Ferrara | University of Ferrara | University of Ferrara | University of Ferrara | University of Tuscia

Abstract ID: 11
Topic: Climate
Presenter Name: Quintarelli Valentina
Contribution: Post

Recently, intensive agricultural practices have enabled global food demand to be met by increasing productivity per unit area but has led to the simplification of agroecosystems through the excessive use of agrochemicals determining a gradual loss of soil fertility. Previous research showed how hairy vetch (*Vicia villosa* Roth.) could play a key role in the reduction of synthetic fertilizers, even if, the termination methods of the hairy vetch biomass should be deeply evaluated for improving crop yield and mitigate soil CO_2 emissions. The main goal of this study is to examine how the different termination methods of hairy vetch biomass affects plant growth and fruit yield and mitigate soil CO_2 emissions during processing tomato growing season. The experiment was carried out during the 2023 at F.lli Baretta farm located in Ferrara, Italy (44°72’39’’;70°39’39’’; N, 12°08’’39’;12°39’39’’; E, altitude 2 m). Tomato plants of a commercial variety (*Lycopersicon esculentum* Mill.) cv. Heinz 1301 F1 were produced in a private nursery. Experimental treatments consisted of three different hairy vetch (*Vicia villosa* Roth.) residue managements: (i) mowed and green manured at 10 cm of soil depth (GM); (ii) finely cut and left on the soil surface in conservation tillage (hereafter called MOW), and (iii) biomass terminated with roller crimper and left on the soil surface as organic dead mulch (hereafter called RC). In addition, a bare soil treatment was cultivated (hereafter called C). Tomato plants were transplanted under field conditions on 29 April 2023, and managed under organic farming practices until tomato harvesting on 9 August 2023. Measurements of soil CO_2 emissions, temperature and moisture were determined by using an EGM-5 portable CO_2 gas analyzer and TDR FieldScout 350, respectively. The readings were performed every 10 days throughout the growing season. At the same time, NDVI readings were performed to assess tomato plant response by means of RapidScan, respectively. Results on soil CO_2 emissions showed how RC treatments determined reduced emissions throughout the tomato growing season compared with the other treatments, while GM tended to show the high values. Soil moisture was higher in all termination treatments compared with C, especially at 7 and 11 cm of soil depth where tomato roots are mainly concentrated. The NDVI values of tomato plants was similar in all hairy vetch treatments regardless the termination methods and higher than in the control treatments. Similarly, tomato fruit yield was similar among the hairy vetch treatments than control. The preliminary results of this study

provided a better understanding related to the choice of termination method of hairy vetch cover crop for tomato cultivation, Considering the similar tomato fruit yield, it is conceivable to state that leaving hairy vetch residues on the soil surface as dead mulches may be a feasible strategy for slowing down the mineralization process and enhancing the synchronization between nitrogen release and tomato requirements throughout the cropping season. In addition, the enhanced values of soil moisture, especially in MOW and RC, indicate this agronomical approach environmentally-friendly in term of water-saving practice, while mitigate soil CO_2 emissions.

Enhancing sustainable camelina cultivation through intercropping: a pathway towards climate neutrality

by Elena Pagani | Federica Zanetti | Erika Facciolla | Andrea Monti | University of Bologna | University of Bologna | University of Bologna | University of Bologna

Abstract ID: 12
Topic: Climate
Presenter Name: Elena Pagani
Contribution: Post

Climate neutrality by 2050 is the ultimate goal of the European Green Deal and it requires an increase in energy efficiency and significantly higher shares of energy from renewable sources in an integrated energy system. Camelina (*Camelina sativa L Crantz*), a minor oilseed crop, has currently gained attention as feedstock for renewable diesel production for several reasons; such as its high seed oil content (ranging from 30 to 42%), favourable fatty acid composition (significant amount of unsaturated fatty acids), relatively short growing season (up to 90 d), and minimal inputs requirements such as water, fertilizer, and pesticides compared to some other crops. Additionally, camelina can be used as a rotational crop in agricultural systems, providing agronomic benefits to subsequent crops. However, there is a restricted understanding regarding the possible yields of camelina cultivated within various intercropping systems. Intercropping is the simultaneous cultivation of multiple crops in the same area, and offers several benefits for sustainable agriculture, even under organic farming. The aim of the study was to compare sole-camelina with camelina intercropped with peas, chickpeas, lentils, and naked oats with respect to seed yield, oil content, and fatty acid composition. The field experiment was carried out during two growing seasons 2022-2024, at the organic experimental farm of the University of Bologna (Italy) in Ozzano dell’Emilia. The experimental design was a completely randomized block design with four replicates. Camelina was sown in two different trials: I) in winter sowing as sole-camelina (SCw) and intercrop with peas (ICp) and chickpeas (ICc), whereas II) in spring sowing as sole-camelina (SCs) and intercrop with lentils (ICl), and naked oats (ICo). Sole-camelina was row-seeded at 8 kg ha^{-1}, while in the intercropping systems it was broadcasted at half of that rate (50:50). The harvest was carried out at the beginning of June for SCw and ICp, at the end of June for SCs and ICl, at the beginning of July for ICo, and at the end of July for ICc. One way ANOVA was carried out for each trial (i.e. winter and spring). The first-year results showed that SCw produced higher seed yield than ICc but not than ICp, while SCs produced higher seed yield of ICo but not of ICl. Seed oil content in winter-sown camelina was higher in ICp (30%) than SCw and ICc (average mean of 27,5 %), while in spring-sown camelina, it was higher in ICl and SCs (average mean 26,3%) than ICo (18,9%). The fatty acid composition was affected by intercropping, but the obtained differences were negligible. The second-year trial is currently ongoing, and additional data will be available by the time of the conference. In conclusion, intercropping resulted in a sustainable way to cultivate camelina with peas and lentils without reducing seed yield and

oil content. It might be possible to improve the camelina seed yield by reducing the seeding rate of the companion crop (i.e., chickpeas and naked oats), aiming at reducing their competition for available resources (i.e., soil, and light) and thus promoting the growth of camelina.

LCA methodologies to assess biodiversity in agricultural systems with crop-livestock interaction

by Huayang Zhen | Pietro Goglio | Fatemeh Hashemi | Maxime Fossey | Christel Cederberg | Hayo van der Werf | Marie Trydeman-Knudsen | Aarhus University | University of Perugia | Aarhus University | IDELE | Chalmers University | INRAE | Aarhus University

Abstract ID: 22
Topic: Climate
Presenter Name: Pietro Goglio
Contribution: Post

Agriculture approximately occupies five billion hectares, 38% of the world land surface area. Agricultural intensification (through land management change) and expansion (land-use class change) have driven global biodiversity loss. However, no consensus has been reached on assessing the biodiversity impacts of land management (e.g., crop, pesticide, tillage management) with life cycle assessment (LCA). Through a systematic literature review of LCA methods for assessing biodiversity impacts integrating participatory approaches involving experts in agronomy, LCA, biodiversity and livestock and feed science. This study intended to investigate and describe characteristics of key LCA methods identified through expert panels and provide some recommendations. We evaluated 11 expert scoring-based (ESB) and 32 biodiversity indicator-based (BIB) methods. Generally, BIB methods performed better than ESB methods in terms of the three criteria scores robustness, completeness, and applicability. The investigated methods focus on different biodiversity loss drivers and various biodiversity levels and aspects, but have in common that they consider limited biodiversity characteristics and do not represent the comprehensive biodiversity concept. Six of the evaluated methods were identified as suitable for agricultural LCA. At the global (regional) level, SAR-3 (Species Area Richness) (SAR-4), Functional Diversity Index, and Countryside SAR-1 were recommended as the consider land-use class change due to water consumption and several biodiversity characteristics (threat status, occurrence of species, and habitat suitability). Functional Diversity Index was the only method which assesseed functional biodiversity systematically, though some methods also considered functional biodiversity coarsely, e.g. Swiss Agricultural LCA—Biodiversity and Biodiversity Intactness Index. At the farm level, the BioImpact Metric, Swiss Agricultural LCA-Biodiversity (SALCA-Biodiversity), and Fuzzy Thinking Biodiversity Assessment were recommended, the last one being user-friendly with simple, fewer, and quantitative parameters that can involve land management practices. All these methods had various limitations which include limited accounting of land management (e.g, pesticide impact, crop diversification). Several of the LCA methods identified were developed to assess biodiversity impact outside the European continent (e.g., functional diversity index, the bioimpact metric) or for a limited set of crop management practices. SALCA-biodiversity was the LCA method which consider a broader range of land management practices (e.g, fertilizer application, crop diversification, grassland management, pesticide use). We recommend to use different methods to compare or

complement biodiversity assessments. An important aspect when choosing methods is how the method for all cultivation processes in complex production systems. For some regions, it is encouraged to develop new methods based on the current methodological frameworks. Future studies shall (1) treat land management as a biodiversity loss driver and model its direct biodiversity impacts at the midpoint level; (2) Include more biodiversity characteristics to better reflect biodiversity's multidimensionality; (3) integrate positive biodiversity impacts related to agroecological practices; (4) establish a sensible method for evaluating land management practices in LCA biodiversity impact assessment; (5) harmonize the methods of modeling land management practices with the other biodiversity impact assessment methods. This research reviewed the state-of-the-art, identified the research needs, and will contribute to the methodology improvement of incorporating land management into LCA.

High-performance and stable bread wheat varieties responses under multi-environmental trial using AMMI and GGE models

by Mohamed Allam | Mariam Atait | Emanuele Radicetti | Roberto Mancinelli | Dipartimento di Scienze Agrarie e Forestali (DAFNE), Università degli Studi della Tuscia | Dipartimento di Scienze Agrarie e Forestali (DAFNE), Università degli Studi della Tuscia | Dipartimento di Scienze Chimiche, Farmaceutiche e Agrarie (DOCPAS), Università degli Studi di Ferrara | Dipartimento di Scienze Agrarie e Forestali (DAFNE), Università degli Studi della Tuscia

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Presenter Name: Roberto Mancinelli
Contribution: Post

Climate change and the worldwide warming have become a challenge for the globe to sustain earth's resources. The industrial, agricultural, and economic activities to meet consumer demands have significantly contributed to these circumstances. Different performance of genotypes across different environments is referred to as genotype by environment interaction (G×E). Wheat crop varieties respond differently to different growing conditions implying that the correct choice of varieties by growers is necessary for specific production conditions, to avoid losses due to genotype × environment interactions (G×E). The main threat for wheat crop in Europe is the altering of the environmental conditions which can greatly affect the productivity in coming years. Therefore, the evaluation and selection of suitable plant variety is a critical step for identifying the scope of genotype in given environment. Moreover, the impact of climate changes is changing the dynamics of agricultural activities, especially in the Mediterranean area, as it has been labelled as a hotspot for climate change. This suggests a need for improved novel agricultural practices and use of eco-friendly approaches for sustainable crop production. In this study, the relative performance of eight commercial bread wheat varieties were investigated over two successive growing seasons (2020/21 and 2021/22) at four locations representing (8 environments) two agroecological zones of Europe (north and central Europe). Varieties were tested under three levels of fungicide application. Treatment 1 (FULL) consisted of two application of fungicides, Seguris Xtra at dose of 1 L/ha at stem elongation stage and the second application of Prosaro at a dose of 1 L/ha at flowering stage. Treatment 2 (OPTIMUM) consisted of only the second application of Prosaro at flowering stage (1 L/ha). Treatment 3 (MINIMAL) was no fungicides application (CONTROL). Timings and split dose of fungicide treatments as applied in the study are common practice at each location. Treatments and varieties were arranged in a split-plot design and replicated three times. Characteristics such as grain yield (GY), number of spikes per m^2 (SN), grain number per spike (GN), and test weight (TW) were evaluated. The Additive main effects and multiplicative interaction (AMMI) and Genotype main effect (G) plus genotype by environment interaction (G×E) (GGE) models were used to visualize

genotypes and environments using biplots that help to explain the G×E interaction. Also, the phenotypic stability was evaluated using Weighted Average of Absolute Scores (WASSBY) index which allows weighting between the performance and stability of the variety. Multi-environment experiments represent an important step in plant breeding, where AMMI and GGE model are significant tools to select genotypes with high adaptability and stability. Fungicide application was not effective to improve grain yield and quality parameters compared to non-treated plants for the considered commercial varieties of bread wheat. The study revealed that G×E interaction was an important source of wheat yield variations, and WASSBY index was able to discriminate among the studied varieties. The study suggested promising candidates of bread wheat for high and stable production under study conditions, with the potential for their use in further studies.

Sustainable biomass potential resources and availability in Europe and in Italy, for bioenergy and new biofuels.

by Lisa Caturegli | Arianna Baldinelli | Silvia Tavarini | Leonardo Tognotti | Aristide Giuliano | Nicola Pierro | Isabella De Bari | Luciana G. Angelini | Department of Agriculture, Food and Environment, University of Pisa | Department of Civil and Industrial Engineering, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa, Via del Borghetto 80, 56124 Pisa, Italy | Department of Civil and Industrial Engineering, University of Pisa | ENEA, Italian National Agency for New Technologies, Energy and Sustainable Economic Development | ENEA, Italian National Agency for New Technologies, Energy and Sustainable Economic Development | ENEA, Italian National Agency for New Technologies, Energy and Sustainable Economic Development | Department of Agriculture, Food and Environment, University of Pisa

Abstract ID: 33
Topic: Climate
Presenter Name: Lisa Caturegli
Contribution: Post

The revised European Renewable Energy Directive (RED III) updates its list (Annex IX) of approved raw materials and biowaste for bioenergy processes, including biofuels and other energy derivatives. To support the development of local biofuel and bioenergy supply chains, a comprehensive GIS-based database is essential for identifying the most promising biomass-based processes in each region. This requires collecting both qualitative and quantitative data on significant feedstocks. Currently, there is no comprehensive information repository for managing specific feedstocks and other bio-waste (such as biomass and biowaste, or crops grown on severely degraded land). Determining the harvesting potential and seasonality of these resources is crucial. The enhancement and expansion of the Biomass Atlas issued by ENEA is the first step towards defining, analyzing, and optimizing bioenergy supply chains with a regional focus. The goal is to create an implementation framework for the bioenergy processes addressed in Spoke 3 (Bioenergy and New Biofuels for Sustainable Future) Network 4 Energy Sustainable Transition (NEST) within the PNRR. The proposed methodology aims to map crops grown on marginal land and assess bio-waste availability relevant to achieve RED III goals, with the objective of establishing a detailed list of promising industrial crops for marginal lands. The core activity involves data collection and analysis from research projects or direct surveys/interviews. Regarding marginal land crops mapping, the methodology relies on information/results from national, European, and international projects on energy crops grown on degraded/marginal lands. A key result is a database for marginal land crops in Italy and EU. This database identifies the most suitable crops for marginal/degraded lands, aiming to define agronomic techniques and innovative processes for obtaining low ILUC (Indirect Land Use Change) risk agri-feedstocks, ensuring no competition with the food supply chain. The selection of biomasses promotes circular, efficient, and sustainable production chains from both economic and social perspectives. The database is composed by: I) a table including 28 industrial crops belonging to different plant categories (oilseed, fiber crop, lignocellulosic,

and woody crops) selected for their suitability to be grown on marginal lands. The table includes name, origin, potential European cultivation sites, reasons for cultivation on marginal lands, crop category, and market products), along with bibliographic references; II) a dataset related to non-EU projects on innovative cropping systems for marginal lands. This comprehensive approach supports and enhances bioenergy supply chains, contributing to a sustainable energy future as envisioned by RED III and the PNRR. Acknowledgment. Project funded under the National Recovery and Resilience Plan (NRRP), Mission 4 Component 2 Investment 1.3 - Call for tender No. 1561 of 11.10.2022 of Ministero dell'Università e della Ricerca (MUR); funded by the European Union – NextGenerationEU, Project code PE0000021, Concession Decree No. 1561 of 11.10.2022 adopted by Ministero dell'Università e della Ricerca (MUR), CUP - I53C22001450006, Project title "Network 4 Energy Sustainable Transition – NEST".

System-based Precision Agriculture for Sustainable Crop Production

by Davide Cammarano | Department of Agroecology, iClimate, CBIO, Aarhus University, Tjele, Denmark

Abstract ID: 38
Topic: Climate
Presenter Name: Davide Cammarano
Contribution: Post

The *major challenge* addressed is the systemic mismanagement of nitrogen (N) fertilizer in agricultural fields leading to problems such as leaching of nitrates into groundwater and emission of harmful greenhouse gases. Digital technologies are commercialized in agriculture (available from the early 1990s) but have failed with N fertilization. Despite agriculture is the least digitized sector (as highlighted at the last World Economic Forum) to make a reliable recommendation, researchers need to extract and simplify complex science into practical and relevant information enabling advisors and farmers to use such information to make N recommendations for individual fields. But severe bottlenecks in research, development and application of precision agriculture cause key research to be disconnected. With this project we propose to develop a framework that explores and fills the gaps within the system. We focus on ways to a strategic and tactical N management that maximizes farmers' income and minimize N leaching and greenhouse emissions. The main outcome of the project is a research infrastructure (On-Farm Experimentation and On-Farm Research) encouraging involvement of key stakeholders that will generate the data needed for this better understanding. The project will show a way in which farmers can substantially lower the environmental footprints while maintaining economic viability. This research infrastructure will also be used beyond this proposed project to include other agronomic issues (e.g. agrochemicals, weeds management) and for educational purposes. The objectives of the proposed project are: i) Developing a N management system that minimizes N losses in arable farming. This is achieved by combining sensing of soil and crop at high spatial and temporal resolution with crop-soil models; ii) Strengthening collaboration among soil and plant research on precision agriculture within Denmark aimed at supporting the green transition; iii) Capacity building through establishing a long-term on-farm experimentation platform that supports research, teaching and stakeholder interactions. The *main novelty* of the project is that observations and modeling are combined using a digital twin (DT) approach. A DT provides not only a real-time, up-to-date view of the state of crop and soil, but also allows to make predictions about future states of the system under different management options.

Responses of bread wheat yield to long-term (1976–2020) fertilization regimes under different rotations

by Sara Bosi | Lorenzo Negri | Giulia Oliveti | Rocco Enrico Sferrazza | Marco Sangiorgi | Francesca Ventura | Guido Baldoni | Giovanni Dinelli | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna

Abstract ID: 40
Topic: Climate
Presenter Name: Giovanni Dinelli
Contribution: Post

The design of a cropping system that gives high and stable crop yields is crucial to ensure food security for the growing world population under the ongoing climatic change. Also, to save the Planet, the efficiency of agronomic inputs must be increased. To detect their effects on crop yields, long-term field experiments (LTEs) are needed. The paper discusses the yields of wheat (*Triticum aestivum* L.) that were obtained from 1976 to 2020 in an LTE performed in the experimental farm of the University of Bologna. It compares mineral and organic fertilizations within three crop rotations in a split-plot design with two replicates. The rotations were continuous wheat, a biennial rotation (wheat-corn (*Zea mays* L.)) and a 9-year rotation (alfalfa (*Medicago sativa* L.)-alfalfa-alfalfa-corn-wheat-corn-wheat-corn-wheat). The fertilizer treatments were unfertilized control (N0), 20 Mg ha^{-1} FW of cattle manure (M1N0), two rates of urea (100 and 200 kg N ha^{-1}) without (N1 and N2, respectively), and with the manure addition (M1N1 and M1N2). The nitrogen use was calculated as the difference between the grain yields of fertilized and control plots, divided by the rate of the applied nitrogen (agronomic efficiency, by Fageria and Baligar, 2005). The N application with manure was given a standard value of 0.4 %. On average, the 9-year rotation gave a wheat yield increase of 27% and 15% with respect to continuous wheat and to the 2-year rotation, respectively. Manure increased yield by 32% and the two rates of urea with no manure by 78% and 100% compared to unfertilized control. In the 9-year rotation N agronomic efficiency (23.4) was higher than in continuous wheat (14.9) and in the 2-year rotation (18.3). The lowest rate of urea was always the most effective. In the 9-year rotation this was evident in wheat grown 2 and 4 years after alfalfa, but the difference was slight after 6 years from the ley termination. The yearly variability of wheat yield and agronomic N efficiency under the various managements (expressed as CV%) were evaluated considering annual rainfall and mean temperatures. The highest variabilities of yields and N efficiency were observed in the 9-year rotation and with the lowest rate of mineral fertilization. In a changing climate, good result of wheat crops in terms of yield and fertilizer use, can be obtained in a long rotation, with a limited rate of mineral N.

Monitoring, reporting and verification system for EU carbon farming implementation: a case study based on agroforestry in Northern Italy plain

by S. Monaco | S. Bergante | R. Barbetti | M. Fantappié | R. Farina | M. Bascietto | F. Palazzi | P.M. Chiarabaglio | CREA-IT Engineering and agro-food processing Turin | CREA-FL Forestry and Wood Casale Monferrato | CREA-FL Forestry and Wood Casale Monferrato | Agricolture and Enviroment Firenze | Agricolture and Enviroment Roma | CREA-IT Engineering and agro-food processing Monterotondo | CREA-IT Engineering and agro-food processing Turin | CREA-FL Forestry and Wood Casale Monferrato

Abstract ID: 49
Topic: Climate
Presenter Name: stefano monaco
Contribution: Post

Introduction

The EU strategy for climate neutrality by 2050 (EU Reg. 2021/1119) is based on greenhouse gas (GHG) emissions reduction but also implies carbon removals in the LULUCF sector, with a target of 310 million tonnes of CO_2 equivalent per year from 2030 and specific national targets (UE Reg. 2023/839). To achieve this objective, the Commission presented a Proposal for a Regulation establishing a certification framework for carbon removals (COM/2022/672 final) to both facilitate the delivery of public funding based on results and promote a voluntary carbon market through the establishment of strict, transparent and verifiable standards. For this purpose, suitable carbon farming solutions (e.g. maintenance of permanent grassland, agroforestry, conservative agriculture, restoration of peatlands and wetlands) and a reference monitoring, reporting and verification (MRV) system have been outlined in the Communication on the Sustainable Carbon Cycle (COM/2021/800 final). Therefore, it is necessary to evaluate tailored regional carbon farming practices and to apply standardized methodologies and rules for MRV. Here we describe the procedure to validate a MRV system applied to agroforestry as a novel carbon farming practice for arable farms in the Po valley. The research is part of the Horizon project “MRV4SOC” aimed at evaluating Tier3 methodologies for estimation of soil organic carbon (SOC) accumulation and GHG balance. The activity is carried out in the CREA-Research Center for Forestry and Wood experimental farm ‘Mezzi’ and in surroundings areas, located in the flooding area of Poriver, in Piedmont Region, North Italy (45°08'05.7"N 8°30'03.5"E). The research uses a combination of sampling, remote sensing and modelling (RothC and ECOSSE) methods and open-access data for feeding the model (i.e. agricultural statistics, soil maps). The ability of RothC to simulate past SOC accumulation with and without poplar plantation will be tested using 2024 and past SOC contents in the different fields with contrasting managements: 1) traditional cultivated with common rotations in arable farms as baseline, 2: carbon farming with poplar plantation included in the arable farm rotation, 3: carbon farming with poplar rows planted along arable fields edges. A scenario analysis with different densities of tree plantation at landscape scale to estimate potential SOC accumulation through the investigated carbon farming scheme compared to the baseline (business as usual) will be carried out as in Farina et al. (2017). The study will produce the following insights: i) estimation of SOC accumulation below the soil tilled layer accounting for carbon input from roots and soil organic matter dynamic in sub-surface soil layers in agroforestry system, using the model ECOSSE modified by Begum et al. (2022) ; ii) use for Vis-NIR for lab and in-field rapid and cost-effective determination of SOC through the development of a local spectral library (Barbetti et al., 2023); iii) short–term SOC turnover (i.e. CO_2 emissions monitoring) and assessment of the competition between trees and arable crops in a new established (2024) alley crop field trial in 'Mezzi' farm; iv) an assessment of plant carbon inputs with in-situ techniques (above and below-ground) and RS imagery (Sentinel-2).

Potential growth and development of black oat and white mustard cover crops in response to three sowing dates

by Matteo Sampietro | Luca Bechini | Marta Colombo | Roberto Fuccella | Davide Reginelli | Pietro Marino | Università degli Studi di Milano | Università degli Studi di Milano | Università degli Studi di Milano | Università degli Studi di Milano | Università degli Studi di Milano | Università degli Studi di Milano

Abstract ID: 88
Topic: Climate
Presenter Name: Matteo Sampietro
Contribution: Post

Black oat (*Avena strigosa* Schreb.) and white mustard (*Sinapis alba* L.) are two cover crop species cultivated in northern Italy. Their growth and frost resistance in response to sowing date is not well known, and therefore their mathematical modelling is limited. Therefore, we carried out a field experiment in Landriano (PV, Italy) aimed at measuring their growth, development, and frost damage under potential production conditions.We used a split-plot design with four replications; the main plot was the sowing date (SD1: August 31st, 2023; SD2: September 19th; SD3: October 11th), while the sub-plot was the crop species. Preliminary field operations included fertilization with 207 kg K/ha using potassium sulfate, then mouldboard plowing and rotary harrowing, followed by the application of 150 kg N/ha in the form of calcium nitrate at sowing for SD1 and SD2 (75 kg N/ha for SD3). A weather station and soil moisture and temperature sensors were installed. Sprinkler irrigation was applied when soil water content was lower than 50% of total available water (Soil and crop sampling was carried out at key stages, recording phenological stage, plant population density, height, leaf area index (LAI), above-ground biomass (AGB), and soil moisture and mineral nitrogen concentration. We report here only the results at the end of November. Biomass samples will be analysed for nitrogen (N) and carbon (C) concentration. Crop frost damage was monitored through image analysis during winter, followed by computer analysis to assess the impact on all treatments. Plant population densities were as follows: 163, 226 and 221 plants/m² for SD1, SD2 and SD3, respectively, for black oat, and 107, 160 and 150 plants/m² for white mustard. Plant population density was lower in SD1 compared to SD2 and SD3 due to heat injury to seedlings. Black oat produced 5.7, 3.8, and 0.2 t DM/ha for SD1, SD2, and SD3, while white mustard biomass was 5.9 (at the end of October), 4.4, and 0.2 t DM/ha. Plant height for black oat was 0.71, 0.43, and 0.09 m for SD1, SD2, and SD3, respectively; the corresponding values for white mustard were 1.30, 0.97, and 0.09 m. Phenological stages showed that white mustard reached an advanced vegetative stage for SD1 and SD2 (BBCH 19), while SD3 was at the third true leaf stage (BBCH 13). Black oat in SD1 and SD2 was at the stem elongation stage (>30 BBCH), while in SD3 it was at stage 23 (tillering). An almost complete fraction cover by the crop (>95%) was achieved for both species before frost for SD1 and SD2, whereas black oat SD3 reached maximum cover in spring. These data are being used for calibrating the simulation model CropSystVB for black oat and white mustard. The model will be used to provide insights for

the development of a decision support system for choosing cover crops in northern Italy.
Acknowledgments. Work carried out in the project SUCCO, cofunded by EAFRD with the Rural Development Program 2014-2020 of Regione Lombardia (Operation 16.1.01, EIP-AGRI Operational Groups).

Development of a decision support system for cover crop choice

by Luca Bechini | Federico Ardenti | Marta Colombo | Daniele Della Torre | Alfio Ferrara | Pietro Marino | Lorenza Michelon | Sergio Picascia | Silvia Salini | Matteo Sampietro | Vincenzo Tabaglio | Andrea Fiorini | Università degli Studi di Milano | Università Cattolica del Sacro Cuore | Università degli Studi di Milano | Condifesa Lombardia Nord-Est | Università degli Studi di Milano | Università degli Studi di Milano | Condifesa Lombardia Nord-Est | Università degli Studi di Milano | Università degli Studi di Milano | Università degli Studi di Milano | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore

Abstract ID: 91
Topic: Climate
Presenter Name: Luca Bechini
Contribution: Post

We are a living lab operating in Lombardia, northern Italy. To increase the accessibility to farmers and advisors of research results on cover crops, we are developing a decision support system (DSS) that, based on the description of farm situation (soil, climate, crop rotation, manure availability) will suggest the best cover crops, their suggested sowing date, their suggested termination date and method, together with their agro-ecological benefits. The DSS will be developed for the plain areas of Lombardia, but our methodology is interesting also for other applications. To define the rules of the DSS we integrate results from three sources. We obtain from published papers the agro-environmental effects of cover crops measured in field experiments in temperate climates. We collect in a unique database the single measurements from each paper, fully describing their context (soil, climate, rotation, management). We will standardize the results based on thermal time, to use them even if they were obtained in areas with different temperature than ours. At the moment the database contains 4907 records from 176 papers. We integrate these data with our own field experiments (2011-2024) on different soil types in northern Italy: on various species we measured cover crop aboveground biomass and N content, weed control, N_2O emissions, and mulch decomposition after termination. In 2023/2024 we carried out an experiment in potential and actual production conditions, comparing three sowing dates for four species. We use a mechanistic cropping system simulation model (CropSystVB) to compare scenarios of cover crop cultivation. The model was integrated with the capability to simulate crop emergence based on hydrothermal time (to consider soil water potential) and crop frost damage. Once calibrated with our experimental data, the model will be used to compare the effects of cover crops in different soil types, locations, sowing dates, nitrogen availability, residue management options, and termination dates. Finally, we are developing a Bayesian network (BN) to integrate the evidence from the three sources with the empirical knowledge of the operational group. A BN is a model representing a number of variables and their conditional probabilistic relationships. The categorical variables of our BN describe the farm context (soil, climate, cover crops, management) and their effects (e.g. weed control, leaching reduction). Once calibrated with all data available, the BN will be

used to predict the values of some variables (cover crops and their management: output of the DSS) after having fixed (inputs of the DSS) the levels of the variables describing the constraints (soil, climate) and the objectives (agro-ecological functions of cover crops). The BN is also a tool to compare scenarios, that is to describe the effects of various management options in different soil and climate conditions. The DSS will be implemented as a free web app, which will be usable since the first semester 2025. Acknowledgements. Work carried out in the project SUCCO, cofunded by EAFRD with the Rural Development Program 2014-2020 of Regione Lombardia (Operation 16.1.01, EIP-AGRI Operational Groups).

Development of Innovative Earth Observation Tools for Adaptative Management of Alpine grasslands

by Rodolfo Ceriani | Eugenio Carlon | Francesco Fava | Department of Environmental Science and Department of Environmental Science and Policy , Università degli Studi di Milano; Department of Agricultural and Environmental Sciences, Università degli Studi di Milano | Department of Environmental Science and Policy , Università degli Studi di Milano | Department of Environmental Science and Policy , Università degli Studi di Milano

Abstract ID: 101
Topic: Climate
Presenter Name: Rodolfo Ceriani
Contribution: Post

In the Italian Alps the last decades have seen a significant trend of abandonment and degradation of grazing mountain pastures and meadows, altering valuable ecosystem services, and compromising circularity of agricultural production at farm and regional level. This study, developed with UNIMONT (Bs, Italy) in the framework of the PNRR Agritech and CIRCAGRIC-GHG projects, aims at developing innovative digital agriculture tools and practices at multiple scales for adaptative management of grasslands, with the Val Camonica alpine valley (Italy) as a case-study and perspective living laboratory for improved territorial management of mountain regions. At landscape scale, available land-use and land cover (LULC) maps in the alpine region fail to capture the variability in pasture types and land-covers that reflect abandonment and transition of grasslands to forests, shrubland or degraded conditions. This strongly limits our capacity to monitor and understand grassland degradation processes and their impacts on ecosystem services (e.g., carbon stocking, water cycle regulation, etc.), thus our capacity to support informed decision-making on territorial planning. Therefore, a new LULC map (10m resolution) for the high Val Camonica region (715 km2) was created by applying machine learning classification on Sentinel-1 (radar) and Sentinel-2 (optical) satellite data, combined with a digital elevation model. Specifically, the thematic map includes 7 pastures typologies with different vegetation composition and productivity, reflecting transitions from more extensive to more intensive use of grasslands. For training and testing, a dataset of 700 photo-interpreted and field-checked ground truth points was used. Preliminary results show a classification accuracy of 82% for the pasture classes. The classification scheme is implemented in an open-source cloud computing environment and can be updated annually. Historical pastoral land-cover loss dynamics have also been evaluated using historical regional land-cover data (i.e., DUSAF 1999 and land-cover map 1980, Lombardy Region), showing a significant decrease in available grazing area and a general decline in pasture quality. At local scale, we aim at using satellite remote sensing to develop management systems providing timely information on pasture quality and nutritional value during the growing season, to inform adaptative grazing management and promote a more-efficient use of mid to high-elevation alpine pastures. Specifically, we will evaluate the potential of last-generation field (ASD Fieldspec4) and satellite (PRISMA, EnMAP, Sentinel 2) remote sensing data to monitor pasture biomass, nutritional status and

composition (i.e., green/non-green biomass, proteins, fibers, lignin content). Satellite hyperspectral sensors provide continuous spectral narrow-bands (about 10 nm) in the 400 - 2500 nm range, opening new opportunities for pasture characterization and mapping. Multiple field campaigns are planned during summer 2024 on mid-high elevation pastures in Val Camonica coupling hyperspectral reflectance measurements from field and satellite sensors, field agronomic data collection and lab analysis. Predictive models will be developed to (i) understand the potential of different satellite sensors and processing methodologies to provide reliable information on the seasonal dynamics of pasture quantity and quality, (ii) generate intra-seasonal maps that could facilitate decision-making on livestock grazing through the definition of adaptative management units.

Participatory land evaluation for improved agricultural decision making in protected areas: insights from the Northern Andean Bio-corridor, Ecuador

by Pietro De Marinis | Stefano Bocchi | Francesco Fava | Eugenio Carlon | Dipartimento di Scienze e Politiche Ambientali - UNIMI | Dipartimento di Scienze e Politiche Ambientali - UNIMI | Dipartimento di Scienze e Politiche Ambientali - UNIMI | Dipartimento di Scienze e Politiche Ambientali - UNIMI

Abstract ID: 103
Topic: Climate
Presenter Name: Pietro De Marinis
Contribution: Post

Agriculture plays a pivotal role Agroecology has been proposed as one of the main approaches able to understand complex agroecosystems, and to design adaptative management practices to support resilient and sustainable production. Participation is one of the agroecological principles. Increased social organization and greater participation in decision-making by food producers and consumers can positively contribute to decentralized governance and local adaptive management of agricultural and food systems. Here, our action-research focuses on a case study provided by the “BIAN” North Andean Bio-corridor project. The project is devised to create a bio-corridor connecting existing protected areas, and to enhance the resilience of local communities by promoting sustainable agricultural practices within the North Andean Bio-corridor, Ecuador. Our research adopts participatory evaluation and decision aiding methodologies, and couples them with an adapted FAO Land Evaluation methodology to produce a participatory land suitability map of three pilot zones and provide recommendations to adapt farming activities and practices to the BIAN’s conservation and regeneration goals. Available secondary information about land capability factors was collected and elaborated in GIS environment. Primary quantitative and qualitative descriptive data about the degree of limitation posed by the identified capability factors against a set of locally relevant land use types was collected in April 2024 through semi-structured interviews with relevant experts and participatory workshops. Simplified Pair Wise Ranking and Analytic Hierarchy Process (AHP) methodologies were used to trigger, collect and elaborate farmers’ and technicians’ opinions, during, one-day-workshops held in each of the three distinct pilot areas (1) El Carmelo(Carchi), Tabacundo(Imbabura), and Mariano Acosta(Pichincha); involving a total of 72 farmers and 28 local technicians. As preliminary results, the most relevant local land uses were identified, and a shared definition and hierarchization of land capability factors was produced. The participants were asked to identify the most relevant land uses that affect sustainability, positively or negatively, in the target territories. Partially different sets of crops and other land uses in the three pilot territories were identified, such as Peas or Broad Beans, Barley or Wheat, Greenhouses (Floriculture), Corn monoculture, Corn-Beans intercropping, Potatoes, Pastures and Livestock, Agroecological farms. The limiting land capability factors for each land use were ranked by the participants. AHP includes the computation of consistency

rations (CR) of preference matrixes to assess the reciprocal consistency of the preferences expressed. The data collected show acceptable ($CR<0.2$). Through this action-research, local technicians and communities are involved in the decision making process and trained on how to conduct participatory evaluations for landscape management initiatives. Simultaneously, important recommendations are defined collectively to cope with the needed changes in crops and cropping practices. According to the proposed methodology, the collected data will be analyzed and integrated with secondary data in geospatial environment (GIS, literature) to generate a land suitability map for the three pilot territories. Ultimately, this process will involve local technicians and farmers in jointly determining technical improvements to enhance agriculture's contribution to the conservation and regeneration goals of the BIAN.

On-farm and plot experimentations of climate-smart agricultural practices in Northern Italy

by Elisa Marraccini | Vittoria Giannini | Gabriela Alandia Robles | Giorgio Borreani | Gemini Delle Vedove | Francesco Ferrero | Donato Loddo | Cristina Marzachì | Carmelo Maucieri | Tanja Mimmo | Carlo Nicoletto | Silvia Panozzo | Alessandro Peressotti | Gabriele Rolando | Luigi Sartori | Enrico Sturaro | Ernesto Tabacco | Massimo Tagliavini | Eren Taskin | Gaetano Roberto Pesce | Maurizio Borin | University of Udine | DAFNAE, University of Padua | University of Udine | DISAFA, University of Turin | University of Udine | DISAFA, University of Turin | IPSP-CNR, Legnaro | IPSP-CNR, Turin | University of Padua | Free University of Bolzano-Bozen | DAFNAE, University of Padua | IPSP-CNR, Legnaro | University of Udine | DISAFA, University of Turin | DAFNAE, University of Padua | DAFNAE, University of Padua | DISAFA, University of Turin | Free University of Bolzano-Bozen | Free University of Bolzano-Bozen | DAFNAE, University of Padua | DAFNAE, University of Padua

Abstract ID: 107
Topic: Climate
Presenter Name: Elisa Marraccini
Contribution: Post

Digital technologies like precision farming, artificial intelligence or prediction systems are essential to increase the efficiency in the use of resources. This is of primary importance in Northern Italy where climate change and price surges are affecting the sustainability of cropping systems. In this context, the Task 4.2.1 of the Italian Agritech National Center set up a network of farms, both experimental and commercial, in order to test in real conditions innovative and climate-smart agricultural practices, with a living lab approach. Thanks to a partnership of five universities and research centres, it was possible to extend a wide network of both plot experiments (PEs) and on-farm experiments (OFEs) with the purpose of deepening knowledge on some targeted resources: water, carbon, energy and/or a combination of them in cropping systems of Piemonte, Trentino Alto-Adige, Veneto, Friuli Venezia Giulia regions. So far, 7 PEs in the university experimental farms and 20 OFEs in partner farms are ongoing, all for a minimum duration of 2 years. The main topics were related to water management (10) and carbon management (4), to the nexus carbon-water (8) and to the nexus carbon-energy (5). The PE and OFE experiments were covering a wide range of topics: from the effect of cover crops on soil fertility in different agro-ecosystems, such as vineyards and arable crops, to the reduction of carbon footprint through crop rotation in mixed dairy farms. In several PEs and OFEs innovative cultivars and crops were tested such as: i) quinoa as an alternative for soil undergoing salinization in the Adriatic coastal areas, ii) drought-tolerant maize hybrids as a response to increasing summer droughts in Northern Italy, iii) different mixes of cover crops to test their ability to provide different soil ecosystem services. The results of these PEs and OFEs will be shared in the network, both in dissemination actions and demonstration activities, to increase the capacity building of the different stakeholders involved in the living lab facilities.
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Underutilized crops: sustainability and modelling approach to assess their use as biofuel

by Claudio Russo | Valerio Cirillo | Nausicaa Pollaro | Fabio Terribile | Alessia Perego | Andrea Chiodini | Albino Maggio | Department of Agriculture, University of Naples Federico II | Department of Agriculture, University of Naples Federico II | Department of Agriculture, University of Naples Federico II | CRISP Research Center, University of Napoli Federico II | Department of Agricultural and Environmental Sciences, Università degli Studi di Milano | Eni S.p.A. Renewable, New Energies and Material Science Research Center (DE-R&D) | Department of Agriculture, University of Naples Federico II

Abstract ID: 126
Topic: Climate
Presenter Name: Claudio Russo
Contribution: Post

Biofuels represent a renewable source of energy, but their production has raised concerns regarding its possible impacts on food security. Indeed, the current biofuel production primarily relies on food crops and arable lands. To overcome this inconsistency, it has been proposed to cultivate second-generation biofuel crops on marginal lands, since this option could bring benefits in terms of food security and sustainability. To fully exploit this option, it will be critical to calibrate plant growth models to estimate the potential biofuel production on marginal land from second-generation feedstock, as well as to assess their sustainability gain compared to first-generation crops. We analyzed life cycle assessments (LCA) present in the scientific literature for the main first-generation crops (*Zea mays, Triticum aestivum, Glycine max, Helianthus annuus and Brassica napus*) and potential underutilized crops (*Camelina sativa, Brassica carinata, Carthamus tinctorius, Ricinus communis and Thlaspi arvense*) in order to assess the greenhouse gas emission (GHG) linked with their production processes. For the calibration of ARMOSA, a process-based model, we collected biometric and phenological parameters of the crop, weather data, and soil data. Where not available, weather and soil data were obtained using ERA-5 or LUCAS topsoil, respectively. From the analysis of LCA it was concluded that the average GHG of biofuel obtained from second-generations feedstock was 48% lower than first-generation crops. Moreover, on average, the GHG for biofuel from second-generation crops were below the threshold of the Renewable Energy Directive II (RED). More specifically, *Carthamus tinctorius* was the most sustainable crop (50% below the RED II threshold), followed by *Ricinus communis* (27% below), *Camelina sativa* and *Thlaspi arvensis* (both 7% below). Among the second-generation crops, only *Brassica carinata* showed higher emission with respect to the RED II threshold. The parameterization of *Ricinus communis* showed high Pearson correlation coefficient values between ARMOSA simulation and real measured for several phenological and biometric parameters (emergence date, r = 0.98; flowering date, r = 0.91; harvest date, r = 0.82; above ground biomass, r = 0.85; yield, r = 0.87). For *Carthamus tinctorius* it was possible to calibrate only the harvest (r = 0.76) and the (r = 0.85). Similarly, *Brassica carinata* was calibrated only on flowering date (r = 0.82), harvest date (r = 0.82) and yield (r = 0.81). Biofuels are not the silver bullet to solve the ongoing

global energy challenge but can contribute to reduce the environmental impact of fossil fuels. Marginal lands could become an essential element of a sustainable biofuels industry. However, reliable plant growth models that may help in performing cost-benefit analyses for biofuel production with second-generation feedstocks on marginal lands are critically necessary. This approach can support policy decisions for a rationale planning of land use worldwide by a sustainable and economical point of view. The next step will be to identify the characteristics of the marginal land to be used for biofuel production.

Rooftop Agrivoltaics: bio-agronomical response of Lactuca Sativa L.

by Giovanni Ventura | Giuseppe Marco Tina | Caterina Caruso | Laura Siracusa | Tonia Strano | Francesco Mugheddu | Antonio C. Barbera | Department of Agriculture, Food and Environment—Di3A, University of Catania | Department of Electrical electronic and computer engineering DIEEI, University of Catania, | DepartmentDepartment of Agriculture, Food and Environment—Di3A, University of Catania | Institute of Biomolecular chemistry ICB, CNR | Institute of Biomolecular chemistry ICB, CNR | Institute of Biomolecular chemistry ICB, CNR | Department of Agriculture, Food and Environment—Di3A, University of Catania

Abstract ID: 145
Topic: Climate
Presenter Name: Antonio C. Barbera
Contribution: Post

Agrivoltaics is the sharing of solar radiation between photovoltaics (PV) and sunlight-dependent agricultural activities, achieving sustainable goals from green energy production to reducing land consumption. In municipal areas, urban horticulture contributes significantly to the food and nutritional security of their inhabitants (Orsini et al., 2013), where rooftop agriculture (RA) is a building-based form of urban agriculture. The aim of this work is to evaluate the potential of urban rooftop horticulture agrivoltaics by lettuce agronomic and quality traits response. In a pilot-scale vertical double-sided mini-modules agrivoltaic system (AV) (oriented along the North-South direction), located on DIEEI building roof the bio-agronomical response of Lactuca sativa L. (var. longifolia) grown in pots receiving different Photosynthetic Photon Flux Density because of the pots relative position inside or outside the AV was studied. A randomized block experimental design with four replications was adopted. On each pot-plant system by weight difference, measurement of water loss, was carried out. At harvest time the lettuce aerial biomass dry weight, and the quantification of carotenoids (UHPLC coupled with a spectrophotometric detector) were determined. The data sets were analyzed by ANOVA. Daily meteorological data by the meteo station adjacent to the agrivoltaic plant, whereas the precipitation data were collected from SIAS, meteorological station (Catania, Italy) were collected. The cumulative water consumption over the entire lettuce crop cycle was significantly higher ($p=0.05$) by an average of 5.13%, in the External West (E.W.), Internal East (I.E.) and External East (E.E.) pots positions compared to both Full Sun (F.S) and Internal West (I.W.) place. Considering, the leaf dry weight the pots positions inside or adjacent to the AV showed a significantly higher values (14.8%) to full sun lettuce exposed with the highest relative value for I.E.. Because of the previous results, the lettuces water production efficiency, as a function of their position, appears to be significantly better by 14.1% for plants grown in positions inside the AV compared to those in Full Sun. Regarding the lettuces foliar carotenoid content, the Internal West position presented significantly higher values of 54.9% compared to all other positions, where the F.S. position presented the relative lowest contents. The results confirm the excellent potential of agrivoltaic systems in urban rooftop horticulture.

Specifically, lettuce plants grown under partial shading conditions determined by the PV modules exhibited a higher dry weight and carotenoid leaves content, according Ilić et al. 2019, than in full sun conditions. Although, the water consumption of plants grown inside AV, was on average, higher than in full sun, lettuces showed a higher Water Use Efficiency than in full sun conditions. Overall, this study’s findings highlight the potential for improving crop production in AV while calling for further research on specific agronomic studies for these peculiar agroecosistems ensuring effective long-term environmental sustainability. Acknowledgements. The present study was partially funded by GEOSTUDIO GROUP S.T.P. Srl

Effect of irrigation with different NaCl concentration on total biomass and inflorescences production of three chemotypes of Cannabis

by Ida Di Mola | Augusto Siciliano | Alfonso Gallo | Giuseppe Rofrano | Luigi Jacopo D'Auria | Eugenio Cozzolino | Lucia Ottaiano | Maria Eleonora Pelosi | Ferdinado Esposito | Nunzio Fiorentino | Mauro Mori | DIA, Università di Napoli Federico II | IZSM | IZMS | IZMS | IZMS | CREA, Research Center for Cereal and Industrial Crops | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II

Abstract ID: 156
Topic: Climate
Presenter Name: Ida Di Mola
Contribution: Post

The aim of the current research was to assess the effect of irrigation with water at different NaCl concentration on three chemotypes of Cannabis for inflorescences production. The chemotype I was the variety "Trainwreck" (Humboldt Seeds California), a dominant sativa plant (30% Indica 70% Sativa; THC 20%, CBD 0%); the chemotype II (THC 7%, CBD 7%) was a variety in registration phase by Istituto Zooprofilattico Sperimentale del Mezzogiorno (IZSM); the chemotype III (CBD 10%, THC 0.3%) was a phenotypic selection performed by IZSM of the dioic variety Eletta Campana. The test plant material came from the experimental cultivation of IZSM, authorized by the Ministry of Health (decree sp 81/22). One rooted cutting per each chemotype was transplanted on October 2, 2023 in 7 lt pots, located in a growth chamber under controlled conditions. The vegetative phase lasted 40 days during which the light/dark ratio was 18 and 6 hours and the mean temperature 24.5°; then, plants were subjected to a photoperiod of 12 h of dark and 12 of light and a 25.4° mean temperature to promote flower induction. The inflorescences were harvested, on mean, 6 times per each chemotype starting from December 4 and until the middle of January. Four salinity levels of irrigation water were compared: tap water, and water with NaCl adding in order to reach an electrical conductivity of 2.0, 4.0, and 6.0 dS m^{-1}, namely referred to EC0, EC2, EC4, and EC6, respectively. Each treatment was replicate 4 times. The saline water irrigation started on 13 October and finished on 5 January 2024, per a total of 15 waterings and caused an increase in EC soil that passed from 0.14 dS m^{-1}, at the beginning of the test, to 0.16, 1.27, 1.80, and 2.16 dS m^{-1}, at the end, for Eco, EC2, EC4, and EC6, respectively. At each harvest, the following measurements were made: total and stems fresh biomass, number of leaves, inflorescences, and ramifications and their weights. The increasing levels of salinity caused a decrease in all parameters with the lowest significant value in EC6: -64.6, 59.8, 41.8, 59.2, 56.4, 67.5, 47.0, 47.2%, for total and stem weight, and number and weight of leaves, inflorescences, ramifications, respectively, compared to EC0. Among the varieties, the chemotypes II showed the highest value of total biomass (154.8 g pt^{-1}) and stems (28.9 g pt^{-1}) weight, as well as of number and weight of leaves (72.4 n° pt^{-1}, and 31.7 g pt^{-1}) and inflorescence (46.7 n° pt^{-1} and 52.9 g pt^{-1}), while the lowest values were

recorded for the chemotype I. Finally, by preliminary data, increased levels of salinity of irrigation water seem to determine a decrease in cannabinoids content.

Livestock manure digestate treatments to reduce GHG and NH3 emissions and meet crop nutrients requirement

by Laura Zavattaro | Nunzio Fiorentino | Alessandra Apostolico | Elena Cervelli | Elio Dinuccio | Raffaele Grieco | Lucia Ottaiano | Ester Scotto di Perta | Anna Verde | Stefania Pindozzi | Department of Veterinary Sciences (DSV), University of Torino | Department of Agricultural Sciences, University of Napoli Federico II | Department of Agricultural Sciences, University of Napoli Federico II | Department of Agricultural Sciences, University of Napoli Federico II | Department of Agricultural, Forest and Food Sciences (DISAFA), University of Torino | Department of Agricultural and Food Sciences, University of Bologna | Department of Agricultural Sciences, University of Napoli Federico II | Department of Agricultural Sciences, University of Napoli Federico II | Department of Agricultural Sciences, University of Napoli Federico II | Department of Agricultural Sciences, University of Napoli Federico II

Abstract ID: 160
Topic: Climate
Presenter Name: Laura Zavattaro
Contribution: Post

Agriculture is responsible for 10.3% of the EU’s GHG emissions and about 94% of NH3 emissions, with N and P losses exceeding the European limit by a factor of 3.3 and 2.0, respectively, thus threatening terrestrial, aquatic, and atmospheric ecosystems. One cause is the suboptimal management of animal manure in livestock and crop production, which is a major source of pollution due to N, P and C losses. Anaerobic digestion is a consolidated process that can provide an effective support in livestock manure management, ensuring the production of biomethane and more stabilised effluents for agricultural use. Nevertheless, some constraints are still reported in the application of anaerobic digestion in livestock farming since it is a process that does not affect the total N and P content of fed animal manure. Given the importance of the implementation of such a process aimed at producing methane and organic fertilisers, further treatments are strategic to ensure the achievement of both mineral fertiliser and polluting gas (NH3, N2O, CH4, and CO2) reduction targets. Specifically, great attention has to be given to the valorisation of the utilisation of digestate in the field, while avoiding the release of gases in the atmosphere. The national-funded PRIN project LiMIT DGGAS (2023-2025) aims at testing two promising treatment strategies based on the recovery of nutrients in digestate, in two contrasting environments, Torino (TO) in NW Italy and Napoli (NA) in S Italy. Treatment strategies include a separation, NH3 stripping of the liquid phase and vermicomposting of the solid phase, at NA site; and a cascade separation followed by ultrafiltration at TO site. These digestate treatments produce various matrices that can be used as fertilisers: liquid fraction, solid fraction and solid fraction after vermicomposting at NA; and liquid fraction, ultra-filtered liquid fraction for fertigation, and solid fraction at TO. These amendments/fertilisers will be tested in controlled conditions to assess their fertilisation efficiency, nutrient release dynamics and gaseous emissions. Italian ryegrass will be used as a test plant in the two environments, on the same two soils in each environment, using improved fractions produced locally. Mineral fertilised and unfertilised controls will allow

the comparison of the agronomic performance of improved digestate- derived amendments/fertilisers with standards. Ammonia emissions after distribution will be collected according to protocols provided by ALFAM2 model, to improve the dataset for digestate use in Mediterranean climate. Expected results of the projects are: 1) Reducing constraints of treatment strategies for valorizing nutrients from digestate; 2) Evaluating fertilisation efficiency of treated digestate; 3) Estimating NH_3 e GHGs emissions from relevant phases of the livestock manure digestate chain; 4) Providing dataset for ALFAM2 model; 5) Conducting a techno-economic analysis and territorial assessment of treatment strategies adopted. Accordingly, the project will trace the road for i) a control on by-products quality, ii) valorisation of agronomic utilisation of digestate, and iii) reduction of environmental effects due to the release of pollutant gases, as required by policy-makers and stakeholders.

Foliar fertilizer on reducing nitrate leaching and nitrous oxide emissions in potato field

by Jingru Yin | Aarhus University

Abstract ID: 164
Topic: Climate
Presenter Name: Jingru Yin
Contribution: Post

Nitrogen (N) fertilizer has long been used in agriculture to improve crop yields but the surpluses in consequence cause environmental problems, for example nitrate leaching is a main cause of the water pollution and nitrous oxide (N_2O) emission is responsible for climate change and ozone depleting. Therefore, optimal management of N in agriculture is crucial for both sustaining crop production and safeguarding environmental sustainability. As a target-oriented strategy, foliar fertilizer which applies nutrient liquid directly to leaves was reported to have positive effects on soil ecosystem (Kannan, 2010; Niu et al., 2021), but the study on mitigating N losses in crop field remains deficient. Therefore, foliar fertilizer was applied in this study. Its effects on N_2O emission and nitrate leaching were analyzed. The experiment was conducted in a 5-ha potato filed located in Foulum (56°29 N, 9°34E), central Jutland of Denmark, in which nitrate concentration was measured from suction cups and N_2O was collected through manual chambers periodically during the growing season from May to late August 2023. The field was divided into 4 strips, each strip has both foliar and business-as-usual (BAU) fertilizer applications. N_2O flux was calculated by HMR package in RStudio (R Core Team 2023). Cumulative N_2O flux (g/ha) were calculated by linear interpolation between daily fluxes. Drainage was simulated from EVACROP (Olesen and Heidmann, 1990). Nitrate leaching was then calculated from model-calculated drainage and nitrate concentrations, which were estimated by using a drainage-weighted interpolation between the sampling dates (Vogeler et al., 2020). Analysis of variance (ANOVA) was processed in MATLAB (The MathWorks, Inc.). Compared with BAU application, the reduction on nitrate leaching and N_2O emission were seen in foliar fertilization practice which is significant ($p < 0.05$) especially after rainfall. The plant absorption mechanism of foliar fertilizer provides a foundation for further understanding. Soil properties and field topography were utilized for underlying explanation on a few unexpected data points. Same study on other crops is expected to be conducted in this field for the coming years. Overall, foliar fertilizer shows great potential for reducing N loss which is promising as a standard practice in modern agricultural fields.

Simulating the impact of climate change scenarios on phenology and crop water requirements: a case study on olive tree in Apulia region

by Anna Maria Stellacci | Francesco Gentile | Maria Vincenza Chiriacò | Sergio Noce | Gabriele Pizzileo | Giovanni Russo | Francesco Fabiano Montesano | Salvatore Camposeo | Giuseppe Lopriore | Ignazio Samarelli | Pasquale Losciale | Giovanni Francesco Ricci | Annunziata Fiore | Martina Di Venosa | Leonardo Costanza | Matteo Stelluti | Giovanni Lacolla | Mario Alberto Mastro | Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari | Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari | CMCC Foundation - Euro-Mediterranean Center on Climate Change | CMCC Foundation - Euro-Mediterranean Center on Climate Change | CMCC Foundation - Euro-Mediterranean Center on Climate Change | Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari | Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari | Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari | Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari | Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari | Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari | Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari | Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari | Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari | Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari | Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari | Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari | Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari

Abstract ID: 168
Topic: Climate
Presenter Name: Anna Maria Stellacci
Contribution: Post

Assessing the potential impact of climate change on the duration of phenological stages and cropping cycle is fundamental to estimate crop water requirements and optimize the allocation of limited water resources and land among different crops in Mediterranean regions. An approach based on thermal requirements was used to simulate the variation of the onset and duration of the phenological stages and the crop water requirements of olive tree under future climate change scenarios. The study was carried out in Apulia region on five locations selected within different homogeneous climatic zones delineated within ACLA 2 project. Climate model simulations were derived from the EURO-CORDEX bias-adjusted database for each of the five locations selected. The Representative Concentration Pathway (RCP) 4.5 was considered. The database consisted of simulated bias-adjusted daily weather data for the time interval 01.01.1971-29.11.2100 of mean surface temperature, maximum surface temperature, minimum surface temperature and precipitation flux and data were obtained averaging an ensemble of 23 model members. Four time series were considered: the current period, considering the thirty-year time series 1991-2020, and three future scenarios considering the time intervals 2021-2050, 2051-2080, 2081-2100; pluriannual

mean data were computed for each time interval. In each area, the reference starting dates for each phenological stage (budbreak, inflorescence emergence, flowering, pit hardening, veraison) and location were defined according to phenological observations repeated over years. With the current climatic conditions, the thermal requirements (expressed as growing degree days-GDD) to complete each phenological stage were computed (Rubino et al., 2012). This information was then used under future climate scenarios to assess the starting date of the stages from inflorescence emergence to veraison, whereas the date of budbreak was kept constant for each site. After defining crop cycle parameters for each climatic condition and site, daily reference evapotranspiration (ETo) was computed using Hargreaves equation and daily maximum crop evapotranspiration (ETc) was quantified. Crop cycle length from budbreak to veraison varied within selected climatic zones and specifically from 178 days, for the site of Grottaglie, to 218 days, for the site of Nardò. A progressive reduction of the duration of the budbreak to veraison period was observed in future simulated scenarios. Greater differences were observed in the interval between budbreak and inflorescence emergence and between pit hardening and veraison; a less intense variation was instead recorded in the central part of the crop cycle. A progressive reduction of total crop water requirements was observed in the future simulated scenarios due to the reduced duration of the budbreak to veraison period for all the investigated sites. At the same time, a progressive decrease of rainfall water availability was recorded passing from the actual conditions to the 2021-2050, the 2051-2080, the 2081-2100 climate scenarios particularly in the initial (budbreak to inflorescence emergence) and final part of the crop cycle (pit hardening to veraison).

Insights Into Grapevine Growth Monitoring Using Synthetic Aperture Radar (SAR) Imagery

by Riccardo Rossi | Martina Mori | Luca De Guttry | Gloria Padovan | Anna Rita Balingit | Nicolina Staglianò | Marco Bindi | Camilla Dibari | Marco Moriondo | Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence | Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence | Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence | Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence | Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence | Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence | Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence | Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence | Institute of BioEconomy of the National Research Council (CNR-IBE)

Abstract ID: 176
Topic: Climate
Presenter Name: Riccardo Rossi
Contribution: Post

Monitoring of grapevine plants is crucial for farmers, especially in Mediterranean regions where climate change demands timely responses throughout the season to mitigate potential impacts on both the quantity and quality of final yields. Variations in canopy architecture are key indicators of vineyard health status, aiding in detecting nutritional deficiencies and guiding the adoption of best management practices for achieving optimal growth-yield balance. In this regard, the all-weather and day-and-night capabilities of Synthetic Aperture Radar (SAR) satellites make this tools particularly valuable for assessing crop growth dynamics, surpassing several limitations inherent to optical sensors. While recent SAR technology has proven effective in monitoring pastures (Wang et al., 2019) and open-field crops (Kobayashi and Ide, 2022; Bhogapurapu et al., 2021), its application in viticulture has been somewhat constrained primarily to tasks such as land-cover classification and soil moisture assessment (Bakon et al., 2024). This limitation arises from the vineyard's complex multi-layered structure and canopy spatial arrangement, compounded by the resolution of satellite images. To enable accurate monitoring of architectural evolution, it is thus crucial to develop innovative approaches to disentangle the vines' SAR-sensed signal from the inter-row spontaneous grass vegetation. Accordingly, this study aimed to develop a methodology to isolate grapevine-specific information from Sentinel-1A (S-1A) SAR backscatter measurements (i.e., VH and VV polarizations), enabling a continuous and accurate assessment of grapevine growth and canopy development. For this purpose, 15 SAR images were collected from April to September 2023 over ten 10m x 10m squares, each enclosed on S-1A pixels within a 4-hectare *Sangiovese* vineyard (Siena, Tuscany, Italy). For each date, the σ0VH, σ0VV, σ0VH(dB), σ0VV(dB), ScaledVH, ScaledVH-VV, ScaledVH+VV and Sentinel Normalized Index (SNI) parameters related to each sampling plot were then calculated as the average of 9-pixel neighborhood values, accounting for the geometric distortion between images. At 128, 192 and 250 days of the

year (DOY), the volume of all the vines (VolV) and spontaneous vegetation in the inter-row (VolS) were obtained and summed (VolTOT) for each plot, by manually measuring the canopies dimensions and grass height. The results highlighted that the ScaledVH-VV index is the most responsive in capturing the evolution of both VolV and VolTOT ($r = 0.74^{***}$ and 0.72^{***}, respectively), with negligible interference from the inter-row grass signal. Consequently, SAR imagery may be considered as a promising source for monitoring the growth evolution of the vine canopies throughout the season, being minimally affected by the herbaceous layer. After validation, the proposed approach will provide valuable continuous insights into grape growth and development, offering easily accessible inputs for crop models for an optimized vineyard management.

Session: CROP

Apulia Regenerative Cotton in Agroforestry System: first results and prospective

by Pasquale Campi | Gabriele de Carolis | Smone Pietro Garofalo | Giuseppe Scarascia-Mugnozza | Mesele Negash Tesemma | Anna Francesca Modugno | CREA - Research Centre for Agriculture and Environment | CREA - Research Centre for Agriculture and Environment | CREA - Research Centre for Agriculture and Environment | European Forest Institute-Biocities Facility, Rome | European Forest Institute-Biocities Facility, Rome | CREA - Research Centre for Agriculture and Environment

Abstract ID: 14
Topic: Crop
Presenter Name: Pasquale Campi
Contribution: Oral

Cotton cultivation has had a long tradition in southern Italy until the last century. Nowadays, reintroducing a crop that has been present in Apulia since the XII century may represent an important opportunity. This research aimed to restore and scientifically assess the regenerative agroforestry-based cotton production systems in Italy. The experimental activities were carried out during the 2023 season at the experimental farm of CREA, located in Rutigliano, southern Italy (40° 59' 32'' N; 17° 02' 02'' E; 147 asl). Following the principles of regenerative agriculture, cotton has been cultivated under two different systems: monocropping cotton (MC), on an area of 0.7 ha, and agroforestry-based cotton (CAF), on an experimental plot of 0.3 ha. CAF system involved intercropping cotton with a 7-year-old peach orchard of late ripening, spaced at 5 m × 5 m. Irrigation volume was scheduled to restore 100% of the crop evapotranspiration with a drip irrigation system. The irrigation volume applied was 3604 m^3 ha^{-1} for MC and 1662 m^3 ha^{-1} for CAF. Preliminary results show that the stem water potential (Ψs) in CAF was significantly lower (and therefore the plants were more stressed) than in MC treatment (- 2.9 ± 0.94 Bar and - 2.27 ± 0.56 Bar, respectively). From the end of July, at the stage of full vegetative growth of the crop, until the end of August, no statistically significant differences in the Ψs of either thesis were identified. The LAI of cotton grown in the CAF showed significantly lower values. This is mainly due to the lower density of plants due to the presence of the peach orchard. At peak plant development, cotton had LAI of 4.41 and 2.38 for MC and CAF respectively. Fresh and dry AGB follows the same pattern as LAI. The yield was 3.58 (± 0.34) and 1.72 (± 0.30) t ha^{-1} respectively for MC and CAF treatments. At harvesting time, the moisture content of seeded cotton fiber averaged 12%. The incidence of seeds was about 55%. There was no difference in water productivity (WPi) in the two treatments ($p > 0.05$). The WPi was 0.96 and 1.03 kg m^{-3} respectively for MC and CAF. It should be noted that the lower production of cotton in CAF treatment is due to the presence of the peach orchard planted at a very dense sixth to adapt it to an agroforestry system for cotton. Future perspectives for the following years include the validation of the regenerative agroforestry-based cotton growing with plants arranged in wider rows for (1) testing alternative agroforestry and regenerative farming practices to produce sustainable cotton; (2) applying precision agricultural techniques to match irrigation and soil fertility in cotton crop management.

Impact of Using Different Remotely Sensed Variables on Wheat Grain Yield and Nitrogen estimation with the DSSAT-CERES-Wheat Model in a data assimilation scenario

by Riccardo Fazioli | Federica Carucci | Luca Marrone | Davide Tahani | Raffaele Casa | University of Tuscia | University of Tuscia | University of Tuscia | University of Tuscia | University of Tuscia

Abstract ID: 45
Topic: Crop
Presenter Name: Riccardo Fazioli
Contribution: Oral

The integration of biophysical variables observations estimated from remote sensing into crop simulation models, within a data assimilation framework, has a huge potential for providing spatially and temporally consistent yield and quality maps at the field scale. This information is particularly valuable for a range of applications, both for precision agronomic management and for market and crop insurance contexts. The present study evaluates whether the assimilation of seasonal observations of Leaf Area Index (LAI), alone or combined other variables such crop aboveground biomass (CWAD) and crop N content (CNAD), obtainable from hyperspectral remote sensing, could improve the estimation of wheat grain yield and nitrogen content with the DSSAT crop model. This work was carried out in the context of the PRIS4VEG Italian Space Agency (ASI) project, to explore potential applications of hyperspectral satellites such as PRISMA launched by ASI. Model initial conditions and parameters were established using management, soil and weather data collected from different surveys carried out in the Rieti Plain (Central Italy) during the 2022-2023 and 2023-2024 wheat growth seasons. Different simulation treatments were set up, varying N fertilisation rates from 0 to 300 kg ha^{-1} with a 30 kg step, under contrasting weather and soil conditions. A wet (2011-2012), mean (2014-2015) and dry (2022-2023) seasons were chosen from Rieti rainfall records. Three contrasting soil profiles, respectively clay, loam and sandy texture were also used. DSSAT simulations for these scenarios were used to generate synthetic observations of LAD, CWAD and CNAD by sampling the variables at 15 days intervals along the season (assumed as likely frequency of satellite data) and adding a random error. Data assimilation, using a calibration approach, was then tested employing a fixed parametrization of DSSAT for the case of a N fertilization of 150 kg ha^{-1}, for the calibration of all the simulated scenarios, using synthetic observations. The CroptimizR 0.5.1 R package, was used for model calibration, using the Nelder-Mead simplex algorithm, to calibrate the DSSAT model. After the model calibration was performed, using the different sets of synthetic observed dynamic variables (only LAID, only CWAD, and LAID + CWAD), the goodness of fit between simulated and observed grain yield and N values was determined by computing the root mean square error (RMSE). These tests revealed that the calibration of the DSSAT model using seasonal observations of crop biophysical variables, which can be retrieved from remote sensing in a data assimilation scenario, does indeed improve the estimation of wheat grain yield and N content as compared to the baseline

open-loop DSSAT simulation. Moreover, it showed that, in most cases, the use of biomass and canopy N content observations, which are variables typically retrieved from hyperspectral sensors such as PRISMA, improve the estimation accuracy, in addition to the use of only LAI observations, which are typically available from multispectral sensors such as Sentinel-2. The validation of these results with ground observations was carried out using data from field campaigns in Rieti in 2024 and Sentinel-2 derived biophysical variables whenever PRISMA data were not available.

Developing operational procedures for site-specific weed management in maize: preliminary results from the Lombardy OG project PRECISION WEED

by Paola Pasta | Marco Rimoldi | Hicham Iderrami | Marco Davide Michel Torrente | Daniele Manenti | Aldo Calcante | Roberto Oberti | Pietro Marino Gallina | Giorgio Ragaglini | Department of Agricultural and Environmental Sciences Università degli Studi di Milano | Department of Agricultural and Environmental Sciences Università degli Studi di Milano | Department of Agricultural and Environmental Sciences Università degli Studi di Milano | Department of Agricultural and Environmental Sciences Università degli Studi di Milano | Condifesa Lombardia Nord Est | Department of Agricultural and Environmental Sciences Università degli Studi di Milano | Department of Agricultural and Environmental Sciences Università degli Studi di Milano | Department of Agricultural and Environmental Sciences Università degli Studi di Milano | Department of Agricultural and Environmental Sciences Università degli Studi di Milano

Abstract ID: 143
Topic: Crop
Presenter Name: Paola Pasta
Contribution: Oral

Weeds are the main biotic factor in reducing crop yields on a global scale, and herbicides are the main mean for their management, helping to improve crop yield. Currently, chemical weed control is the most adopted solution by farmers, but the need of reducing the use of synthetic molecules and the risk of increasing resistance by weed species, combined with recent European policies on environmental sustainability, have led to the introduction of new technologies. Precision agriculture and data analysis are promising fields of development to ensure a faster transition for low chemical herbicide systems. The application of site-specific weed control can reduce the amount of applied agrochemicals, but its adoption by farmers is still rather low due to the lack of methodologies and knowledge. The objective of the experimentation conducted was to assess the degree of infestation at field level and subsequently, through the analysis of the NIR-RED vegetation index, prescription map for site-specific post-emergence weed control of maize was elaborated. In addition, both the use of other vegetation indices for the identification of infestation and the effect on the final maize yield were evaluated. The study was conducted on a maize field at "Angelo Menozzi" experimental farm (Landriano, PV). Forty-two plots were intentionally left untreated in the pre-emergence phase to achieve a suitable level of weed infestation for the experiment. The prescription map was elaborated based on images acquired by a drone (UAV) during the V3-V4 phenological stage of corn. A quadcopter (DJI Mavic 3) equipped with cameras for agricultural applications, conducted aerial surveys at 40 meters of altitude on 11, 17 and 26 of May, collecting images of the field in RGB channels and in four spectral bands (560 nm, 650 nm, 730 nm, and 860 nm). Upon processing, various vegetation indices (VI), NIR-RED, EXG, EXGR, NDVI, TSAVI and PVI were calculated. In the plots different treatments (uniform vs site-specific) and application thresholds were established based on detected weed pressure (low, medium, and high) and

according with a split-plot design. NIR-RED was used to derive a weed infestation map and successively the prescription map for herbicide distribution. Precision application was operated with a boom-sprayer (iXter B16biXtra, Kverneland) equipped with RTK-GPS and individually controlled nozzles. At harvesting, yield sampling was performed by collecting maize ears and weeds within a defined area. Statistical analysis involved the comparison of VI and grain yield using regression analysis to assess the predictability of infestation status of VI respect with ground truths and ANOVA to assess the effect of treatment and application thresholds on yield and infestation level. The results of this study indicate that the implementation of the prescription map in the site-specific management plots resulted in a significant 70% reduction in herbicide use compared to the uniformly managed plots. Statistical analysis using ANOVA tests showed statistically significant differences between treatments and application thresholds for both vegetation indices and yield. Further experiments on maize, winter wheat and soybean will concern the optimization of developed procedures in comparison with proximal-sensing based ones.

An overview of soybean-based cropping systems in North-Eastern Italy

by Alessandra Virili | Wendy Vernaza Cartagena | Mauizio Borin | Carmelo Maucieri | Vittoria Giannini | Elisa Marraccini | University of Udine | University of Padua | University of Padua | University of Padua | University of Padua | University of Padua | University of Udine

Abstract ID: 19
Topic: Crop
Presenter Name: Alessandra Virili
Contribution: Pitch

In Italy almost 2/3 of the total soybean surface is located in Veneto and Friuli-Venezia Giulia. Despite the relevance of soybean in cropping systems of North-Eastern Italy, scarce information is available on soybean-based cropping systems (SB-CS), including the main issues and the innovations adopted by farmers. Therefore, in the frame of the project PRIN PNRR ECO_DRESS, an online survey was carried out to obtain insights on SB-CS following the tracking method of on-farm innovations. The survey was composed of four sections: 1) main characteristics of the farm (location, surface, farming system); 2) soybean and SB-CS; 3) main issues related to soybean; 4) adopted innovations. The survey was sent to individual farmers collaborating with the universities involved in the project and to several farmers' associations. After one month we collected 22 answered surveys. Conventional farms made up 55% of the sample with an average arable crop surface of 103 ha (min 3.5 ha, max 250 ha), showing a high structural diversity of the participating farms. Of those farms, 86% were equipped of irrigation, soybean was cropped as main crop exclusively in 30% of farms, while in 70% of the farms both as main and second crop. On average, soybean yield as main crop was 3.7 Mg/ha, while as second crop 2.9 Mg/ha. Farmers' answers revealed that 72% of the farmers preferred soybean as main crop for its high yield and better insertion in the crop rotation, whereas 28% of the farmers preferred soybean as second crop for organizational reasons. The most frequent preceding crops were maize and sunflower when soybean was the main crop, while winter cereals or rapeseed when soybean was as second crop. The crop rotations were generally short, with a return of soybean every 2-3 years in half of the farms. Weeds represented the main biotic issue, followed by green stem syndrome, brown marmorated/green stink bug and red spider mite. The main abiotic issues were drought and heat waves for soybean as main crop, hail for soybean as second crop. When asked which innovations were implemented in SB-CS, most of the farmers focused on weed management. Cover crops were used by 59% of the farmers, mainly crucifers or cereal-legume mixtures. Intercropping was implemented only by 4 farmers of the sample mainly with a winter cereal or with buckwheat. This survey highlighted several points related to SB-CS: the increasing importance of soybean as second crop despite its lower yield, the short return period of soybean (2-3 years), the impact of climate change on sowing dates and grain quality, the emerging issues related to pest management and finally sporadic use of cover crops or intercropping as strategies for weed and pest management. Acknowledgements. This research was funded by PRIN 2022 PNRR "ECOsystem services enhancement in

DiveRsifiEd Soybean-based Systems" (P2022WY7NH), which received funding from the European Union Next-Generation EU -component M4C2, investment 1.1. This manuscript reflects only the authors' views and opinions, neither the European Union nor the European Commission can be considered responsible for them.

Chickpea and common wheat intercropping for supporting agroecological weed control

by Gabriele Nerucci | Federico Leoni | Alessandra Virili | Daniel Marusig | Gemini delle Vedove | Stefano Carlesi | Elisa Marraccini | Anna Camilla Moonen | Scuola Superiore Sant\\\'Anna | Scuola Superiore Sant\\\'Anna | Università degli studi di Udine | Università degli studi di Udine | Università degli studi di Udine | Scuola Superiore Sant\\\'Anna | Università degli studi di Udine | Scuola Superiore Sant\\\'Anna

Abstract ID: 99
Topic: Crop
Presenter Name: Gabriele Nerucci
Contribution: Pitch

The intercropping of grain legumes with cereals, such as chickpea (*Cicer arietinum* L.) and wheat (*Triticum aestivum* L.), can be a valuable agroecological practice to support nutrient availability and non-chemical weed control in low-input systems without negative impacts on crop productivity. Optimizing weed suppression without negative effects on crop yield can be achieved by carefully choosing appropriate cultivars tailored to intercropping and to specific environmental conditions. This approach requires the selection of species and cultivars able to share their unique traits in a complementary manner. The efficacy of chickpea-wheat intercropping for weed control has been proven in several studies. However, very little is known about how intercropping drives the weed community and how it affects the weed community diversity. For example, a neutral effect of the intercropping treatment on pooled weed data could fail to identify the differential response of individual species in the weed community and the consequences this may have for the competitive capacity of weed community or for its diversity. Moreover, it has been suggested that diverse weed communities are less competitive and can simultaneously promote other ecosystem services. This study assessed the effects of chickpea-wheat intercropping on the weed control efficiency and community composition during the growing cycle. We hypothesized that intercropping would foster a more diversified and less competitive weed community than the sole crop. The experiment was repeated in two locations: Pisa, central Italy and Udine, northern Italy. Five chickpea cultivars were compared: three Kabuli types (*Sultano*, *Lambada* and *Castellano*) and two Desi types (*Nero della Murgia* and *Castor*). They are all commercial cultivars from Italy, France and Spain. Only one wheat cultivar, *Bolero*, was used. Each chickpea cultivar was grown either alone or intercropped with wheat. The results of this study demonstrate that intercropping can improve weed control compared to chickpeas as a sole crop mechanically weeded, in both sites (ANOVA, $p = 0.0042$). The effect was more evident in the Pisa area ($p = 0.0017$), where intercropping reduced weed biomass by more than 50%, compared to sole chickpea. Weed diversity (Shannon Index) was higher in intercropping systems than in sole crops in Pisa whereas no differences were observed in Udine. This was due to the higher infestation of *Chenopodium album* in chickpeas as sole crop in Pisa, that negatively affected weed community diversity. This result was further confirmed by the analysis of weed community composition (NMDS analysis followed by PERMANOVA) in Pisa, which indicated a significantly different weed community

composition in chickpeas as a sole crop compared to intercropping ($p = 0.002$). Surprisingly, the weed community composition in intercropping was not significantly different compared to wheat as a sole crop ($p = 0.011$), highlighting that intercropping between cereals and legumes drives the weed community composition towards typical weeds of sole cereals.

Phytopastoral characterization and productivity of natural pastures within the territory of the Madonie Park (Sicily)

by Nicoletta Lala | Giuseppe Di Miceli | Gianniantonio Domina | Mario Licata | Simona Prestigiacomo | Lucia Dinolfo | Dep. of Agricultural, Food and Forest Sciences, University of Palermo | Dep. of Agricultural, Food and Forest Sciences, University of Palermo | Dep. of Agricultural, Food and Forest Sciences, University of Palermo | Dep. of Agricultural, Food and Forest Sciences, University of Palermo | Dep. of Agricultural, Food and Forest Sciences, University of Palermo | Dep. of Agricultural, Food and Forest Sciences, University of Palermo

Abstract ID: 173
Topic: Crop
Presenter Name: Simona Prestigiacomo
Contribution: Pitch

Grasslands are a significant component of Europe's land use, covering over one-third of the continent's agricultural area. They play a crucial role in providing food for herbivores and ruminants and offer essential ecosystem services, including erosion control, water regulation, water purification, carbon storage, biodiversity enhancement, and wildfire prevention. Grasslands also support efficient nutrient cycling and provide cultural services. Despite their importance, permanent grasslands in Europe have been declining for over 50 years, with the extent varying regionally. Data on grassland distribution and productivity across Europe are fragmentary and incomplete. Over the past decade, the mountainous area of the Madonie, in northern Sicily, has been subjected to a gradual decline in economic activities, including hospitality and agriculture, largely due to climate change. Concurrently, an increase in wild ungulates as wild boars and deer has placed substantial pressure on grazing resources, resulting in a significant issue for small and medium-sized livestock farms in the area. Agroforestry, an integrated approach, between trees, crops, and livestock holds promise for sustainable food production and natural resource conservation. In light of these issues, a study was initiated at Madonie Park to better understand the impact of uncontrolled intensive grazing by wild animals on the environment, agricultural activities, and ecosystem services. This study is focused on floristic, vegetation, phytopastoral, and productive characterization in order to deepen knowledge, to update and to have a precise overview of mountain pastures. This will enable subsequent analysis and potentially propose sustainable alternatives within the context of agroforestry. Research activities started in October 2023 in an area within the Madonie Park, ranging from 900 to 1635 meters above sea level. Therefore, seven significant sites were identified that represent the physical and vegetational variability of the study area, and exclusion cages of 3×5 meters were installed in each of them. These areas were compared with adjacent areas subjected to direct use by wild animals. Various surveys were conducted to comprehensively analyze vegetation and pastures. Vegetation was analyzed using the Braun-Blanquet method, vegetation structure and density were examined using the linear analysis method developed by Daget and Poissonet, and pastoral value was calculated using specific indices. Additionally, potential load on pastures was assessed by introducing fragility coefficients, which indicate pasture

sensitivity to environmental pressures. Preliminary results from the study have shown significant differences in floristic composition between grazed and ungrazed areas. Areas not grazed by ungulates showed a greater diversity of herbaceous species, with plant formation characterized by the presence of 4 - 5 dominant and indicative species. The previous different pastoral use has led to the creation of various units of vegetation. The findings suggest that more careful and deliberate grazing management can promote biodiversity recovery and restore the original structure of pastures. This has important implications for the conservation management of Madonie Park, suggesting the need to implement an approach aimed at creating synergistic interactions between agriculture, forestry, and grazing. Acknowledgements. NODES project financed by MUR-M4C2 1.5 of PNRR, EU - NextGenerationEU*(Grant agreement no. ECS00000036).*

Evaluation of innovative cropping system in marginal hill area in north italy

by Alexandro Ferreira | University of Bologna

Abstract ID: 15
Topic: Crop
Presenter Name: Alexandro Ferreira
Contribution: Post

In recent years, the concept of marginal lands has gained significant scientific and policy interest, particularly due to the increasing demand for biomass for non-food purposes. In Europe, a considerable portion of land is already classified as marginal, and this is likely to expand due to climate change. The HE-MIDAS project aims to evaluate the suitability of a number of resilient industrial crops on marginal land. Among these, safflower, hemp, crambe and miscanthus have been evaluated in North Italy at the experimental farm of the University of Bologna (Ozzano dell'Emilia). The site is characterized by poor chemical composition (sand >65%), and a medium slope (10-15% varying across the site). In order to achieve a differentiate feedstock production and to promote biodiversity, a strip intercropping system had been set up, including alternate wide strips (4-12 m) alternating annual and perennial crops. The project is currently in its second year of trial. In the first growing season (2023), the three annual crops achieved satisfactory production levels, reporting for safflower and crambe a seed yield of 1.7 and 2 Mg DM/ha, respectively, while for industrial hemp the total harvested biomass was 12 Mg DM/ha. To sum up, the production levels of individual annual crops were on average with previous results under non-limiting conditions. The perennial grass, miscanthus, has not been harvested yet, since it is still at the establishment phase, which a problematic part of its management and the past year precipitation occurred in May had a negative effect on its vigor. In this growing season (2024), all annual crops were sown between late January and late March. The density (plants m^{-2}) achieved by the crops is comparable to the density levels achieved under non-marginal conditions. Specifically, hemp density is 120 plants m^{-2}, crambe density is 120 plants m^{-2}, and safflower density is 30 plants m^{-2}.

Regarding miscanthus, a second rhizome transplant was performed in April to address failures from the previous year. The establishment was not optimal due to a concentration of rainfall towards only the end of the month. However, the late-month rains are expected to have helped. Activities are ongoing, and the next productive results will be available at the end of the cultivation cycle. In conclusion, the HE-MIDAS project represents a significant effort to assess the potential of resilient industrial crops on marginal lands, offering promising prospects for soil restoration, biodiversity enhancement and addressing challenges related to climate change, while creating new economic opportunities for farmers.

Assessment of Yield and Quality of Processing Tomato (Solanum lycopersicum L.) Fruits Improved by Biodegradable Mulching Films in Hot Arid Environment

by Iacuzzi Nicolò | Tortotici Noemi | Alaimo Federica | Farruggia Davide | Mori Mauro | Tuttolomondo Teresa | Department of Agricultural, Food and Forest Sciences, University of Palermo | Department of Agricultural, Food and Forest Sciences, University of Palermo | Department of Agricultural, Food and Forest Sciences, University of Palermo | Department of Agricultural, Food and Forest Sciences, University of Palermo | Department of Agricultural Sciences, University of Naples Federico II | Department of Agricultural, Food and Forest Sciences, University of Palermo

Abstract ID: 16
Topic: Crop
Presenter Name: Iacuzzi Nicolò
Contribution: Post

Mulching is a common practice used in agriculture to provide numerous benefits such as preserve soil moisture, regulate soil temperature, weeds control, protect crops from pests, and reduce the use of pesticides and herbicides. Depending on their colour (black, light, white or green), the mulching films absorb and/or reflect solar radiation. These effects can influence soil temperature and, consequently, growth and productivity of crops. Although polyethylene is perfectly recyclable, it is not always possible to collect, process and regenerate it. Polyethylene can fragment and plastic particles can reach different habitats, causing damage to ecosystems. In recent years, research has focused on the use of biodegradable mulches obtained from vegetables, which do not contain toxic substances. Mater-Bi® is a polymer obtained from starch complexed with polyesters, certified biodegradable and compostable. This polymer is used to obtain various biodegradable products, including mulching films with a thickness of 12-15 micrometers (µm). These mulching films degrade in a few months, but they are sufficient for medium-short cycle crops. At the end of the cultivation cycle, biodegradable mulching films can be incorporated into the soil, avoiding removal and disposal costs. Several studies have shown positive effects on yields and quality parameters of different species mulched with MaterBi® films (Di Miceli et al., 2024; Filippi et al., 2009; Cozzolino et al., 2010). This research was conducted to evaluate the effects of biodegradable mulching films on morphological, productive, and qualitative parameters of tomato cv. "Rio Grande", grown in open fields in southern Italy. Four mulching treatments: black biodegradable film in Mater-Bi® thickness 12 µm (MB12), black biodegradable film in Mater-Bi® thickness 15 µm (MB15), black and white biodegradable film in Mater-Bi® thickness 15 µm (BW15) and Bare Soil (BS), were compared using a randomized complete block design with three replicates. The soil temperature was monitored at 5 cm below the ground level. The average temperature in the bare soil was lower than that detected under the biodegradable films in Mater-Bi®. All biodegradable films generated an improvement in morphological and physiological characteristics of tomato plants, compared to plants grown in bare soil. The highest commercial yield and the highest dry matter of the fruits were recorded with MB 15 films.

The MB 12 film produced the highest hydrophilic antioxidant activity (HAA) and ascorbic acid content while the MB15 film generated the highest lycopene content in fruits. The preliminary results of this study show that mulching with Mater-Bi® biodegradable film can improve productive and qualitative performance of tomato grown in environments characterized by high temperatures during the cultivation cycle.

The effect of foliar application of organo-mineral fertilizer on processing tomatoes grown in the low and high fertility soils

by Grazia Disciglio | Laura Frabboni | University of Foggia | University of Foggia

Abstract ID: 17
Topic: Crop
Presenter Name: Grazia Disciglio
Contribution: Post

The application of plant biostimulants has recently been extensively studied on tomato crops under abiotic stress conditions (temperature, drought, salinity, nutrition) to improve growth, yield and fruit quality and minimize the negative effects of stress (Gedeon *et al*. 2022, Liava *et al*. 2023). However, the availability of information under conventional nutritional conditions on soils with different fertility levels is relatively limited. This study seeks to evaluate the effects of the foliar application of organo-mineral fertilizer on the productive and qualitative characteristics responses of tomato plants grown in two soils with different levels of fertility. The trial was carried out in 2021, in the countryside of Foggia, in two separate farms. The average percentage of sand was higher in the Field 1 (36.8%) than in Field 2 (18.9%). Additionally, Field 1 had a slightly lower nutritional content compared to the Field 2 (organic matter, N, P2O5, K20). The commercial organo-mineral fertilizer Radicon®, mainly based on humic acids and amino acids, was applied in each field by foliar spraying, three times during the growing season compared to a control. Plants treated with Radicon® significantly increased marketable yields in both Fields 1 and 2. (averaging 119.4 and 129.1 t ha^{-1}, respectively) compared to the controls (averaging 102.8 and 120.8 t ha -1, respectively). Furthermore, the statistical analysis of the results highlighted that, although the marketable yield, as a field average, was greater in the fertile soil (125.0 t ha^{-1}) than in the less fertile one (111.1 t ha^{-1}), significant increases were greater in less fertile soil (16.1%) than in fertile ones (6.8%). Several fruit quality parameters (SSC, TA, pH, total phenols and colour index - a*/b* ratio) showed no statistically differences between biostimulant treatment and control nor between fields. The mean values varied between 4.1 and 4.4 °Brix for SSC, 0.39 and 0.41 g citric acid 100 ml^{-1} juice for TA, 4.21 and 4.34 for pH, 2.21 and 2.30 mg GAE/g dw for total phenols, and 0.95 and 1.18 for the color index (a*/b* ratio). While the values for DM and lycopene tended to be higher in Radicon® treatment (averaging 6.0% and 0.90 mg/g fw) compared to control (averaging 5.5% and 0.83 mg/g fw). The results demonstrate the positive effect of the foliar application of the organo-mineral Radicon®, and that it is more effective in less fertile soil than in fertile ones.

Combining Supervised Clustering Methods to Improve Weed Detection from RGB images

by Leonardo Ercolini | Nicola Grossi | Nicola Silvestri | Dip. di Scienze Agrarie, Alimentari e Agro-Ambientali, Università di Pisa | Dip. di Scienze Agrarie, Alimentari e Agro-Ambientali, Università di Pisa | Dip. di Scienze Agrarie, Alimentari e Agro-Ambientali, Università di Pisa

Abstract ID: 20
Topic: Crop
Presenter Name: Leonardo Ercolini
Contribution: Post

In the Precision Agriculture (PA) sector, Site-Specific Weed Management (SSWM) represents a viable solution to reduce the use of agro-chemicals and promote the spread of more sustainable cropping systems. However, the difficulty of discriminating weeds from crop cover by processing field images remains the main limitation of a widespread use of this approach. Although artificial intelligence (AI) has demonstrated considerable potential in overcoming this limitation, AI techniques require a high level of expertise and the availability of a largest annotated database to train the algorithms and solve the problem. This study aims to propose an image processing technique, based on the integration of two different supervised pixel-clustering methods, able to increase significantly the accuracy of maize pixels classification. The RGB images were acquired at 4-5 leaf stage (June, 20 2023) on the experimental field, cultivated with maize (FAO class 600, Pioneer P1547 cv). The flight was carried out at an altitude of 10 meters using the drone DJI MAVIC 2 PRO equipped with a 1-CMOS camera. The images were first orthorectified with Agisoft Metashape Professional Edition and then classified by using the ERDAS Imagine software. The pixel clustering was set up on four classes (soil, shade, maize and weeds) and the training set was structured on 40 samples for each class. We set the supervised classification algorithm by using eight combinations of four parametric rules (Maximum Likelihood, Mahalanobis Distance, Minimum Distance, Spectral Correlation Mapper) and two non-parametric rules (Parallelepiped and Feature Space). Their accuracy was verified by calculating the confusion matrix (producer and user accuracy), and k-statistic for each class. The two combinations that showed the highest accuracy in identifying the maize class were Spectral Correlation Mapper x Feature Space (SCMxFS) and Mahalanobis Distance x Feature Space (MDxFS), with k-values of 0.60 and 0.71, respectively. By combining the high capability of the two methods to classify pixels belonging to a specific uncertainty area, such as the edges of maize leaves for SCMxFS and the centre of maize leaves for MDxFS, it was possible to improve the final accuracy in maize classification. By masking the maize class, we obtained a simplified image on which we applied again the supervised classification on three classes (soil, weed and shade). However, this process led to additional errors caused by combining the first with the second classification, especially because of the elimination of weed pixel that were recognized as maize pixels. Therefore, a dissolving operation was recommended to mitigate this drawback by eliminating isolated groups of pixels. Finally, the k-statistic obtained with the proposed method for weed class reached a value of 0.77, which

was noticeably higher than the values resulted from the separately application of SCMxFS and MDxFS (0.66 and 0.62, respectively). The accuracy values of users and producers also confirmed an increase in the effectiveness and reliability of the proposed method. The capability to estimate the weed cover from RGB images by using a pre-implemented procedures can favour the adoption of a proper economic intervention threshold in managing the post emergence weeding.

Feed autonomy depends on the crop intensification of mixed dairy farms in Friuli Venezia Giulia

by Alessandra Cicuttin | Elisa Verardo | Martina Bertacco | Gabriela Alandia | Cristina Pavanello | Mirco Corazzin | Elisa Marraccini | University of Udine | University of Udine | University of Udine | University of Udine | University of Udine | University of Udine | University of Udine

Abstract ID: 26
Topic: Crop
Presenter Name: Elisa Marraccini
Contribution: Post

Feed autonomy is a goal of EU policies for increasing food security, as mixed dairy farms are dependent on external fodder and concentrates, thus affecting the farm economic sustainability. Feed autonomy is defined as the capacity of a farm to provide its own feed and is assessed through the balance between feed (fodder, grains, cakes, etc) production and feed consumption by livestock to achieve a production objective. Feed autonomy thus considers both fodder and concentrate autonomy. There is little information on feed autonomy of Italian farms and their dependence on external resources is high (feed costs represent 45% of variable costs). This research aimed at understanding the current situation of Friuli Venezia Giulia (FVG) dairy farms feed autonomy as well as its main drivers. For this, a sample of 16 mixed dairy farms was selected in both mountain and plain areas of FVG. Farms had an average surface of 87 ha and 163 dairy livestock units. Data on feed production and consumption was gathered through an interview and the collection of farm registers. The French tool Optialibio was used to assess feed, fodder and concentrate autonomy. Despite it was originally created for organic dairy farms, this tool was considered capable to assess the feed autonomy of a diversity of farms including permanent grasslands. Farms sampled reached an average of 67% feed autonomy composed by 80% of fodder autonomy and 9% of concentrate autonomy. According to the fodder autonomy, we identified three groups: 1) farms having a complete fodder autonomy (100%) are characterized by a dominance of arable crops in their rotations although with a dependency of external protein crops, and a high feed autonomy (82%); 2) farms having a high fodder autonomy (80-92%) with a complete dependence on concentrates, and an occasionally need to integrate their production with external fodder with feed autonomy of 68%; 3) farms having a partial fodder autonomy (< 60%) composed of small and medium-sized farms relying on permanent grasslands that need to integrate with external fodder resources and are dependent on external concentrates, having a feed autonomy of almost 50%. When comparing these groups with both structure and performance farm indicators, we found significant relations of the level of autonomy and both the ratio of herd size and the livestock intensity (LU/fodder UAA), and the milk production intensity. This latter finding showed that the dairy farm intensification seems to be related with a higher feed autonomy. Possible strategies to increase feed autonomy less intensified dairy farms can be a renewed use of summer grazing fodder resources; the creation of local markets for concentrates with arable farms, and an increase of protein crops in crop rotations. Acknowledgements. This research was partly funded by 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), in particular Task 4.2.1 and Task 4.2.4. This manuscript reflects only the authors' views and opinions, neither the European Union nor the European Commission can be considered responsible for them.

Digital Image Analysis: an innovative method to assess nutritional status of common wheat

by Alessandro Rossi | Lisa Caturegli | Clarissa Clemente | Silvia Tavarini | Luciana G. Angelini | Giuliano Sciusco | University of Pisa - Department of Agriculture, Food and Environment | University of Pisa - Department of Agriculture, Food and Environment | University of Pisa - Department of Agriculture, Food and Environment | University of Pisa - Department of Agriculture, Food and Environment | University of Pisa - Department of Agriculture, Food and Environment | University of Pisa - Department of Agriculture, Food and Environment

Abstract ID: 32
Topic: Crop
Presenter Name: Alessandro Rossi
Contribution: Post

Common wheat (*Triticum aestivum* L.) is one of the most important crops, whose profitability is linked to the increase of quality characteristic and input optimization. The main parameter in determining wheat price is grain protein content, which is strongly influenced by nitrogen (N) availability during advanced stages of development. Therefore, N application between flag leaf just visible and watery grain ripe phenological stages (37-71 BBCH scale) is pivotal. In terms of resource efficiency and with a precision farming perspective, it is essential to develop ways of monitoring plant nutritional status, to have reliable decision support tools during advanced crop development stages. Indices based on crops spectral characteristics or leaf-clip sensors, have been widely investigated by researchers. Moreover, such tools, in which photosynthetic pigments content are used as an indicator of leaf N content, are nowadays commercially available. Besides costs, the limitation of proximal instruments lies in the requirement of multiple measurements to obtain a reliable picture of the state of the entire field. Unmanned Aerial Vehicle (UAV)-mounted multi-hyperspectral sensors can solve this problem, but they require the use of expensive equipment and specialized knowledge for data analysis. The aim of this study was to evaluate whether Red Green Blue (RGB)-based indices, such as the Green Leaf Index (GLI) and Dark Green Colour Index (DGCI) can effectively assess the presence of N deficiencies in wheat at advanced development stages, providing comparable information to those obtained from widely known indices, such as Normalized Difference Vegetation Index (NDVI) and Nitrogen Balance Index (NBI). A fertilization trial was performed on common wheat (var. 'Bologna') testing four nitrogen x sulphur fertilization strategies in comparison with an unfertilized control. Each fertilization strategy was replicated 3 times in containers of 100-L volume (0.25-m^2 area and 0.4-m height). Starting from flag leaf opening (BBCH 47), weekly measurements were carried out. NDVI was obtained using a handheld crop sensor (GreenSeeker Model, HSC-100, Trimble, Sunnivale, USA), while NBI was obtained using leaf-clip sensor (Dualex®, Force-A, Orsay, FR). Aereal images were obtained using a Mavic Mini quadcopter UAV (DJI, Shenzhen, China), and analysed using GIMP software (version 2.10.36). A total of four flights were carried out. Subsequently, a correlation analysis was performed among the obtained indices using R software (version 4.2.3). Both DGCI and GLI

showed a statistically significant correlation with proximal sensing indices. However, the strongest correlation (r = 0.84) was observed between DGCI and NDVI. On the contrary, GLI showed weaker correlations with all the assessed indices. In accordance with these results, DGCI can provide comparable information to that obtained from multispectral or leaf-clipper sensors, during late wheat development stages. The use of such low-cost tools can be carried out directly by the farmer, promoting the spread of precision farming practices. However, further studies will be necessary in order to confirm these preliminary findings, considering different cultivation and environmental conditions, including plot-scale or field-scale trials.

Supporting EU Green Deal targets: in silico improvement of rice genotypes to enhance their competitiveness against weeds

by Martina Clerici | Livia Paleari | Ermes Movedi | Chiara Marchetti | Roberto Confalonieri | Università degli Studi di Milano, ESP, Cassandra lab | Università degli Studi di Milano, ESP, Cassandra lab | Università degli Studi di Milano, ESP, Cassandra lab | Università degli Studi di Milano, ESP, Cassandra lab | Università degli Studi di Milano, ESP, Cassandra lab

Abstract ID: 36
Topic: Crop
Presenter Name: Martina Clerici
Contribution: Post

Within the EU Green Deal, the Farm to Fork strategy is defining a variety of actions aimed at increasing the environmental friendliness of food systems. Among the proposed targets, the reduction in the use of chemical pesticides and the increase in the agricultural land devoted to organic farming play a key role. Such a regulatory scenario is casting a shadow over the mid-term suitability of the genotypes released in the last years based on the Green Revolution principles. Current genotypes, indeed, were developed targeting, on the one hand, a dwarfing process and the increase in harvest index at the expense of plant organs without a direct commercial interest and, on the other hand, a massive use of inputs. A consequence of these breeding targets is the development of genotypes that have lost competitiveness against weeds and this – in the case of constraints in the use of herbicides – could rapidly become a critical threat to food security. Herbicides, indeed, represent about 50% of the total pesticides used worldwide and are, undoubtedly, the dominant technology for weed control. Besides being a staple food for half of the world population, rice is one of the crops for which weed control can be considered as particularly challenging (among the reasons, one of the main rice weed belongs to the same species of cultivated genotypes). The objective of this study was the definition and evaluation, in silico, of high-yielding rice ideotypes more competitive against weeds and thus suitable for organic farming or for contexts for which herbicides use is constrained. The analysis was conducted targeting the three main European rice producers: Italy, Spain and Greece, considering a 20-year timeframe centred on 2050. To address the uncertainty in future climate projections, two diverging socioeconomic pathways (SSP2-4.5 and SSP3-7.0) and two alternative GCMs (IPSL and MPI) were used. Ideotyping was perform by combining variance-based global sensitivity analysis techniques and crop simulation modelling, the latter based on the integration of the rice model WARM and the crop-weed competition model WeedyCoSMo. Specific trait distributions were derived for European rice germplasms to maximize the *in vivo* feasibility of the ideotypes. Results revealed marked differences in the ideotype profiles designed by targeting organic and conventional systems, and – regardless of the climate change scenario – the traits identified as the most promising to increase competitiveness against weeds (and thus to assure high yields in organic farming contexts) were involved

with early vigour, light extinction coefficient and plant height. Simulated yield benefits achievable in case such ideotypes will be realized in vivo were 13.72%, 8.60% and 14.74% for Italy, Spain and Greece, respectively. A spatially-distributed analysis carried out by hypothesizing different scenarios of herbicide reduction in conventional farming further confirmed the potential of the ideotypes. Our results demonstrate the potential of model-based ideotype breeding to effectively support crop improvement when regulations and citizens' sensitivity to environmental issues evolve in the frame of global climatic changes.

Intercropping cover crops with maize for sustainable weed management

by Papandrea Giulia | Fogliatto Silvia | Beltramo Alessandro | Di Furia Ivan | Bennani Zineb | Vidotto Francesco | Università di Torino - DISAFA | Università di Torino - DISAFA | Università di Torino - DISAFA | Università di Torino - DISAFA | Università di Torino - DISAFA | Università di Torino - DISAFA

Abstract ID: 37
Topic: Crop
Presenter Name: Papandrea G.
Contribution: Post

The use of cover crops as a living mulch can inhibit weed development and potentially allow a reduction in herbicide use. A two-year field experiment on the use of a living mulch in maize interrow was carried out in 2023 and 2024 in north-west Italy. The aim of the study was to test the combination of an inter-row living mulch, either of *Secale cereale* (rye) or *Trifolium alexandrinum* (Egyptian clover), and an in-row chemical weed control with a pre-emergence herbicide (Terbuthylazine + S-metolachlor + Mesotrione). In 2023, the cover crops were seeded in mid-March, approximately one month before maize, and in mid-April, the same day as maize; the seeding rate was 180 kg/ha for rye and 50 kg/ha for Egyptian clover. A chemical control performed with the same herbicide mixture but broadcast sprayed and an untreated control with spontaneous weeds were also included. Both cover crops and weeds were either mowed once during the growing season (in mid-June) or not mowed. Cover crops and weed development assessments involved density, soil cover and biomass, while crop assessments included maize height, growth stage and vegetation indices. Maize was harvested in October and grain yield and plant biomass were assessed. Before mowing, in the plots seeded one month before maize, rye produced 113.3 g/m^2 of dry biomass while Egyptian clover developed 131.9 g/m^2 of dry biomass; the same species seeded the same day as maize averaged 135.2 g/m^2 and 260.5 g/m^2 of dry matter, respectively. Weed biomass was significantly reduced in all treatments compared to the untreated control (217 g/m^2), except the treatment with rye seeded a month before maize and not mowed; the lowest weed biomass was obtained with Egyptian clover seeded with maize (32.5 g/m^2), regardless of mowing. In terms of height, the crop was not affected by competition from cover crops, as no differences were found throughout the cropping season. However, NDVI and NDNI were lower in plots with rye seeded with maize and not mowed compared to the mowed clover seeded in the same date. In terms of yield, the chemical control and the clover seeded with maize treatment (regardless of mowing) showed the highest values (14.9 Mg/ha and 14.7 Mg/ha, respectively), which differed only from the mowed rye seeded the same day as maize (11.4 Mg/ha). Given the current EU policies on pesticide reduction, such as the Farm to Fork strategy, this technique could represent an alternative to reduce the input of herbicides for weed control. Overall, in fact, the spring establishment of the cover crops allowed to reduce the competition with the crop while maintaining a good efficacy in reducing weeds. Egyptian clover, in particular, performed better both for weed control and for the crop development. However, mowing was probably

not necessary, since it only partially affected the overall weed biomass but had an impact on weed composition, as it favoured grass species regrowth.

Towards a sustainable potato production: the case of Bologna Potato PDO

by Giovanni Dinelli | Marco Sangiorgi | Rocco Enrico Sferrazza | Giulia Oliveti | Lorenzo Negri | Sara Bosi | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna

Abstract ID: 39
Topic: Crop
Presenter Name: Giovanni Dinelli
Contribution: Post

The potato, native to the Andean territories of South America, was introduced to Europe during the 16th century, but it was only during the 18th century that it spread to various European countries. The spread of the potato in the Bolognese area occurred in the early nineteenth century, thanks to the agronomist Pietro Maria Bignami. The Bologna Potato became part of the official list of typical Italian products in 2010, attributable to the PDO (Protected Denomination of Origin) certification. As part of the PDIDOP project, financed by the Emilia Romagna region, as part of the PSR-GOI 2022, an experimental trial was initiated with the producers of the Bologna Patata Consortium with a dual purpose: a) to evaluate how to rationalize the chemical input and b) to identify alternative treatments against insecticides for the control of wireworms (*Agriotes* spp). As regards the first aspect, a survey was conducted among 42 farmers, using questionnaires and interviews. It was then possible to process the set of data relating to the agronomic practices adopted, fertilization interventions and the use of phytosanitary treatments. Regarding the fertilization practices, only 27% of the farmers applied organic fertilizers (with over 70% using only mineral fertilizers). Only 16% included a legume in their rotation (5 years after potato cultivation). Then 70% of farmers cropped the potato in succession to the wheat, contravening the agronomic rule which imposes deep-rooting crops in succession to a legume crop. These data explain the particularly low average values of both organic matter (1.90 ± 0.6%) and labile carbon (0.22 ± 0.1 g/Kg). It was then possible to observe a wide variability in both the overall doses of applied fertilizers and in the overall number of treatments for crop protection. However, generally no significant correlation was observed between the applied chemical input and production yields. As regards the second objective, according to an on-farm research approach, three alternative treatments (to common soil insecticides) for the control of wireworms (respectively based on *Metarhizium brunneum*, nematodes and *Beauveria bassiana*) were tested on three farms of the consortium. Although the wireworm attacks were shown to be of medium/low magnitude in the 2022/2023 agricultural season, the best results in terms of damage reduction and yield were obtained with products based on nematodes and Beauveria bassiana. Although the data collected could only be referred to a single agricultural year, it was possible to start a process of developing both fertilization and crop protection interventions with the consortium farmers. This was considered important when taking into account the increasingly pressing need to adopt more

sustainable practices able to counteract the effects of climate change.

Nutritional traits in florets of safflower grown in Sicily as affected by sowing time and plant density

by Vivienne Panebianco | Paolo Caruso | Salvatore L. Cosentino | Silvio Calcagno | Valeria cafaro | Cristina Patanè | Di3A, University of Catania | Di3A, University of Catania | Di3A, University of Catania | CNR-IBE | CNR-IBE | CNR-IBE

Abstract ID: 41
Topic: Crop
Presenter Name: Cristina Patanè
Contribution: Post

Safflower (*Carthamus tinctorius* L.) is a multipurpose plant belonging to the Asteraceae family, mostly cultivated for seed oil extraction for food and industrial application. Its drought tolerance makes it an excellent alternative for the arid marginal areas of Sicily, where it may offer a greater chance of success than major traditional crops, in a context of climate change. Safflower florets contain numerous compounds, mainly pigments from the flavonoids family, with beneficial effects on human health due to their antioxidant, antiseptic, and anti-inflammatory action. Moreover, the florets have great potential for the agri-food sector as they are rich in nutrients. Despite the various positive aspects, little interest has been addressed by the agronomists towards this crop. In semi-arid cultivation areas, early sowings of safflower allow the crop a better exploit of water stored in the soil during the rainy season, escaping part of the warm season during the growing period. Sowing density, as well, could influence some nutritional traits of the florets. In this regard, a research was conducted in 2019 on a cultivar of safflower (*Catima*) in a typical hot arid environment of Sicily, where the effects of sowing time (I: 24 February, II: 28 March, III: April 26) and plant density (P25 and P50, 25 and 50 plants/m^2, respectively) were studied on florets production and some nutritional traits (proteins, phenols and flavonoids). Per each sowing time, two harvests were carried out, between the end of June and the beginning of July. Plant production of florets progressively increased with the advance of sowing (from 2.36 to 5.06 g/plant) and was reduced with the increase of plant population from 25 to 50 plants/m^2 (from 4.23 to 3.39 g/plant). However, despite yield reduction per plant, the increased number of plants in P50 resulted in a significant increase in florets production per unit area. Crude protein content (on average 17%) was reduced shifting the sowing to April and was approximately 3% lower at high plant density (in P50). The content of total phenolics, on average 5 mg/g FW, was progressively reduced with the shift of sowing from February to April. Flavonoids content (on average 2.29 mg/g FW) did not significantly change with sowing time, although it was slightly higher in the first sowing (April). Their content significantly declined (by approximately 6%) with the increase of plant density from 25 to 50 plants/m^2. These results revealed that early sowings in February may be beneficial for safflower cultivated in semi-arid regions of Sicily, also taking into account the positive effects of early sowings on nutritional traits of florets. High plant densities may lead to greater yields but reduce the nutritional quality of florets. Further researches on safflower are required to promote this still underutilized but economically promising crop.

Spatial relationships between satellite-derived Copernicus HR-VPP crop seasonal productivity maps and ground yield maps in wheat and maize in support of precision management strategies.

by Luca Marrone | Federica Carucci | Riccardo Fazioli | Davide Tahani | Davide Cau | Raffaele Casa | University of Tuscia | University of Tuscia | University of Tuscia | University of Tuscia | Genagricola 1851 S.p.A, Annone Veneto (VE), Italy | University of Tuscia

Abstract ID: 46
Topic: Crop
Presenter Name: Luca Marrone
Contribution: Post

The estimation of the spatio-temporal variability of crop yield within a field is an essential part of the information required to improve the agronomic management in precision agriculture. For example, the identification, from the time series of yield maps, of stable high or low yielding areas, as well as temporally instable areas, supports the delineation of uniform management zones, for the creation of prescription maps. In the absence, for most Italian farms, of long time series of yield maps obtained from combine harvesters equipped with yield monitors, spatial and temporal patterns of crop productivity can be inferred from earth observation satellite data, such as Sentinel-2. In this context, the High-Resolution Vegetation Phenology and Productivity (HR-VPP) suite of products, delivered by the Copernicus Land Monitoring Service at 10 m resolution from January 2017 onwards, and freely available in the WekEO platform (www.wekeo.eu) are particularly interesting. The suite of products includes total productivity (growing season integral; TPROD) and seasonal productivity (growing season integral above the start and the end days; SPROD). TPROD and SPROD are calculated as the growing season integral of the Plant Phenology Index (PPI) computed as the sum of all daily values between the start and the end of the growing season, and as the sum of all daily values minus their base level value, respectively. They have been conceived as indicators of crop productivity, thus could be potentially used for supporting field zoning for precision agriculture purposes. This study aimed at assessing the spatial relationships between Sentinel-2 derived TPROD and SPROD products, and ground-based crop yield spatio-temporal patterns. For this purpose, data from a range of agricultural fields with herbaceous crops such as wheat and maize, located in Maccarese (Central Italy) and Jolanda di Savoia (Northern Italy) were used. For each field, yield data were recorded at harvesting by a combine harvester equipped with a GNSS yield mapping system. The raw data were pre-processed for outliers' and errors removal with R and Vesper software was used for geostatistical interpolation using block kriging interpolation to a 10 m grid aligned with Sentinel-2 pixels. For each field, the TPROD and SPROD products were obtained from WEkEO, which is the EU's Copernicus DIAS reference service for environmental data, virtual environments for data processing. The pixel-based spatial correlation between the TPROD or SPROD maps and the ground yield maps was assessed by

obtaining a linear model of coregionalization and assessing the codispersion coefficient against the hull of perfect correlation, and computing the Dutilleul t-test for the spatial processes of the SpatialPack package implemented in R. This test allowed to evaluate the consistency of the maps predicted by the satellite using TPROD and SPROD, with the yield maps showing a good spatial correlation between the maps in most cases.

Wheat-Vetch Intercropping: Agronomic Advantages in Organic Agriculture

by Michele Denora | Donato Casiello | Andi Mehmeti | Pierluigi Casiero | Domenico Mario Melone | Vincenzo Candido | Enrica De Falco | Domenico Ronga | Gabriele Cioffi | Antonio Landi | Costanza Fiorentino | Michele Perniola | Department of European and Mediterranean Cultures, University of Basilicata | Department of European and Mediterranean Cultures, University of Basilicata | Department of European and Mediterranean Cultures, University of Basilicata | Department of European and Mediterranean Cultures, University of Basilicata | Department of European and Mediterranean Cultures, University of Basilicata | Department of European and Mediterranean Cultures, University of Basilicata | Pharmacy Department, Agricultural Course, University of Salerno | Pharmacy Department, Agricultural Course, University of Salerno | Pharmacy Department, Agricultural Course, University of Salerno | Pharmacy Department, Agricultural Course, University of Salerno | School of Agricultural, Forestry, Environmental and Food Sciences, University of Basilicata | Department of European and Mediterranean Cultures, University of Basilicata

Abstract ID: 47
Topic: Crop
Presenter Name: Michele Denora
Contribution: Post

The importance of diversifying industrialized agriculture is increasingly recognized to mitigate the negative externalities of low-diversity cropping systems (IPES-FOOD 2016). In Europe, interest in legumes has grown within the context of the "protein transition" (Aiking and de Boer 2018) and sustainability-based legislative initiatives aimed at reducing dependency on agrochemical inputs and increasing agrobiodiversity (e.g., the EU Green Deal's "Farm to Fork" strategy) (European Commission 2020). Intercropping is an important agricultural practice benefiting from interspecific facilitation (Stagnari et al., 2017). This work aims to study intercropping as an agroecological practice, elucidating the mechanisms of interspecific interactions influencing nitrogen fixation and transfer. The experiment was conducted at the cooperative "La Generale" in the Genzano di Lucania countryside (PZ), within the framework of the AgrEcoMed research and innovation project, funded by the PRIMA Foundation, in line with the prevailing agroecological approach in Mediterranean countries. During the 2022-2023 growing season, an experiment was conducted on durum wheat (*Triticum durum* Desf.) var. Tirex intercropped with common vetch (*Vicia sativa* L.) var. Ereica. The aim of this study was to quantify the dynamics of symbiotic nitrogen (N) exchange, fixed by legumes and transferred to cereals, and assess the potential benefits of intercropping in balancing resource competition and facilitation among crops. The experimental treatments consisted of comparing wheat intercropped with vetch (respectively wheat sowing rate of 150 kg/ha and 80 kg/ha for vetch), wheat in monoculture at the same sowing density as the intercropping (150 kg/ha), and wheat at conventional sowing density (230 kg/ha). In this study, the compared plots were not fertilized with mineral N, as required by organic farming regulations. The overall effects were quantified using the nitrogen balance, measuring soil nitrogen content and plants nutrient uptake of the different cropping systems. The results showed no significant differences in grain yield

between wheat grown in monoculture (2.8 t/ha) and wheat intercropped with vetch (2.6 t/ha). However, in intercropped wheat, the N content in the grain was significantly higher (24,5 g/Kg) and nitrogen uptake 63.7 Kg/ha compared to respectively 20,7 g/Kg and 57.8 Kg/ha in monoculture wheat. This trend was also observed in the straw. Overall, intercropped wheat accumulated more N than monoculture wheat, with a total N uptake of 91.3 Kg/ha compared to 76.1 Kg/ha for monoculture wheat. This Δ of 15.2 Kg/ha of N indicates an active dynamic of symbiotic nitrogen exchange between legumes and cereals. Wheat-vetch intercropping in organic agriculture proved to be the most advantageous both agronomically and economically, with a positive nitrogen balance of intercropping respect to the negative balance of monocropping, a higher total yield of 3.7 t/ha (wheat+vetch) respect to wheat in monocropping (2,8 t/ha), higher wheat protein content (14%) and the higher economic value. These results underscore the importance of legumes in providing agroecological services.

Essential Oil Yield of Lavandula angustifolia L. Cultivated under a Dynamic Agrivoltaic System

by Grazia Disciglio | Francesca Stefanelli | Annalisa Tarantino | Laura Frabboni | Department of Agriculture, Food, Natural Resources and Engineering, Univ. Foggia | Department of Agriculture, Food, Natural Resources and Engineering, Univ. Foggia | Department of Agriculture, Food, Natural Resources and Engineering, Univ. Foggia | Department of Agriculture, Food, Natural Resources and Engineering, Univ. Foggia

Abstract ID: 53
Topic: Crop
Presenter Name: Grazia Disciglio
Contribution: Post

Agrivoltaics (AV) is a concept that combines agriculture and solar photovoltaic energy production on the same land. This approach aims to optimize land use by simultaneously growing plants and generating renewable energy. Previous research has indicated that artificial shading conditions can decrease yields in some crops (Midmore et al., 1988). However, cultivation under photovoltaic panels is feasible for species that can tolerate partial shading, such as medicinal plants. It is recognized that essential oil content fluctuates with seasons and climatic or stress conditions (Baydar, 2009). Given the partial shading provided by agrivoltaic systems, this work aims to evaluate the concentrations of essential oils (EOs) in lavender (*Lavandula angustifolia* var. Royal Purple L.) grown under a dynamic AV system, compared with the same crop grown in full sun. The study was conducted during the 2022 and 2023 seasons at the Dynamic Agrivoltaic System field of M2 Energy S.r.l. Company, located in the agricultural area of San Severo (41° 41’ N; 15° 22’ E; altitude, 86 m a.s.l.), Foggia district. Below the dynamic AV system, two zones are distinguished on the ground surface based on the rotation of the solar panels: one always in the shade (UP) and another between the panels, alternately shaded (BP). The lavender crops grown in these two zones were compared to those grown in full sun in an adjacent zone (T). In each zone, every year, during two harvests in June (indicated A) and July (indicated B), flowers were collected from three plots (three replicates), dried in an oven at 30 °C, and used for hydrodistillation using a Clevenger-type device (Clevenger, 1928). The yield of lavender EOs (%) showed significant differences among the UP, BP, and T plots and years, while no differences were noted between the June and July harvests. In each year, the EO values were significantly higher in the UP plot (averaging 1.57% in 2022 and 1.89% in 2023) compared to the BP (averaging 1.42% in 2022 and 1.70% in 2023) and T plots (averaging 1.33% in 2022 and 1.61% in 2023). The best results obtained from the lavender crops in the UP plot may be attributed to the shading effect of the solar panels, lower air temperature, or reduced presence of weeds in these plots compared to the T plot, which had a negative effect on crops. The greater yield of EOs (%) in the UP plot may have been caused by lower solar radiation, which stressed the plants and led to increased EOs production. Acknowledgements. We thank the M2 Energia S.r.l. Company for putting at disposal the agrivoltaic field.

Coupling Light Use Efficiency and Random Forest for Scalable Crop Biomass Estimation in MRV Platforms

by Manuele Ragazzi | Michele Croci | Andrea Ferrarini | Niccolò Pellegrini | Lorenzo Cremonesi | Marta Bertola | Giorgio Impollonia | Stefano Amaducci | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore

Abstract ID: 54
Topic: Crop
Presenter Name: Manuele Ragazzi
Contribution: Post

Accurate quantification of soil organic carbon (SOC) stocks and fluxes is essential for understanding and mitigating climate change impacts in agricultural landscapes. Monitoring, Reporting, and Verification (MRV) platforms offer a scalable approach by integrating remote sensing data with crop and soil models. MRV platforms usually consist of three modules: i) a soil module, which produces a soil organic carbon baseline; ii) a plant module, which quantifies the amount of carbon that is fixed into plant biomass, and iii) a modelling module, which predict changes in soil organic carbon as a function of environmental conditions and agronomic management. In this study, conducted as part of the Agritech project, we focus on developing the plant module, a hybrid approach for the estimation of crop yield and aboveground biomass based on the integration of Light Use Efficiency (LUE) and Random Forest (RF) algorithms. This approach aims to enhance the estimation of plant carbon input, a crucial element in understanding SOC dynamics. The Light Use Efficiency (LUE) model presents a simple but robust framework for the terrestrial gross primary production (GPP) estimation, which is provided as the product of the incoming photosynthetically active radiation (PAR), the fraction of PAR that is absorbed by the plant (fAPAR), the maximum light use efficiency and the environmental stress factors (e.g., temperature, water, CO_2). Satellite-derived Vegetation Indices datasets were utilized to estimate fAPAR, while ground-truth measurements on winter wheat, maize and processing tomato in 2022 and 2023 seasons provided data for calibration and validation of the model. Temperature and water stresses are obtained from satellite-provided data, such as Landsat-8-derived Land Surface Temperature (LST) and Land Surface Water Index (LSWI) from MODIS. Two models were compared for biomass estimation: a standalone Light Use Efficiency (LUE) model and an integrated LUE-Random Forest (LUE-RF) model. In the LUE-RF model, synthetic biomass data generated by the LUE model were used to train a RF algorithm. Both models were then validated at three different special scales: elementary sampling unit (ESU), field and regional scale. Our findings indicate that the LUE model, when properly calibrated and integrated with satellite data, offers a reliable and scalable approach to predict crop yield and biomass. Moreover, we found that the integration of LUE-derived biomass into Random Forest can enhance the accuracy of the yield and biomass estimation.

Cover crops in Mediterranean organic vineyard as an agroecological practice to improve weed control

by Francesca Calderone | Aurora Maio | Tommaso La Malfa | Nicola Aloisi | Aurelio Scavo | Danilo Scordia | Fabio Gresta | University of Messina | University of Messina | University of Messina | University of Messina | University of Messina | University of Messina | University of Messina

Abstract ID: 58
Topic: Crop
Presenter Name: Francesca Calderone
Contribution: Post

The European Community considers a priority the transition to a more ecofriendly wine sector driven by environmental and food safety issues. The purpose of this study was therefore to evaluate the effectiveness of an innovative soil management approach in a Mediterranean organic vineyard to provide sustainable weed control and to reduce the water-nutritional competition with vines. In particular, the research focused on the cover crop adoption and its alternative management, consisting of rolling and crimping able to provide a combination of mulching and green manuring functions. The field trial was performed in 2023-24 in 14-year-old organic vineyard of *Vitis vinifera* L. located in Rodì Milici (Messina, Italy, lat. 38°06' N; long. 15°08' E, 100 m a.s.l), on a red berried Nero D'Avola cultivar. The experimental factors were type of cover crop (spontaneous and artificial) and type of termination (green manure and rolling-crimping), compared with a bare soil (control) according to a randomized complete block design replicated three-time. The inter-row treatments were: i) native vegetation; ii) a grass mixture (*Hordeum vulgare* L., *Avena sativa* L. and x *Triticosecale*); iii) a legume mixture (*Vicia faba* L. var *minor*, *Hedysarum coronarium* L. and *Trifolium alexandrinum* L.); iv) a mixture of both legume and grass species. The soil was dish harrowed in autumn at 20 cm and the cover crops were mechanically sown according to the range suggested by the Pennsylvania State University guidelines. In May, when different species were around the flowering stage, each treatment was management as follows: i) mowed and buried; ii) folded by a roller crimper. The cover crop effects on weed control was determined by assessing soil cover percentage according to Braun-Blanquet scale at three different monitoring times. Cover crop dry biomass yield was determined in 1 m^2 quadrats in each treatment and replication. All grass and legume species showed a good soil cover, with the highest average percentage detected in grass and legume mixture (79%) and the lowest in legume mixture (39%). No differences appeared between cover crops in their effectiveness to reduce weeds pressure relative to the native vegetation. Findings showed a weed dry biomass significantly higher in the native vegetation (2.19 t ha^{-1}), than grass mixture (1.35 t ha^{-1}), legume mixture (1.29 t ha^{-1}) and grass/legume mixture (1.19 t ha^{-1}). This latter showed also the highest dry matter yield (5.77 t ha^{-1}), than grass or legume mixtures (4.60 and 4.49 t ha^{-1}, respectively). The present study provides preliminary information about the use of cover crops as a valid and sustainable weed control solution in vineyard to be transferred to winegrowers of the Mediterranean area. Overall, the grass/legume mixture behaved better than the others in cover the ground

and limiting weeds. Further investigations are planned to determine the carbon sequestration according to the termination method, and the regulatory ecosystem services the cover crops will provide to the vineyard system.

Characterising double cropping in Friuli Venezia Giulia (Italy) using the Land Parcel Identification System

by Antonio Bruno | Elisa Marraccini | Philippe Martin | DI4A, Università di Udine | DI4A, Università di Udine | Université Paris-Saclay, INRAE, AgroParisTech

Abstract ID: 59
Topic: Crop
Presenter Name: Antonio Bruno
Contribution: Post

Double cropping (DC) indicates growing and harvesting two crops in the same field on one year. This agronomic technique, spread particularly in low-land tropical and subtropical areas, is a form of crop intensification. Where climate and soil condition are suitable, DC is a way to make more economically resilient the farm, a technique to better control diseases and weeds, and increase ecosystem variability. Despite its interest, in Mediterranean regions few DC systems have been investigated, e.g. in fodder or biomass production but few studies dealt with their identification and accounting at territorial level. We propose a method to account for DC using as case study the Friuli Venezia Giulia region. As data source we used crop data from 2019 and 2020 LPIS (Land Parcel Identification System). Starting from raw data, we firstly reclassified crops names to be consistent with the two databases. Then, we cleaned the database by deleting polygons of less than 1000 m^2. In the database, we considered as DC multiple records on a same parcel. Once identified possible DC sequences, we excluded from the analysis parcels where the two crops cycle were overlapped (e.g. wheat and barley) or where crop type was not explicit (e.g. arable crop instead of the crop name). The obtained data have been validated in a sample of five local farms. From this method, we show that DC area represents 4.85% of the total usable agricultural area of LPIS in the two years and that cereals and legumes cover more than 90% of all double cropped area. Among legumes, soybean is the most abundant second crop occupying 1/3 of double cropped surfaces. Among cereals, soft wheat (18%), barley (18%) and corn (12%) are the most abundant double crops. The most abundant combination main-second crop is “cereal-legume” with 55% (2019) and 52% (2020) of the double cropped surface, e.g. barley and soybean; followed by “cereal-cereal” that reach the 27% for both years, e.g. wheat and corn. Finally, there is the combination “industrial crop-legume” where we assist to an increase in terms of surface, from 6% in 2019 to 11% in 2020, i.e. rapeseed-soybean. Corn is usually preceded by the same winter cereals that precede soybean (barley 9%, soft wheat 7% and triticale 4%). Other crops in combination with winter cereals are fodder crops (9%), sorghum (4%). LPIS database seems a promising as source of data for territorial studies on crop sequences, including DC. These data can be validated either through on-farm surveys or using satellite images, e.g. Sentinel 2. Regarding our results, we confirm that soybean and corn are the most important second crops after winter cereals and we assessed and map for the first time the surface interested by DC. Future work will assess the place and the frequency of DC in regional crop rotations, along with the drivers

of their adoption. Acknowledgements. We acknowledge the founding of Friuli Venezia Giulia region under the SICaNSE project.

Direct sowing of processing tomato on biodegradable mulching film as an alternative agronomic technique

by Domenico Ronga | Annamaria Di Serio | Vincenzo Alfano | Anna Ciancolini | Dalila Villlano | Michele Falce | Pharmacy Department, University of Salerno | Chemestry and Biology Department, University of Salerno | Pharmacy Department, University of Salerno | Novamont S.p.A. | Novamont S.p.A. | Novamont S.p.A. Via G. Fauser n. 8, 28100 NO, Italy

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Topic: Crop
Presenter Name: Domenico Ronga
Contribution: Post

Tomato (*Solanum Lycopersicum* L.) is among the world's most widespread horticultural crops. Recently Cammarano et al. (2022) reported the climate change can affect the processing tomato production sustainability due to an increase of temperature and volume of the irrigation water. Considering these issues, the aim of this work was to evaluate the direct sowing of processing tomatoes on biodegradable mulch film (BMF), as an innovative agronomic adaptative strategy. The study was conducted, during spring-summer 2023, at Manfredonia in the province of Foggia (Italy). In particular, mechanical sowing on BMF and transplanting without BMF (both with a density of 28.000 plants/ha) of processing tomato, cultivar Pretender, were assessed on a sandy soil. During the entire crop cycle, weather conditions were monitored and agronomic (plant height, soil water content, collar diameter and epigeal and hypogeal biomasses, fruit water productivity and nitrogen agronomic efficiency), physiological (phenological phase (BBCH), foliar pigments such as chlorophyll, flavonols, anthocyanins, NFI index, leaf temperature,) and qualitative measurements (fruit color, pH and °Brix) were carried out through the use of traditional and digital instruments. A randomized block design was used with three replicates for each thesis. All data collected were computerized, subjected to analysis of variance (ANOVA) and the averages were separated by Duncan's $p<0.05$ test. Among the most interesting results sowing on BMF highlighted a reduction of irrigation water consumption (-57%) and nitrogen application (-29%), while improving yield (+27 t/ha) and preserving quality (°Brix, pH and color) that were comparable to that one obtained with transplanting. These preliminary results offer an interesting solution to improve the processing tomato sustainability and to validate the obtained results a second year of field experiment is ongoing.

Sorghum-legume mixtures for forage production in Northern Italy

by Daniele Cavalli | Luciano Pecetti | Tommaso Notario | Riccardo Pessina | Roberto Salvatore Pilu | Pietro Marino Gallina | Paolo Annicchiarico | Council for Agricultural Research and Economics - Research Centre for Animal Production and Aquaculture | Council for Agricultural Research and Economics - Research Centre for Animal Production and Aquaculture | Council for Agricultural Research and Economics - Research Centre for Animal Production and Aquaculture | Università degli Studi di Milano - Department of Agricultural and Environmental Sciences - Production, Landscape, Agroenergy | Università degli Studi di Milano - Department of Agricultural and Environmental Sciences - Production, Landscape, Agroenergy | Università degli Studi di Milano - Department of Agricultural and Environmental Sciences - Production, Landscape, Agroenergy | Council for Agricultural Research and Economics - Research Centre for Animal Production and Aquaculture

Abstract ID: 63
Topic: Crop
Presenter Name: Daniele Cavalli
Contribution: Post

Intercropping sorghum (*Sorghum bicolor* [L.] Moench) with cowpea (*Vigna unguiculata* [L.] Walp.) or soybean (*Glycine max* [L.] Merr.) could be a valuable means to raise the protein content of the forage and maintain satisfactory yield under drought conditions. In summer 2023, a field experiment was established in Terranova dei Passerini (45°11’35”N, 9°4’47”E), under organic farming, to assess the effects of legume species and plant type, and crop spatial arrangement on the forage yield of binary associations sorghum-legume. The experiment was designed as a randomized complete block (three replicates) and included six treatments of intercropping (three legumes-sorghum mixtures × two spatial arrangements) and four of sole cropping. Sorghum (variety Felsina; 36 seeds m^{-2}), a determinate-erect (CE) and an indeterminate-climbing (CC) cowpea (28 seeds m^{-2}), and soybean (variety Buenos, medium plant height and MG I; 46 seeds m^{-2}) were cultivated in sole cropping, or in intercropping (one legume and sorghum, both sown at half their planting density in pure stand), with the two species either mixed within each row, or sown in alternate rows. On June 8th, plots were fertilized (150 kg P_2O_5 ha^{-1}) and sown. Due to severe drought, emergence was poor, and on June 28th plots were thinned at 30% to maintain the expected legume to sorghum ratio. The field was kept free of weeds by hand and irrigated twice. Treatments were harvested for forage production on October 10th. The dry matter and N content of aboveground biomass (AGB) was measured separately for each species. The performance of intercropping was assessed with the partial land equivalent ratio (pLER = $AGB_{intercropping}$ / $AGB_{pure\ stand}$) of sorghum and legumes, and the total land equivalent ratio (LER = $pLER_{sorghum}$ + $pLER_{legume}$). Intercropping reduced sorghum AGB (–72%), without differences between mixtures, and legume AGB by 30% in alternate-rows and 15% in mixed-rows treatments. Reduced plant density due to drought at emergence likely favoured legume competition with sorghum. Similarly, the lower legume density within each row of the mixed-rows treatments could have reduced intra-row competition

between legume plants compared to cultivation in alternate rows. Total AGB was lower for pure stand of sorghum and CC in alternate-rows compared to CE in mixed-rows. The $pLER_{sorghum}$, $pLER_{legume}$ and LER were higher for CE (0.37, 0.89 and 1.26, respectively) while for CC and soybean they averaged 0.25, 0.72 and 0.97, respectively. In addition, $pLER_{legume}$ and LER were higher in mixed-rows (0.85 and 1.13, respectively) than in alternate-rows (0.70 and 0.99, respectively) mixtures. Intercropping did not influence N concentration in AGB of sorghum and legumes. Concentration of N in total AGB was lower for sorghum in pure stand (1.48%), intermediate for cowpea treatments (2.15–2.46%), and higher for soybean in intercropping (2.85–2.92%) and in pure stand (3.42%). Intercropping provided equal or greater forage yield with higher N content compared to pure stand of sorghum. Severe drought at emergence could have favoured legume development. The second year of the experiment will provide further evidence on the effects of the studied factors on the forage production.

Agroecological benefits of ley-farming on forage legume self-reseeding capability and weed suppression in a semi-arid Mediterranean organic farming system

by Aurora Maio | Francesca Calderone | Tommaso La Malfa | Marianna Oteri | Aurelio Scavo | Danilo Scordia | Fabio Gresta | University of Messina | University of Messina | University of Messina | University of Messina | University of Messina | University of Messina | University of Messina

Abstract ID: 64
Topic: Crop
Presenter Name: Aurora Maio
Contribution: Post

Ley-farming, i.e. the growing of self-regenerating annual legumes in rotation with grain or tilled crops, is an agroecological practice developed in Australia as an alternative to crop-fallow. In this system, forage legumes regenerate naturally from the soil seed-bank and likely reduce the N fertilizer needs of the subsequent cereal grain crop thanks to their N-fixing ability. This research follows a previous study on cereal-legume double cropping between durum wheat and forage legumes at different organic N fertilization rates. The objective was to investigate the self-reseeding capability of three forage legumes, combined with the residual effects of different N fertilization rates for grain crop rotation in the subsequent growing season. A field experiment was performed in an organic farm located in Patti (38°11′ N, 14°99′ E, Messina, South Italy) during the 2023/2024 growing season in a clay soil. Three forage legumes (*Trifolium subterraneum* L. var. Urana, *Lotus corniculatus* L. var. Gran San Gabriele, *Medicago polymorpha* L. var. Scimitar) were established in 2022/2023 growing season, intercropped with durum wheat in a split-plot design (sub-plot) with three N fertilization rates (0, 60 and 120 kg N ha^{-1}, respectively N0, N1 and N2) as main plots and three replication per treatment. A single plot measured 5 × 8 m (40 m^2). In 2023/2024, the same design was used to assess the self-reseeding capability of forage legumes. Legume and weed aboveground biomass was determined from two 0.25 m^2 quadrats per replicate. Both legumes and weeds, sampled on 25 January 2024, were cut 10 cm from the soil surface to simulate an early grazing and oven-dried at 65 °C up to constant weight for dry biomass determination. Data were analyzed by the ANOVA at $\alpha = 0.05$ and means were separated by the Tukey's HSD test. All forage legumes showed a good regeneration from the soil seed-bank, with the significantly highest amount of dry biomass detected in *M. polymorpha* in N1 (2.4 t ha^{-1}) and the lowest in *L. corniculatus* in N0 (0.5 t ha^{-1}). Across the average of N rates, *M. polymorpha* showed the significantly higher dry biomass (2.3 t ha^{-1}) and weed-suppressive ability (−58.1% as compared with the fallow-control), than *L. corniculatus* (0.7 t ha^{-1} of dry biomass and −46.6% of weeds) and *T. subterraneum* (0.8 t ha^{-1} and −42.0%, respectively). Across the average of forage legumes, the greatest dry biomass was found in N1 (1.1 t ha^{-1}), followed by N2 and N0 (1.0 t ha^{-1} and 0.8 t ha^{-1}, respectively). This preliminary study indicated that the use of ley-farming with self-reseeding annual legumes may be a valid solution in semi-arid Mediterranean

environments as eco-friendly practice to reduce soil tillage, fertilizer and herbicide application. Among the forage legumes under study, *M. polymorpha* showed the highest self-seeding and weed-suppressive ability. The field trial will be further used to assess the effectiveness of self-regenerating annual legumes on soil fertility and the N reduction for a subsequent cash crop.

Agronomic performance of a prototype front roller multi-disc harrow for legume devitalisation in wheat-faba bean temporary intercropping

by Giacomo Tosti | Paolo Benincasa | Daniele Antichi | Christian Frasconi | Michele Raffaelli | Dept. of Agricultural, Food and Environmental Sciences - DSA3 University of Perugia | Dept. of Agricultural, Food and Environmental Sciences - DSA3 University of Perugia | Department of Agriculture, Food and Environment (DAFE) University of Pisa | Department of Agriculture, Food and Environment (DAFE) University of Pisa | Department of Agriculture, Food and Environment (DAFE) University of Pisa

Abstract ID: 67
Topic: Crop
Presenter Name: Giacomo Tosti
Contribution: Post

The practice of cereal-legume temporary intercropping (TIC) with legume devitalisation in late winter offers promising advantages for autumn-sown cereals in organic cropping systems, where nitrogen (N) availability is often limited. In this 3-year field experiment, we investigated the effect of TIC on durum wheat yield and quality, focusing on the legume devitalisation method. A novel front roller multi-disc harrow (RMH) prototype was compared with a conventional split rotary hoe (SRH) in terms of devitalisation efficiency and impact on wheat N availability and yield. The results show that the TIC significantly improved N-use efficiency and wheat N status, resulting in higher grain protein content, without compromising yield. RMH did not differ from SRH in terms of devitalisation efficiency and legume N transfer to wheat. Overall, RMH appears to be a suitable tool for cereal-legume TIC management in Mediterranean farming systems, with energy and time saving advantages compared to PTOs.

Evaluation of an olive-cereal agroforestry system in a Mediterranean environment

by Iurato Antonella | Corinzia Sebastiano Andrea | Caruso Paolo | Mancini Giuseppe | Cosentino Salvatore Luciano | Testa Giorgio | University of Catania | University of Catania | University of Catania | University of Catania | University of Catania | University of Catania

Abstract ID: 68
Topic: Crop
Presenter Name: Iurato Antonella
Contribution: Post

Agroforestry and mixed farming systems are viable alternatives to conventional monocropping in the semi-arid Mediterranean environment due to the sustainable intensification of land and water use. Furthermore, these systems enhance the resilience of agroecosystems and rural societies improving the returns on profit for farmers. This study is part of a PRIMA-funded project called TRANSITION - *Innovative Resilient Farming Systems in Mediterranean environments*", involving 10 partners among universities, research institutes, private companies, and a farmers' association from 6 Mediterranean countries (Spain, Italy, Greece, France, Egypt, and Algeria). Winter cereals and olive are among the main herbaceous and tree crops in the Mediterranean environment. Solar radiation is one of the limiting factors in both cereals and olive yield, therefore the optimization of solar radiation interception by the agroforestry systems comprising olive trees and winter cereals has a considerable importance to enhance the system efficiency. The study aims to evaluate the productivity and the light interception of an agroforestry system comprising olive trees and herbaceous crops, specifically winter cereals namely durum wheat (*Triticum durum*) landrace (Timilia), common wheat (*Triticum aestivum*) evolutionary populations (Mixwheat), and rye (*Secale cereale*) variety Irmanu. The field trial was carried out during the 2022-2023 growing season in a 4-year-old olive grove with trees spaced 5.5 m between the lines and 5 m along the line located on a mountainous site (970m a.s.l.) in Sicily (Italy). The lines of trees are along the East-West axis. The herbaceous crops were sowed on a 4.5 m strip between two adjacent lines of trees and in an adjacent field as monocropping control. The sowing of the herbaceous crops took place in January 2023. The amount of photosynthetically active radiation (PAR) intercepted by the trees and crops was measured using the ACCUPAR LP-80 PAR/LAI Ceptometer at different heights above the ground (below the tree canopy and below the herbaceous crop canopy) in several positions between the lines of trees. PAR interception by the trees was higher in the positions on the North side of a tree and along the strips on the North side of the line of trees. Rye reached the highest values of PAR interception in the middle strip, while it was highly affected by the shadows of the trees in the side strips close to the trees. Timilia was the least affected by the shadow of the trees in all the positions. The herbaceous crops produced lower yields in the agroforestry system in comparison to the monocropping system. Rye achieved the highest yields being able to intercept the highest amount of PAR due to the high leaf area index proving that it is the most suited cereal for olive tree agroforestry in the experiment

conditions (Mediterranean mountainous environment). The yield of the herbaceous crops varied significantly according to the sampling site between the lines of trees.

Spectral analysis as a tool for weed and crop identification

by Zineb Bennani | Giulia Papandrea | Marco Signorelli | Alessandro Beltramo | Ivan Di Furia | Silvia Fogliatto | Francesco Vidotto | Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA) University of Turin | Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA) University of Turin | Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA) University of Turin | Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA) University of Turin | Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA) University of Turin | Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA) University of Turin | Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA) University of Turin

Abstract ID: 74
Topic: Crop
Presenter Name: Zineb Bennani
Contribution: Post

Site Specific Weed Management (SSWM) has been largely recognized as a methodology to reduce herbicide use for a more sustainable weed management. Local application of herbicides, aided by weed mapping via remote sensing, may allow the reduction of herbicides without impact on yield production. However, in a context of minimizing the use of herbicides, a more knowledgeable approach is required, notably the identification of weed species via remote sensing. In this study, we assess weed recognition through hyperspectral data and spectral signatures collected in field conditions. Two studies were carried out in the Piedmont region (Italy). In the first study, three paddy fields were selected where the most prevalent and widespread weed species were identified and the spectral signature of the topmost leaf was recorded using a spectroradiometer. For each species, a minimum of 12 observations were collected. The second study was carried at the University of Torino experimental field in Grugliasco. Three annual crops and four weed species were selected and the spectral signature was recorded on 4 leaves per plant, 12 plants per species. The study covered the spectral signature of weed species *Amaranthus retroflexus*, *Chenopodium album*, *Digitaria sanguinalis*, *Echinochloa crus-galli*, *Persicaria lapathifolia*, *Polygonum* spp., and *Potentilla reptans* from the paddy fields and from the levees, and *Papaver rhoeas, Polygonum aviculare, Veronica hederifolia,* and *Avena fatua* from the second study. In addition, the spectral signatures of rice plants (*Oryza sativa*) at each location as well as of barley (*Hordeum vulgare*), wheat (*Triticum aestivum*), and oat (*Avena sativa*) were recorded. The spectral signatures were analyzed through a multivariate analysis and via indices including Normalized Difference Vegetation Index (NDVI) and Green-Red Vegetation Index (GRVI), and Photochemical Reflectance Index (PRI). The statistical analysis of the indices resulted in the categorization of species into homogeneous groups; the analysis of PRI allowed for the distinction between *O. sativa* and *E. crus-galli* while the analysis of GRVI allowed the distinction between cultivated and weedy oat (*A. sativa* and *A. fatua*). The study substantiates the potential of spectral analysis for the distinction between weed species, especially through the development of distinctive indices

through the multivariate analysis.

Weed biodiversity as affected by cultural practices estimated with conventional and innovative methods

by Zineb Bennani | Silvia Fogliatto | Giulia Papandrea | Lorenzo Barchi | Matteo Martina | Luciana Gaccione | Francesco Vidotto | Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA) University of Turin | Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA) University of Turin | Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA) University of Turin | Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA) University of Turin | Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA) University of Turin | Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA) University of Turin | Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA) University of Turin

Abstract ID: 75
Topic: Crop
Presenter Name: Zineb Bennani
Contribution: Post

The carry-over effect of cultural practices has been considered as a missing link in the quest for sustainable weed management. It can help discern their efficacy and improve future planning. In this study, we evaluate the impact of agricultural practices on a historic study over 31 years with the aim to study the effect of rotation and the amount and type of fertilization. The study was carried out in the experimental farm of the University of Torino in Carmagnola (Piedmont) and consisted of a randomized block experiment. In each of the three blocks, two cultural systems were tested: maize in rotation with Italian ryegrass and maize as a monocrop. Three fertilization methods used were: bovine slurry, farmyard manure, and urea, providing respectively 300, 300, and 400 kg/ha of nitrogen along with a non-fertilized control. Ten soil cores with a diameter of 3.5 cm were collected from each plot in three replicas for the assessment of weed seedbank. Two types of assessment were carried out: through the identification of emerged seedlings (germinable seedbank) and through DNA metabarcoding, which to our knowledge is the first time such a technique is used for this purpose. Through the germinable seedbank, the richness and density of weed species were calculated. Both the rotation and fertilization presented significant effect on the richness and abundance of weeds. The preliminary analysis shows that crop rotation resulted in the reduction of emerged weeds from 4700 to 2200 seedlings per m^2. Meanwhile, farmyard manure resulted in the highest weed abundance of 4400 seedlings per m^2 compared to an average of 3000 seedlings for the other fertilization treatments. The DNA metabarcoding study consisted of 100 g aliquots from each soil sample. The soil was airdried and conserved at room temperature. A preliminary testing step was necessary to find the adequate methodology (DNA extraction, primer selection, PCR protocol). The initial results showed that DNA metabarcoding was successful in detecting up to 90% of the recorded species via the germinable seedbank. Moreover, other species were detected which can provide a deeper insight into the biodiversity of the plots over the years, which can be matched with the field’s history.

Crop elicitation approach to enhance bioactive contents in medicinal and aromatic plants

by Enrico Toschi | Giovanni Dinelli | Camilla Tibaldi | Eros D\'Amen | Mattia Alpi | Elettra Frassineti | Ilaria Marotti | Università di Bologna | Università di Bologna | Università di Bologna | Università di Bologna | Università di Bologna | Università di Bologna | Università di Bologna

Abstract ID: 77
Topic: Crop
Presenter Name: Enrico Toschi
Contribution: Post

Production techniques of medicinal and aromatic plants (MAPs) are constantly evolving, due to both compliance with increasingly stringent health regulations and the need to obtain a product with a high content in active compounds as required by the market. It is necessary to search for increasingly innovative and sustainable techniques to improve cultivation processes. Crop elicitation is a widely used technique for the improvement of active ingredient contents by stimulating the production of plant secondary metabolites. Carbohydrates and phytohormones represent one of the most widely used classes of elicitors as bio-stimulants. The aim of the present research was to evaluate the effect of two elicitors, specifically chitosan hydrochloride and salicylic acid, in the improvement of active compounds in three MAPs, *Melissa officinalis* L., *Passiflora incarnata* L. and *Echinacea purpurea* L. Field trials were conducted at Agribioenergia company located in the Emilia-Romagna region, Italy (Medicina, BO,44°28'46"56 N 11°38'20"76 E 25 a.s.l) in 2023 according to a randomized complete block design with salicylic acid and chitosan in one concentration and three replicates. The seeds of the plants were grown in greenhouse and transplanted to the field before the four-leaf stage (between March and April). The first foliar application was performed in the seven-leaf stage, followed by other treatments, eight-days after the previous one, for a total of four treatments. Three days after the last foliar application, the plants were harvested and the total yield per treatment was determined. Leaf samples were then dried for subsequent analyses, i.e total polyphenol (TP), total flavonoids (TF), antioxidant activity (DPPH), content of rosmarinic acid for *M. officinalis*, vitexin for *P. incarnata*, cichoric acid for *E. purpurea*. One-way analysis of variance (ANOVA) in conjunction with Tukey's honest significant difference was performed for comparing the two treatments on the three plants species. Results showed that foliar application of chitosan and salicylic acid did not affect the total yield both for the fresh and dry weight in each species. Chitosan foliar application is influential in stimulating the production of secondary metabolites such as polyphenols and flavonoids in all the three species although with no statistical evidence; the same trend was observed for the antioxidant activity. Application of chitosan resulted in a 20% increment in rosmarinic acid content in *M. officinalis* whereas it did not affect the content in vitexin and cichoric acid in *P. incarnata* and *E. purpurea*, respectively. Salicylic acid foliar application did not affect the production of secondary metabolites in *M. officinalis* and *E. purpurea*. On the other hand, the same treatment showed a positive impact on the production of total polyphenols and

flavonoids and resulted in a 18% increase in vitexin content. To conclude, results obtained so far are encouraging but additional data coming from more years of experimentation (2024 and 2025) will give additional insight on the potential of crop elicitation approach for MAPs cultivation.

Bioherbicide: Organic acids and essential oil for weed managment

by Mattia Alpi | University of Bologna

Abstract ID: 79
Topic: Crop
Presenter Name: Mattia Alpi
Contribution: Post

Due to climate change, weed control is facing new challenges, in order to react to new and different exotic and herbicide resistance species. In addition, the need to reduce environmental and human health impacts, opened the way to the necessity to find new techniques and management strategies to minimize the use of synthetic herbicides. An emerging weed control technique for sustainable agriculture is integrated weed management, which includes the use of bio-herbicides such as biotic agents, natural compounds (allelochemicals, organic acids, essential oil), and nanoparticles. The aim of this study is to evaluate the potential herbicide effects of different organic acids (acetic acid, pelargonic acid, lactic acid and citric acid) and essential oil (eugenol and geraniol) on seeds and plants of 9 different species, which include crops and weeds. In addition, different concentrations (5%, 10%, 20%), irroration volume (200 lt/ha and 300 lt/ha), application method (irroration and wetting) and different adjuvant were evaluated. Germination test were carried out with a randomized plot scheme with 3 replicates for each compound and concentration in petri plates with agar substrate, and different tested compounds were sprayed on 20 seeds at the volume of 2000 lt/ha. Petri plates were incubated at 20°C and 12:12 photoperiod in phytotron for 7 days. In order to better imitate farm conditions, germination tests were evaluated with the same conditions in phytotron with commercial soil, where seeds were sown 2 cm depth in soil and treatment were sprayed directly on the substrate. Pots were incubated and seed germination were evaluated after 10 days for all the treatments. In order to understand the potential herbicide effects for cover crops termination purposes, treatments were evaluated on adult plants of different species in greenhouse conditions. Seeds were sown in 40x20x15 cm pots at different density specific for every species, in commercial substrate. At day 21 (t0) photo of different plots were taken and different treatments were utilized on plants at different concentrations, volume and application methods. Efficacy were evaluated analyzing the reduction of green biomass at day 24 (t1) and day 30 (t2). In addition, plant fresh and dry weigh were evaluated at day 30. As expected, the mean highest effect for all analyzed species concerning seeds germination inhibition, was shown by 20% concentration treatments, followed by 10% and 5%. In details, the highest germination (0,86) and the lowest (0,19) inhibition index was obtained for 20% acetic acid and 5% citric acid, respectively. However, for millet (0,82) and ryegrass (0,95) pelargonic acid 20% shown major inhibition germination index. For adjuvant formulations, the combination of acetic acid 20% and camelina oil had the best results (0,61). Concerning effects of treatments on plants, Acetic acid 20% with sprayed application method at the dose

of 300 lt/ha allowed to obtain a significative reduction on green biomass. Further experimentation on selected treatments and practices in open field trials will be tested, to check treatments technical parameters and feasibility, in order to develop new and more sustainable compounds for weed management to reach Eu 2030 goals.

Evaluation of herbicidal potential of extracts from pruning leftovers and food processing by products

by Beltramo Alessandro | Papandrea Giulia | Bennani Zineb | Cravotto Giancarlo | Di Furia Ivan | Vidotto Francesco | Fogliatto Silvia | Università degli Studi di Torino - DISAFA | Università degli Studi di Torino - DISAFA | Università degli Studi di Torino - DISAFA | Università degli Studi di Torino - DSTF | Università degli Studi di Torino - DISAFA | Università degli Studi di Torino - DISAFA | Università degli Studi di Torino - DISAFA

Abstract ID: 83
Topic: Crop
Presenter Name: Fogliatto Silvia
Contribution: Post

Herbicides are essential tools for weed control in conventional farming systems. Nevertheless, they have some relevant drawbacks, such as the risk of environmental pollution and the selection of resistant weed populations. A potential alternative to herbicides can be products of natural origin, especially if they can be produced within a framework of circular economy. In this, context, a study was carried out with the aim of evaluating the effect of different substances of natural origin extracted from different parts of plants or from by-products of food processing. The tested products were: (i) coffee extract: obtained from concentrated coffee production waste; (ii) extracts from grapevine stems and leaves: obtained from the pruning of different varieties (Dolcetto, Chardonnay, Barbera taken alone or mixed), infected with the phytoplasma disease *Flavescence Dorée* which had to be destroyed. Extractions were carried out under subcritical water conditions (30 min at 150°C). The effect of the extracts on seed germination was tested on some of the most common weed species found in Italian cropping systems: *Digitaria sanguinalis*, *Echinochloa crus-galli*, *Setaria viridis* and *Veronica persica* and on *Lactuca sativa* as a sensitive crop. In both experiments, twenty seeds per species were placed in Petri dishes lined with one filter paper imbibed with 5 mL of deionized water (control) or extracts in their original concentration. At least three replicates were prepared for each species for both the control and the extracts and arranged in a completely randomized design. Petri dishes were incubated for 14 days at constant 25°C with a 12 h photoperiod and germination was recorded daily. The two experiments were repeated twice. Coffee extract was also tested in the greenhouse as foliar application on some monocot and dicot weeds grown in pots and treated with either extract or water (control) at 2-3 leaf stage. Seven days after treatment, visual efficacy as a percentage of damage compared to control and the plant fresh biomass of treated and control plants were determined. The germination test conducted with coffee extract show a significant difference on germination (compared to the control) only for *D. sanguinalis* (19% germination reduction) and for *S. viridis* (16% germination reduction), while for *L. sativa*, *E. crus-galli* and *V. persica* no significant differences were highlighted. Foliar application of coffee extract did not show significant differences with the control for all weeds. Vine extracts show a high variability in terms of total germination for most of the species. A significant difference between Barbera extract

and control was highlighted in both replicates of the experiment for *D. sanguinalis* and only in the second one for Dolcetto extract. *L. sativa* showed a significant difference between Dolcetto extract and control. The studies showed that the tested substances of natural origin can have a potential herbicidal effect, even though a great variability among weed species was observed.

Modelling cropping systems of case study farms to assess nitrogen use efficiency and circularity of Diary Production Systems

by Nicola Alessi | Serena Bonizzi | Marco Botta | Mara Gabbrielli | Maddalena Enrica Zucali | Anna Alfea Sandrucci | Federico Dragoni | Giorgio Ragaglini | Leonardo Vario | Department of Agricultural and Environmental Sciences Università degli Studi di Milano | Department of Agricultural and Environmental Sciences Università degli Studi di Milano | Department of Agricultural and Environmental Sciences Università degli Studi di Milano | Department of Agricultural and Environmental Sciences Università degli Studi di Milano | Department of Agricultural and Environmental Sciences Università degli Studi di Milano | Department of Agricultural and Environmental Sciences Università degli Studi di Milano | Technology Assessment and Substance Cycles, Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB) | Department of Agricultural and Environmental Sciences Università degli Studi di Milano | Department of Agricultural and Environmental Sciences Università degli Studi di Milano Milano

Abstract ID: 85
Topic: Crop
Presenter Name: Nicola Alessi
Contribution: Post

Dairy Production Systems (DPS) are of pivotal importance within the European agricultural sector. However, intensification of DPSs is raising many concerns about their sustainability. For years, the debate has focused on how to reduce impacts caused by nitrogen associated emissions, and large efforts were put on implementing policies and developing technologies fitting with environmental goals. Recently, the transition towards circular economy has raised up the interest on the potential role of livestock as a key loop for nitrogen cycling in agriculture, as ruminants, in particular, allow the conversion of fibrous matters in high quality proteins while producing organic fertilizer, as valuable source of nitrogen for crops. However, whether circularity is an effective meant for sustainability is still an open question. The DairyMix project has the objective to assess the extent to which DPS can contribute to the replacement of exogenous sources of nitrogen as well as which are the trade-offs between environmental and economic goals. To the scope we propose a holistic approach, based on the analysis of dairy farm case studies, by means of the cropping system model ARMOSA. ARMOSA was used to forecast the response curve of different crop rotations, under farm specific conditions, in terms of dry biomass production, nitrogen uptake and losses to increasing levels of nitrogen application, including mineral fertilizer and manure. In Italy we considered six dairy farms of the Lombardy region, varying in terms of utilized agricultural area (from 30 to 270 ha), livestock density (from 2.12 to 7.32 LSU ha^{-1}) and milk production (from 4,945 to 11,830 kgFPCM $head^{-1}$ yr^{-1}). Each farm employs different crop rotations to produce forages for animal feeding. Farm data was collected during technical visits and by means of specific questioners focusing on: land utilization and crop rotations, crop management practices and yield. All this information was used for the set-up of simulations and for ARMOSA parametrization. Model parameters was tuned in order to fit simulated crop biomass production and N uptake with data collected through the

farm surveys. For meteorological data we used the long-term series from AGRI4CAST (1979-2023), while for soil initialization we used profile data from the ERSAF soil database, considering more profiles per farm, in order to represent the range of variability of farm soils. After parametrization we built a modelling exercise aimed at exploring the response curve of dry biomass, Net Energy of lactation (Nel) and Crude Protein (CP) produced under increasing levels of nitrogen applied for crop fertilization. Overall, we simulated 20 rotations under 10 levels of nitrogen rates varying from 0 to double of the N rates declared by the farmers. We analyzed the response curves at crop, rotation and farm level in order: i) to assess the N use efficiency under the farm N rates, ii) to evaluate whether the farm N rates exceed the carrying capacities of the system; iii) to estimate the availability of manure surplus under optimized N rates; iv) to assess the reduced impact in terms of N losses under optimized N rates.

Permanent Legume Living Mulches for supporting the Adoption of Organic farming principles on Conservative Vegetable Systems

by Federico Leoni | Stefano Carlesi | Daniele Antichi | Christian Frasconi | Anna-Camilla Moonen | Istituto di Scienze delle Piante, Scuola Superiore Sant\'Anna | Istituto di Scienze delle Piante, Scuola Superiore Sant\'Anna | CiRAA – Centro di Ricerche Agro-Ambientali \"Enrico Avanzi\" | CiRAA – Centro di Ricerche Agro-Ambientali \"Enrico Avanzi\" | Istituto di Scienze delle Piante, Scuola Superiore Sant\'Anna

Abstract ID: 86
Topic: Crop
Presenter Name: Federico Leoni
Contribution: Post

Conservation agriculture has the potential to increase soil health in organic farming. Nevertheless, the prospect of weed-related challenges frequently discourages farmers from adopting it. Organic and conservative vegetable systems (ORGANI-CA), advocates moving away from direct weed control methods and instead prioritize weed preventive agroecological approach based on the maintenance of the soil coverage to ensure a constant weed competition and promote more diverse weed community, thereby minimizing adverse effects on crops. The use of a permanent living mulch of legumes (pLM) can decrease niche availability for weeds and can improve soil fertility at the same time. Vegetable crops can be transplanted directly into the sward or following strip tillage. However, little is known about the effect of these permanent mulches on the weed community's composition, diversity and competitive ability. Similarly, little is known about the role the living mulch composition plays in determining crop performance. In this experiment we evaluated performance of eight legume living mulch mixtures based on the combination of different ecotypes and cultivars of perennial (*Trifolium repens* (TR) and *Lotus corniculatus* (LC)) and annual self-seeding legumes (*Trifolium subterraneum* (TS) and *Medicago polymorpha* (MP)) on vegetable crops established into the living mulch with strip tillage. Living mulch performance and mixture composition dynamics were evaluated alongside a typical vegetable crop rotation including broccoli (*Brassica oleracea* var Italica) – eggplants (*Solanum melanogena*) – fennel (*Foenicum vulgare*) – tomato (*Solanum lycopersicum*). The objective of the mixtures is to combine the unique traits of perennial and annual self-seeding legume species in a complementary manner, ultimately enhancing the desired services such as vegetable yield and quality as well as weed control and weed community dynamics throughout the entire crop rotation. Results on the effects of pLMs on the vegetable crops show that without the use of external source of fertilizers and reduced tillage, a sufficient marketable yield production, at least equal to the control (CNT) where fertilizers and tillage were used, can be achieved. For broccoli, the pLM mixture LC-TS guaranteed similar marketable yield as CNT (5.31 vs 4.78 fw t/ha) whereas for other pLMs, the yield was generally lower than in CNT. For eggplant, all TR-MP mixtures showed equal yields compared to CNT (21.3 vs 23.2 fw t/ha). However, LC-TS, differently on what was

observed in broccoli, resulted in a significantly lower eggplant yield (11.5 vs 23.2 fw t/ha). For fennel, no significant effect was observed compared to the control. The marketable yield of fennel was generally very low due to two days of saline wind causing severe damage. Throughout the years the pLM showed a progressive reduction in the annual self-seeding component. At the same time there was an increase in weed biomass mainly caused by an increasing abundance of perennial species such as *Picris echioides*, *Plantago lanceolata*, and perennial grasses.

Remote sensing tools to spatialize forage biomass predictions in extensive pasture systems

by Luca de Guttry | Martina Natali | Luisa Leolini | Christian Massari | Sara Modanesi | Sergi Costafreda-Aumedes | Nicolina Staglianò | Marco Moriondo | Giovanni Argenti | Camilla Dibari | Dipartimento di Scienze e Tecnologie Agrarie, Alimentari, Ambientali e Forestali (DAGRI) Università degli Studi di Firenze | Dipartimento di Ingegneria Civile e Ambientale Università degli Studi di Perugia; Consiglio Nazionale delle Ricerche - Istituto di Ricerca per la Protezione Idrogeologica (CNR-IRPI) | Dipartimento di Scienze e Tecnologie Agrarie, Alimentari, Ambientali e Forestali (DAGRI) Università degli Studi di Firenze | Consiglio Nazionale delle Ricerche - Istituto di Ricerca per la Protezione Idrogeologica (CNR-IRPI) | Consiglio Nazionale delle Ricerche - Istituto di Ricerca per la Protezione Idrogeologica (CNR-IRPI) | Consiglio Nazionale delle Ricerche – Istituto per la BioEconomia (CNR-IBE) | Dipartimento di Scienze e Tecnologie Agrarie, Alimentari, Ambientali e Forestali (DAGRI) Università degli Studi di Firenze | Consiglio Nazionale delle Ricerche – Istituto per la BioEconomia (CNR-IBE) | Dipartimento di Scienze e Tecnologie Agrarie, Alimentari, Ambientali e Forestali (DAGRI) Università degli Studi di Firenze | Dipartimento di Scienze e Tecnologie Agrarie, Alimentari, Ambientali e Forestali (DAGRI) Università degli Studi di Firenze

Abstract ID: 87
Topic: Crop
Presenter Name: Luca de Guttry
Contribution: Post

In light of the economic relevance (e.g., forage production) and the ecological significance (e.g., carbon stocking and biodiversity conservation) of extensive grassland systems, the rational management of forage resources is a key aspect in maintaining both their productivity and environmental advantages. In this context, remote sensing and modelling tools can provide detailed information on the state of forage resources over large areas. Therefore, in this study we present a spatialized version of an existing grass growth simulation model (VISTOCK, Bellini et al., 2023), further improved by Leolini et al. (GRASSVISTOCK, *submitted*), applied in a 7 ha-pasture located in the Tuscany region (Borgo San Lorenzo, Florence, IT, 200 m a.s.l.). The model simulates aboveground biomass (AGB, g/m^2 of dry matter) and soil water dynamics (mm of available transpirable soil water) of extensive grasslands relying on meteorological and soil inputs and remotely sensed derived Leaf Area Index (LAI). Sentinel-2 images (level-2A, ~ 50 images/year) were used for calculating the Normalized Difference Vegetation Index (NDVI) and subsequently linearly interpolated over time to obtain a daily time series for the simulation period (2020-2022). LAI was derived from NDVI using the procedure of Bellini et al. (2023). Consequently, the spatialization of the predictions was obtained at a daily time-step over a 10x10 m grid by forcing the model with LAI values for each pixel. The validation was performed on ground measurements of AGB represented by 80 observations collected over the whole pasture during the period 2020-2022. Initial results evidence that additional model implementations are still required ($r=0.43$; RMSE=50 g/m^2). Specifically, AGB tends to be generally underestimated by the model. However, the relatively low RMSE indicates that simulated values are presumably close to the observed measurements. Furthermore, remotely sensed

derived LAI levels off around a value of 3.5 m^2/m^2, likely due to the saturation of NDVI occurring for high LAI levels. Arguably, this may be one of the factors limiting the model's ability to accurately predict AGB. This limitation can be overcome using other vegetation indices (e.g. MCARI2, MTV2 or NRDE), which may be better predictors of LAI (Haboudane et al., 2004). Nevertheless, optical imagery is typically hindered by cloud cover, which reduces the availability of data, thus adding uncertainties during the interpolation phase. A viable option may be using backscattering observations from radar satellites (e.g. Sentinel-1), which are unaffected by clouds and carry information on the vegetation structure and water content. Preliminary results show that Sentinel-1 data have a good potential to improve LAI estimates, thanks to the higher temporal availability of images and the exploitation of machine learning approaches.

Retrieval of Paddy Rice Agronomic Traits from Field Hyperspectral Spectroscopy

by Rodolfo Ceriani | Mirco Boschetti | Gabriele Candiani | Monica Pepe | Francesco Nutini | Fosco Mattia Vesely | Anne Schucknecht | Pardis Siroosi | Stefano Bocchi | Francesco Fava | Department of Environmental Science and Policy, Università degli Studi di Milano; Department of Agricultural and Environmental Sciences, Università degli Studi di Milano | Institute for Electromagnetic Sensing of the Environment, Italian National Research Council | Institute for Electromagnetic Sensing of the Environment, Italian National Research Council | Institute for Electromagnetic Sensing of the Environment, Italian National Research Council, IT | Institute for Electromagnetic Sensing of the Environment, Italian National Research Council | Department of Environmental Science and Policy, Università degli Studi di Milano | Image Simulation and Processing Team, OHB System AG | Department of Environmental Science and Policy, Università degli Studi di Milano | Department of Environmental Science and Politicy, Università degli Studi di Milano | Department of Environmental Science and Policy, Università degli Studi di Milano

Abstract ID: 92
Topic: Crop
Presenter Name: Rodolfo Ceriani
Contribution: Post

Adaptative agronomic management strategies require timely information about crop status. Quantifying the crop's inputs requirements helps avoiding both excessive and insufficient supply, thereby increasing homogeneity in productive quality and quantity across the field. Hyperspectral remote sensing, which measures crop reflectance in the visible, near-infrared and short-wave infrared (350 to 2500 nm) regions, in hundreds of spectral bands, has been widely proposed as a non-destructive technique to retrieve agronomic traits reflecting crop biomass and nutritional status and as an alternative to time-consuming and labour-intensive traditional field measurements. Nonetheless, field measurements provide point data, while airborne imaging spectroscopy is expensive. Thus, these technologies still have limited direct applications for precision crop management or environmental monitoring. Last-generation experimental hyperspectral satellite missions, such as PRISMA (PRecursore IperSpettrale della Missione Applicativa) or EnMAP (Environmental Mapping and Analysis Program), provide remote sensing imagery at high spatial (30m) and spectral resolutions (about 10 nm). This opens up unprecedented opportunities to develop remote sensing applications for crop monitoring and adaptative farming management. The overall goal of this research is to evaluate the potential of hyperspectral satellite remote sensing to monitor paddy rice biomass and nitrogen content at field scale. To this end, during the summer season 2023, from early July to the end of September, we conducted three field campaigns in rice paddies located in Jolanda di Savoia (FE, Italy) to collect hyperspectral measurements and agronomic data, including aboveground biomass (AGB), leaf area index (LAI) and nitrogen content (N). Data were collected across 10 elementary sampling units (ESU) of 60x60 m^2 (corresponding to 4 EnMAP/PRISMA satellite pixels). Within each ESU, measurements were taken on four plots (i.e., 40 plots for each campaign). Multiple EnMAP and PRISMA satellite images were also acquired on the study area during the rice growing

season. The initial phase of the study, presented in this abstract, has been the development of machine learning (ML) models between field hyperspectral and agronomic data at plot scale. The objective was to test robust retrieval methodologies for AGB, LAI and N and to identify spectral features sensitive to the target variables. First, we applied a Principal Component Analysis (PCA) to reflectance spectra to reduce the data dimensionality and identify key spectral bands. Then, a Gaussian Process Regression model (GPR) was trained with a Bayesian optimization (to reduce the time required for training). The preliminary results show good predictive performance (assessed by k-fold cross-validation) for AGB [g/m2] (R2: 0.81, RMSE: 683.00), LAI [m2/m2] (R2: 0.88, RMSE: 0.59) and N content [g/m2] (R2: 0.85, RMSE: 2.35) retrieval. The next phase will be testing a similar methodology on EnMAP/PRISMA images acquired during the field campaigns to generate AGB, LAI and N maps at both field and farm scales.

Advancing Sustainable Agriculture with Biological Nitrogen Fixation: Insights from Utrisha N/BlueN® Trials in Europe

by Bosco, Valentino | Mascanzoni, Elisa | Dzikowski, Marcin | Ceruti, Matteo | Corteva Agriscience | Corteva Agriscience | Corteva Agriscience | Corteva Agriscience

Abstract ID: 93
Topic: Crop
Presenter Name: Mascanzoni, Elisa
Contribution: Post

In the context of increasing environmental concerns and rising fertilizer costs, the agricultural sector is exploring sustainable alternatives to traditional nitrogen fertilization methods. One promising approach is the use of biological nitrogen fixation facilitated by microbial biostimulants. This review examines the application of Utrisha N/BlueN®, containing the nitrogen-fixing bacterium *Methylobacterium symbioticum*, across various crops and climatic conditions. In winter wheat, the largest global cereal crop, trials across the EU demonstrated that Utrisha N/BlueN® could be effectively integrated into nitrogen management plans, offering flexibility in application timing and contributing to high yield and quality.

Potato cultivation, covering over 30 million hectares globally, also benefits from the application of Utrisha N/BlueN®. Trials indicated that foliar application at the row-closing stage significantly improved tuber initiation, chlorophyll content, yield, and quality. For winter oilseed rape, a crop with substantial nitrogen demands, Utrisha N/BlueN® was applied during various stages of growth. The product supplied ammonium nitrogen directly to the leaves, offering an environmentally safe alternative to soil-available nitrogen. The flexibility in application timing, tailored to local conditions, ensured effective colonization and positive impacts on crop development and yield. Additionally, the application of Utrisha N/BlueN® in corn cultivation has shown promising results. Corn, being a high nitrogen-demanding crop, benefits significantly from the enhanced nitrogen availability provided by Utrisha N/BlueN®. Trials have demonstrated that this biostimulant not only improves the overall nitrogen efficiency of the crop but could also enhances several growth parameters and ultimately, grain yield. Overall, the application of Utrisha N/BlueN® across these diverse crops demonstrates its potential as a dependable and sustainable nitrogen management tool. This approach not only supports the nutritional needs of crops but also aligns with global efforts to reduce the environmental footprint of agricultural nitrogen use.

Phytoremediation potential of medicinal and aromatic plants for nickel-contaminated soils

by Elettra Frassineti | University of Bologna

Abstract ID: 95
Topic: Crop
Presenter Name: Elettra Frassineti
Contribution: Post

In a considerable percentage of agricultural land in the Mediterranean region, Nickel (Ni) exceeded 50 mg/kg, and the risk for crop production, ecological and human health is expected to be due to Ni in agricultural soil. The potentially toxic effect of Ni in soil on some crops imposes a strategy of intervention to reduce contamination. Phytoremediation treatments use indigenous or exogenous plants to restore the soil or other environmental matrices. Many medicinal and aromatic plants (MAPs) may accumulate relatively high concentration of toxic metals in their shoots. Physiological mechanisms involved in remediation processes may allow the safe use of MAPs for human consumption while removing contaminants from soil or water. The two MAPs *Hypericum perforatum* L. and *Melissa officinalis* L. are considered Ni tolerant and hyperaccumulating plants, valuable for soil restoration processes. The current study was aimed to evaluate the potential impact of Ni contaminated soil on the adaptability, growth, and phenolics biosynthesis of the two selected MAPs. Ni translocation, plants metal uptake capacity and effect on soil have been investigated. For this purpose, plants were grown in controlled environment since numerous environmental variables may be eliminated. Soil was collected in an experimental farm located Bologna (30% clay, 20% loam, and 50% Sand), were analyzed for total mineral content and physicochemical parameters, before the beginning of trials. Soil was contaminated with Ni $(NO_3)_2 6H_2O$ to reach 100 ppm and 300 ppm, values below and above the D.legs 125/2006 threshold respectively, and a control for each species was provided. A randomized plot scheme with 3 replicates for each condition was adopted. In plant growing phase, greenhouse parameters were set as follows: temperature 25/20°C day/night, photoperiod 14-h light/10-h dark, and plants were irrigated with a nutritive solution composed by ¼ Hoagland solution. The effects of metal contamination on growth (green cover area, growth index), stress parameters (chlorophyll and proline content), qualitative compounds, and antioxidant activity of extracts (DPPH test) 30 days up to 120 days after plants transplant at 30-day intervals had been assessed. Total biomass and essential oil (EO) yields were obtained by harvesting fresh leaves at the end of cropping cycle for each species and condition. For both species Ni content in soil decreased in 300 ppm condition, on the other hand no effects were observed for 100 ppm soils. Both crops well tolerated Nickel contamination in terms of green cover area, growth index and stress parameters, with values comparable to the literature. Biomass yield was not affected by contaminants reaching estimated values of 1187 and 1154 kg/ha for *M. officinalis* and *H. perforatum*, respectively. EO yield significantly increased in plants under Ni stress condition for both

crops, with 0.08% and 0.26 % for *M. officinalis* and *H. perforatum*, respectively. Concerning total phenolics (2244 and 1860 mg/100g GAE for *M. officinalis* and *H. perforatum*, respectively) and antioxidant activity (182 and 173 mmol TE/g for *M. officinalis* and *H. perforatum*, respectively) highest values were obtained under Ni stress conditions for both texted MAPs. Analyses on a second-year experimentation are in progress.

Identification and characterization of agronomic performance of resilient genotypes

by Sara Bosi | Lorenzo Negri | Giulia Oliveti | Marco Sangiorgi | Rocco Enrico Sferrazza | Giovanni Dinelli | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna | Alma Mater Studiorum Università di Bologna

Abstract ID: 97
Topic: Crop
Presenter Name: Sara Bosi
Contribution: Post

Climate change has already negatively affected the agricultural sector in Europe, and this is set to continue in the future (EEA, 2019). The overall impacts of climate change on European agriculture could imply a significant loss for the sector, approximately 16 % by 2050, with large regional variations (EEA, 2019). On a national scale, Italy is at high risk for climate change, due to a high susceptibility to climate change impact, especially related to drought crisis, more frequent in the summer season. In the southerly regions the resulting probable lower realized on-farm maize grain and bio-mass yields must be safeguarded. Finally, aflatoxin contamination is considered as a main emerging issue related to maize grown in Europe. The future climate change scenario of +2 °C above pre-industrial levels hypothesized for Europe is considered realistic and could change several plant-pathogen interactions in the whole continent (Battilani et al., 2016). The overall objective of the CERTI project, funded by the Emilia Romagna region as part of the PSR-GOI 2022, is to evaluate the agronomic performance and adaptability to climatic change of summer cereals such as sorghum (*Sorghum bicolor*) and millet (*Panicum miliaceum*), assessing their adaptability to climatic conditions characterized by warmer temperatures and reduced rainfall. In the 2023 season, 20 sorghum hybrids and 32 millet genotypes were compared in field trials according to a randomized block experimental scheme with 2 replications. During and at the end of the field trial, the following traits were measured: phenology (anthesis, physiological maturity); green canopy cover by digital imaging to estimate radiation interception, water use and senescence; lodging incidence; canopy temperature from anthesis to maturity; SPAD index from anthesis onwards as a proxy value for photosynthetic capacity; grain yield and grain yield components; harvest index; diseases susceptibility. Although the 2023 crop year was particularly difficult due to excessive rainfall at the beginning of the cycle, the different sorghum hybrids showed adaptability to adverse weather conditions compared to corn (+97%). A similar trend was observed for millet, which showed excellent resilience characteristics, rapid crop ground cover and higher yield potential for early genotypes (4.0 t/ha) than for intermediate and late accessions (3.2 t/ha and 3.1 t/ha, respectively). Further studies will be needed to validate the identified traits and the most promising accessions.

Wheat-pea intercropping for forage production in an agroforestry system

by Silvia Pampana | Daniele Antichi | Nicola Silvestri | Nicola Grossi | Leonardo Ercolini | Lorenzo Gabriele Tramacere | Giovanni Rallo | Fatma Hamouda | Angela Puig Sirera | Marco Carrara | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa

Abstract ID: 100
Topic: Crop
Presenter Name: Silvia Pampana
Contribution: Post

Climate change is predicted to adversely affect forage yield and quality. Grass-legume intercropping has been reported not only to increase forage production and quality, but also to better use available soil water, reduce run-off, and increase the yield per unit water. However, cereal and legume crops may experience more intense competition for water and nutrients under drought. Agroecological solutions like agroforestry could mitigate this constraint because trees can provide shade for the crops, and protect the soil from drying out and erosion. Moreover, hydraulic and nutrient lift may happen because of the tree roots, thus making water and nutrients more accessible also for herbaceous crops. In the present research, we compared the agronomic performances of a common wheat (*Triticum aestivum* L., cv Ludwing)/field pea (*Pisum sativum* L., cv Audit) intercropping grown both with (i.e., SILVO-ARABLE) and without trees (i.e., ARABLE), at different N fertilization rates. In 2023 the rainfed field plot experiment was established at the Centre for Agri-Environmental Research “Enrico Avanzi” of the University of Pisa, Italy (43°41’07.6” N 10°20’32.2” E) on a loam soil with pH of 8.1 and 1.69 % w/w of organic matter content.

In the SILVO-ARABLE system, 3-yr old poplar trees (*Populus* × *euramericana* (Dode) Guinier clone I-214) planted in single rows, North-South oriented, were growing between the ditch and the crop. The mixture was fertilized with 0, 70, and 140 kg N ha-1, applied half at tillering and half at stem elongation stage. The experimental design was a two-factor randomized complete block design with three replicates. The field was ploughed in September at 0.3 m depth. 120 and 150 kg ha-1 of P2O5 and K2O were broadcast applied as triple superphosphate and potassium sulphate. The mixture was sown on 2nd February at 240 and 180 kg ha-1 seed rate for pea and wheat, respectively. At pea flowering (29th April), the forage yield was appraised by sampling two areas of 0.25 m2 per plot. Here, we report the first agronomic results on forage yield. The cropping system differently affected the biomass produced by field pea, depending on N fertilization. Without N fertilization, pea yielded similarly in the two systems, but with the medium N rate (70 kg ha-1) pea and total biomass were 20% higher in the SILVO-ARABLE system, while the reverse was true with the highest N rate. Conversely, wheat biomass and proportion were linearly boosted by N fertilization in both systems. Our findings show that agroforestry can maintain significant forage yield at moderate N fertilization rates, besides providing additional ecosystem services. Acknowledgements. This study was carried out within the National Research Centre Agritech 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).

Optimization strategies to diversify food cropping systems: two-year results with protein crops across Europe

by Gabriela Alandia | Nisha Sharma | Signe Marie Jensen | Fulai Liu | Harm Brinks | Johan Wander | Dragica Grozdanic | Lucia Sanchez | Daniel Marusig | Gemini Delle Vedove | University of Udine | University of Udine | University of Copenhagen | University of Copenhagen | Delphy | Delphy | Beotanics | INTIA | University of Copenhagen | University of Udine

Abstract ID: 104
Topic: Crop
Presenter Name: Gabriela Alandia
Contribution: Post

The production of plant protein responds to the Farm to Fork policy strategy for building sustainable food systems. However, farmers face different challenges in order to achieve stable yields. The first work package of the Smart Protein EU project focused on plant protein crop production. Besides the screening of four plant protein species i.e. quinoa, fava bean, chickpea and lentils, the project aimed to validate and test different optimization strategies to support productivity enhancement across Europe. The activities took place in seven countries of north and south (Ireland, Denmark, The Netherlands, Italy, Spain and Portugal). The presentation proposed summarizes the main findings of experiments taking place in 2021 and 2022. In the Netherlands, the application of chemical control for diseases in fava beans showed significantly higher yields (in average 42% more) when compared with the control (non-treated cultivars). Interestingly, there were genotypes that reached 5 t ha^{-1} without chemical control that achieve potential plant protein yields of 1.35 t ha^{-1}. Additionally, a decision support system for farmers (Best4Soil) was validated and forecasted low levels (0 – 15%) of soil borne pathogens when fava bean is planned to be introduced in the crop rotation. The combination of different weed control strategies was tested in Denmark and in Spain. In Denmark, the sowing date (separated of one week) together with the implementation of a false seed bed were evaluated in 2021 in quinoa, fava beans and lentils. Drone images results did not show a significant difference of the weed coverage present in the three species during the first stages of growth (30 DAS). The early direct sowing showed in average higher coverage of weeds (13%) compared to the coverage on the late sowing and the early and late false seed beds that averaged (5%). In Spain, the combination of intercropping and harrowing was evaluated in a farm producing organic chickpea. Results of weed sampling showed that harrowing reduced weeds by 42%, whereas intercropping chickpea with spring wheat reduced weeds by 34%. Moreover, the combination of intercropping + harrowing, reduced weeds by 70%. Also in Spain, the effect of harrowing time + number of passes was evaluated in an organic farm producing lentils. Results showed that early harrowing was more effective for weed control than late harrow passes (55% vs 30% with one pass and 64% vs 35% with two passes). Intercropping of lentils and oats was evaluated in Denmark and in The Netherlands in 2021. In both countries, precipitations before the harvesting period resulted in low yields due to seed shattering. Nevertheless, a positive effect of intercropping was observed in The Netherlands

through significantly higher yields (by 59%) compared to the monocropping system and in Denmark through LER >1 values for the intercropping. Finally, Italy showed that drip irrigation can support lentil production enhancing yields by 24%. The diversification of food cropping systems also requires the diversification of crop management practices. The combination of different strategies can lead to support and enhance yield stability.

Evaluation of the Local Rye "Secena": Environmental Resilience and Potential in the Agro-Food Chains of the Matese Regional ParkRye

by Enrica De Falco | Gabriele Maria Cioffi | Sofia Del Gaudio | Viscardi Antonio | Antonella Vitti | Pellegrino Alfieri | Università degli Studi di Salerno | Università degli Studi di Salerno | Università degli Studi di Salerno; Università della Basilicata | Università degli Studi di Salerno | Università degli Studi di Salerno; Università della Basilicata | Università degli Studi di Salerno

Abstract ID: 105
Topic: Crop
Presenter Name: Enrica De Falco
Contribution: Post

Rye (Secale cereale L.) has been the basis of agriculture for centuries in most of the mountainous and northern areas of Eurasia because it is more resistant than other cereals to low temperatures. It is a very rustic species and has good production even in poor, sandy and acidic soils; it has a moderate tolerance to salinity, while it is especially sensitive to soils with water stagnation and it is quite sensitive to lodging. Currently the surfaces dedicated to the cultivation of to this autumn-winter cereal in Italy are extremely small. Nowadays rye is of great interest due to its nutritional composition and nutraceutical components (Kamal-Eldin et al., 2009; Rakha et al 2010; Arendt e Zannini 2013; Andersson et al., 2018). According to recent studies, modern rye varieties have a relatively narrow gene pool, a condition that is worsening in more recent breeding processes. The preservation of local landraces as unique sources of genetic diversity has therefore become important, to preserve the genetic heritage of rye. In this study, we deliberately focused on the local ecotype "Sècena" coming from the Matese Regional Park. The starting material was found thanks to the activity of the Campania Agro-Biodiversity project (PSR 2014-2020). The experimentation monitored the crop during 2021-22 in two experimental fields located at different altitudes (1050 and 235 m a.s.l.) respectively for Letino and San Potito Sannitico, all in the Province of Caserta (Campania Region, Southern Italy). The rye was sown during the second ten days of August in the experimental field of Letino and during the second ten days of November in the experimental field of San Potito Sannitico. Measurements and surveys were carried out on the experimental fields following the phenological phases of cultivation, with particular attention to the maturation and harvesting phases. The rheological and chemical-physical analyzes were carried out and highlighted some differences in relation to the cultivation area. The results supported the valorization of this cereal in a quality livestock supply chains and for the production of foods of high functional value. In this way the valorization of the local rye “Secena” can contribute to the in situ conservation of biodiversity and can significantly boost the cereal supply chain of the most disadvantaged mountain communities. At last, the results support the idea that rye could be revalued as an "environmentally resilient" source in the future, with a view to cultivating cereals suitable for production even in a condition of global warming.

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Enhancement of the Cilento legumes supply chain: "Pea bean" and "Mandia bean", two case studies

by Enrica De Falco | Gabriele Maria Cioffi | Gianluca Massa | Antonio Viscardi | Zaccardelli Massimo | Università degli Studi di Salerno | Università degli Studi di Salerno | Università degli Studi di Salerno | Università degli Studi di Salerno | Università degli Studi di Salerno, CREA-OF

Abstract ID: 106
Topic: Crop
Presenter Name: Enrica De Falco
Contribution: Post

This paper presents the results of the field research conducted in the years 2021 and 2022 on two varieties of bean: the “Pea bean” and “Mandia beans”, both Plant Genetic Resources included in the ABC project (PSR 2014-2020 Campania Region Measure 10, sub-measure 10.2, type of intervention 10.2.1), with the aim of enhancing and enriching the supply chain and biodiversity of “Cilento legumes”. The field experimentation was carried out in situ in the areas of origin of each bean, respectively at “Graziano Farm” (Sessa Cilento - SA) for the “pea bean” and at “Sansone farm” (Ceraso, SA) for the “Mandia bean”, both included in the area of the “National Park of Cilento, Vallo di Diano and Alburni”. In both cases, during the crop cycles the agronomic and productivity measurements were carried out. Both experimentation confirmed for these varieties of bean an undetermined development. As regards the “Pea bean”, the results highlighted that seed has an average size of rounded to elliptical shape in longitudinal section and broad elliptical in cross section with the weight of 1000 seeds included between 500 g and 530 g; it is a white colored seed, with a unit production of about 1.0 t ha-1. The dimensions of the seed of the "Mandia bean” are decidedly larger, with the weight of 1000 seeds included between 580 g and 600 g; on the opposite the unit production is reduced, amounting to around 0.4 t ha-1. The duration of the maturation period was longer for the “Mandia bean”, also in relation to the size of the seed. The comparison between traditional cultivation with poles and net cultivation on “Pea bean” highlighted higher grain production for traditional cultivation. The agronomic results have highlighted, however, the possibility of margins for increasing production. Both varieties represent a traditional cultivation for their areas of origin and are appreciated for their high organoleptic characteristics. The surveys highlighted that both varieties constitute a very important resource for the horticultural supply chains of the area, even if not high in terms of yield. The productions can be included in a supply chains of “Legumes of Cilento”, in the quality catering and also for transformation, based on the sustainability of crops, especially considering that Cilento falls among the territories that gave rise to the Mediterranean Diet in which legumes play a role of high importance for food value. Acknowledgements. We thank the farms “Graziano” and “Sansone” for their collaboration.

Physiological and agronomic responses of common wheat following foliar application of Methylobacterium symbioticum

by Francesco Valente | Silvia Potestio | Francesco Bozzolin | Anna Panozzo | Giuseppe Barion | Vittorio Bertin | Giovanna Visioli | Yu Wang | Teofilo Vamerali | Department of Agronomy, Food, Natural Resources, Animals and the Environment, University of Padua | Department of Chemistry, Life Sciences and Environmental Sustainability, University of Parma | Department of Agronomy, Food, Natural Resources, Animals and the Environment, University of Padua | Department of Agronomy, Food, Natural Resources, Animals and the Environment, University of Padua, 35020 Legnaro, Italy | Department of Agronomy, Food, Natural Resources, Animals and the Environment, University of Padua, 35020 Legnaro, Italy | Department of Agronomy, Food, Natural Resources, Animals and the Environment, University of Padua, 35020 Legnaro, Italy | Department of Chemistry, Life Sciences and Environmental Sustainability, University of Parma | Institute of Environmental Research at Greater Bay Area, Key Laboratory for Water Quality and Conservation of the Pearl River Delta, Ministry of Education, Guangzhou University | Department of Agronomy, Food, Natural Resources, Animals and the Environment, University of Padua

Abstract ID: 110
Topic: Crop
Presenter Name: Francesco Valente
Contribution: Post

Current agriculture is addressing the growing food demand by intensifying crop cultivation in order to increase productivity. In cereal crops, this has led to a rapid increase in chemical fertilizer use, which is revealing to be ecologically and economically unsustainable. Hence, finding new strategies to mitigate the adverse effects of intensive agriculture has become a primary goal of the EU Common Agricultural Policy. The application of plant growth promoting bacteria (PGPBs) is recognised as a strategy to reduce nitrogen inputs and achieve greater crop sustainability. In this framework, the present study explored the feasibility of cultivating common wheat with a reduced dose of nitrogen fertiliser by supplying the nitrogen-fixing bacterium *Methylobacterium symbioticum* strain SB23 (BlueN®, Corteva Agriscience, IT). The field trial was conducted in 2022-23 in Legnago (Verona, NE Italy) in a fertile sandy-loam soil on the bread-making var. LG Auriga of *Triticum aestivum*, by comparing a full and a reduced nitrogen dose (180 and 130 kg ha^{-1}), with or without foliar application at end tillering stage of the biofertiliser (330 g ha^{-1} with 350 L ha^{-1} of water). Interesting positive effects due to the bacteria application could be observed in wheat growth and physiological parameters, and grain quality, mostly at the reduced dose of nitrogen. Consistently with findings on other crops, *Methylobacterium symbioticum* brought to a delayed leaf senescence, thus allowing a prolonged stay green and photosynthetic activity. An improvement in photosynthetic parameters, such as stomatal conductance and PSII efficiency was also detected, again mostly in the less fertilised treatment. A qualitative test demonstrated that such bacterium shows ACC-deaminase activity, in this way possibly retrieving some nitrogen and reducing the production of ethylene, and thus explaining plant senescence delay. This would explain why *Methylobacterium symbioticum* has better effects on wheat under reduced nitrogen fertilisation. Although its nitrogen-fixation activity was not investigated in this trial, it is

expected that under moderate nitrogen fertilization a greater fixation can also occur. In order to cover the lack of information on the effects of *Methylobacterium symbioticum* on plant roots, this trial found no significant effects on root growth, although the root length density was somewhat increased in the arable layer. Yield and its components were not affected by biofertilization, while both glutenin-to-gliadin and the HMW-to-LMW ratios increased, allowing for the improvement of some rheological properties of the flour. From this preliminary investigation, it is concluded that the recently released biofertilizer containing *Methylobacterium symbioticum* can improve some physiological processes related to nitrogen metabolism of wheat plants, although mainly at reduced chemical nitrogen doses. Under the rainy conditions of 2023, these changes were not translated into yield gains, while increases of the flour tenacity could be exploited in specific oven-cooked products. Although further research is necessary in wheat and other crops, this biofertilizer can currently be exploited to reduce chemical fertilization, under suboptimal conditions, and organic farming.

Plant biodiversity in vineyards: a preliminary study of the Valpolicella Valley

by Cristina Pornaro | Elena Basso | Stefano Macolino | DAFNAE - University of Padova | DAFNAE - University of Padova | DAFNAE - University of Padova

Abstract ID: 112
Topic: Crop
Presenter Name: Cristina Pornaro
Contribution: Post

The vegetation between vineyard rows is considered a service crop because it provides various ecosystem services. It has been demonstrated that compared to tilled soil, inter-row vegetation cover can significantly reduce sediment runoff. To ensure plant persistence and stability, species used in vineyard alleys should be chosen according to their adaptability to specific environmental conditions and management systems. Intensive vineyards often have low biodiversity with a negative effect on the resilience of the entire vineyard ecosystem. A field trial was conducted in the Valpolicella area in northeastern Italy, including different locations (4 vineyards and a permanent meadow). The vineyards were selected as representative of the cultivar and planting pattern in the area. The study aimed at investigate the plant biodiversity on vineyard inter-rows covered by spontaneous vegetation and compare it with a local permanent meadow. Three botanical surveys (Braun-Blanquet method) were conducted in the 4 vineyards and the meadow, for a total of 15 surveys. The relative species abundances and the percentage of soil vegetation cover were recorded in a surface area of 50 m^2, in fall 2023 and spring 2024. ANOVA was performed to test the effect of location on the sum of the number of species recorded in both seasons. Furthermore, ANOVAs were performed to test the effect of location season, and their interaction on total number of species, species exclusive to each season, species shared between the two seasons, dominant species (abundance > 1%) and rare species (abundance < 1%) for each season. The correlations between the analysed parameters and the percentage of vegetation cover were also investigated. The meadow had higher species richness than vineyard inter-rows. Forty-six plant species were recorded in the meadow, while in the inter-rows they ranged from 21 to 32. Comparing the two seasons, number of species, number of exclusive species, and number of rare species were higher in spring for 2 vineyards and the meadow. While no differences were found for shared and dominant species. A significant correlation was found between total number of species and vegetation cover, as well as between number of dominant species and vegetation cover. The difference between the two seasons can be attributed to the stress suffered by vegetation in the summer, which favour warm-season species that are considered weeds as they leave the ground bare in fall. This aspect will be deepened with botanical surveys planed for the next summer. Few studies investigated the biodiversity of native or seeded inter-row vegetation and their evolution over time. Some authors reported that the choice of seeded species and their management can affect number of species and botanical composition in the inter-row vegetation. Our

results confirmed the high difference in species richness existing between permanent meadows and vineyards inter-row vegetation, highlighting the crucial role of grassland management in plant biodiversity. Further studies are necessary to investigate the effect of management practices on the inter-row vegetation for a more conscious management of plant biodiversity in vineyards.

Environmental assessment of organic and conventional cultivated mushroom Agaricus bisporus (J.E.Lange) Imbach production across Europe

by Pietro Goglio | Thomas Ponsioen | Jaime Carrasco Carrasco | Ivanka Milenkovi | Lukasz Kiwala | Klara Van Mierlo | Francesco Tei | Eelsje Oosterkamp | Margarita Pérez | University of Perugia, Italy | Wageningen University and Research, The Netherlands | IRIAF, Spain | Ekofungi, Serbia | UGLK Lukasz Kiwala, Poland | Wageningen University and Research, The Netherlands | University of Perugia, Italy | Wageningen University and Research, The Netherlands | CTICH, Spain

Abstract ID: 118
Topic: Crop
Presenter Name: Pietro Goglio
Contribution: Post

Global production of mushrooms has increased 30-fold between 1978 and 2016, reaching more than 44 million metric tonnes in 2021. China, the largest mushroom producer, produced over 40 Mt of mushrooms, while the European Union produced more than 1 Mt in 2021. The global average consumption is about 100 g per capita per week, making mushrooms a relevant part of consumers' diet and an important source of non-animal protein. Agaricus bisporus (J.E.Lange) Imbach is a mushroom belonging to the Agaricaceae family, division Basidiomycota, in the Fungi kingdom, which is one of the most cultivated mushroom species worldwide. Environmental assessments of mushroom cultivation are still scarce and limited data is available on the environmental impacts related to mushroom cultivation. Therefore, there is a need to have a better and more comprehensive assessment of the environmental impacts of mushroom production, to identify environmental hotspots throughout the value chain, to compare production systems and regions, and to identify potential improvements of mushroom production. This research assessed environmental impacts of three Agaricus bisporus mushroom production systems across Europe: Spain, Poland and Serbia which have quite separate value chains and geographical regions of production. Further, both countries represent 26% and 12% of the overall mushroom market in Europe in 2020. Additionally, the Serbian system was assessed because of its distinct geographical production area, final product and market (organic dry mushroom). Key impacts considered include impact on climate change, energy consumption, eutrophication and acidification. We found that there is a large variability in the substrate composition, which is in all cases was a combination of compost (mainly straw and animal manure) covered by casing materials (mainly peat). Further, energy use, substrate use and yield were very variable across cultivation systems. In particular, the Serbian organic dried mushroom was significantly different from the other conventional fresh mushroom systems assessed here. This affected the life cycle impact assessment results. The largest contribution to environmental impact (about 49.6% on average ranging between 16.4% and 84.4% across all impacts assessed) was associated with compost production, followed by electricity use and casing (respectively 20.3% and 10.3% on average across all systems and impact categories analysed). Thus, optimizing composting and casing production, combined with switching to renewable energy sources appears to be the most effective to reduce the overall environmental impacts of mushroom production. Any mushroom growers can increase sustainability of mushroom production by increasing mushroom productivity and reducing the compost and peat use. This research provides a comprehensive assessment across Europe which could be further expanded to include a more comprehensive and representative overview of the impact of mushroom production at European level.

RISOLO project: Genetic analysis of historical Italian rice varieties

by Martina Ghidoli | Elena Cassani | Michele Salvan | Matteo Petitti | Giuseppe De Santis | Michela Landoni | Paola Casati | Salvatore Roberto Pilu | Department of Agricultural and Environmental Sciences-Production, Landscape and Agroenergy, University of Milan, Via Celoria 2, 20133, Milan - Italy | Department of Agricultural and Environmental Sciences-Production, Landscape and Agroenergy, University of Milan, Via Celoria 2, 20133, Milan - Italy | Reti Semi Rurali, Piazza Brunelleschi 8, 50018 Scandicci (FI), Italy | Reti Semi Rurali, Piazza Brunelleschi 8, 50018 Scandicci (FI), Italy | Reti Semi Rurali, Piazza Brunelleschi 8, 50018 Scandicci (FI), Italy | Department of Earth and Environmental Sciences, University of Pavia, Via S. Epifanio 14, 27100 Pavia, Italy | Department of Agricultural and Environmental Sciences-Production, Landscape and Agroenergy, University of Milan, Via Celoria 2, 20133, Milan - Italy | Department of Agricultural and Environmental Sciences-Production, Landscape and Agroenergy, University of Milan, Via Celoria 2, 20133, Milan - Italy

Abstract ID: 120
Topic: Crop
Presenter Name: Martina Ghidoli
Contribution: Post

Cultivated rice (*Oryza sativa* L.) was domesticated from wild rice (*Oryza rufipogon* Griff.), typically displaying fewer grains per panicle and longer grains than its cultivated counterpart. Additionally, wild rice has long awns, whereas cultivated rice has short awns or lacks them altogether. These changes represent critical events in rice domestication. A major gene, GRAIN NUMBER, GRAIN LENGTH AND AWN DEVELOPMENT 1 (GAD1), regulates these critical changes. GAD1 is located on chromosome 8 and is predicted to encode a small secretory signal peptide belonging to the EPIDERMAL PATTERNING FACTOR-LIKE family. A frameshift insertion in *gad1* destroys the conserved cysteine residues of the peptide, resulting in a loss of function. This mutation causes the increased number of grains per panicle, shorter grains, and awnless phenotype characteristic of cultivated rice. The early 20th century was a formative period for Italian rice cultivation, with several traditional varieties laying the foundation for modern rice farming in the country. These varieties, grown primarily in the fertile regions of Northern Italy, were integral to Italian culinary traditions. Each variety brought unique characteristics to the table, enriching the diversity of Italian cuisine. Today, these historical varieties continue to be celebrated for their contribution to Italy's agricultural and gastronomic heritage. All these historical varieties stem from those introduced in the 19th century from around the world to identify those that could adapt to the Italian environment and resist rice blast disease, which began devastating Italian rice crops in the mid-19th century. The crops at that time were primarily based on a population called “Nostrale”. As part of the project titled "Multiplication, Characterization, and Conservation in Lombardy of High-Quality Rice Seeds for Organic Farming (RISOLO)," funded by the Lombardy Region's Rural Development Program 2014-2020, Operation 10.2.01 – Conservation of Animal and Plant Biodiversity, 18 ancient traditional rice varieties dating back to the late 19th and early 20th centuries were studied. Within the RISOLO project, these varieties, cultivated in open fields

by Reti Semi Rurali and preserved in the Pavia Germplasm Bank, were genetically characterized using SSR molecular markers to clarify any redundancies among the collected accessions. Some of these accessions, such as Chinese Ostiglia and Novara, were found to have awns, a trait selected against by breeders in the 20th century, and are currently under further molecular study to characterize the GAD1 locus.

Investigating FLC Gene in Camelina sativa: the Effects on Flowering Time and Seed Size

by Martina Ghidoli | Michela Landoni | Elena Cassani | Miriam Macalli | Salvatore Roberto Pilu | Department of Agricultural and Environmental Sciences-Production, Landscape and Agroenergy, University of Milan | Department of Earth and Environmental Sciences, University of Pavia | Department of Agricultural and Environmental Sciences-Production, Landscape and Agroenergy, University of Milan | Department of Agricultural and Environmental Sciences-Production, Landscape and Agroenergy, University of Milan | Department of Agricultural and Environmental Sciences-Production, Landscape and Agroenergy, University of Milan

Abstract ID: 121
Topic: Crop
Presenter Name: Martina Ghidoli
Contribution: Post

Camelina sativa, commonly known as camelina or false flax, has emerged as a promising cover crop with significant potential for mitigating climate change which is one of the most pressing global challenges, necessitating the urgent development and adoption of sustainable solutions. Camelina is an oilseed crop native to Europe and Central Asia belonging to the Brassicaceae family. It is known for its resilience to diverse climatic conditions, including arid and semi-arid regions, making it suitable for cultivation in a range of environments, instead, it is currently studied as a biofuel crop and a new source of protein and oil. The seed oil content is about 40%, with a high level of polyunsaturated fatty acids (30-40% α-linolenic acid, 15-25% linoleic acid, 15% oleic acid, and about 15% eicosenoic acid). In this work, there were studied six winter and five spring varieties of *C. sativa* and some lines generated both by the crossing of spring lines and by the crossing of a spring line for a winter line. An agronomic characterization was carried out regarding parameters such as yield, weight of 1000 seeds, and flowering time, and regarding this, FLC gene (Flowering Locus C gene) was studied for all the genetic materials. The data obtained showed that spring varieties exhibited early maturity, high seed weight of 1000 seeds comparable to winter varieties. A strong negative correlation between 1000 seed weight and days to flowering ($r = -0.91$; $p = 3.87E-5$) suggests a physiological and/or genetic relationship between these two traits. This result agrees with previous work, in which spring and winter genotypes were differentiated by most seed shape descriptors and in particular seed weight, furthermore, the main QTL associated with flowering period is located on Chr8 (chromosome 8) linked to a strong QTL associated with seed size. Finally, flowering time and seed size are important characteristics to consider in breeding programs to develop cultivars with desirable flowering characteristics and a seed size that can facilitate the cultivation, harvesting, and processing of camelina seeds. making this precious crop more accessible and economically sustainable for farmers.

Agronomic response of 13 cotton genotypes cultivated in two different Sicilian environments under organic farming.

by Federica Alaimo | Giuseppe Vitale | Nicolò Iacuzzi | Noemi Tortorici | Giuseppe Indovino | Sara Lombardo | Paolo Guarnaccia | Teresa Tuttolomondo | Department of Agricultural, Food and Forest Sciences, University of Palermo | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Agricultural, Food and Forest Sciences, University of Palermo | Department of Agricultural, Food and Forest Sciences, University of Palermo | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Agricultural, Food and Forest Sciences, University of Palermo

Abstract ID: 124
Topic: Crop
Presenter Name: Federica Alaimo
Contribution: Post

Cotton (*Gossypium* spp.), belonging to the *Malvaceae* family, is a semi-xerophytic species native to central and northern America and Mexico. It is one of the most relevant crops for natural fiber production in the textile industry. Of the 39 species belonging to the genus *Gossypium*, *G. arboreum*, *G. erbaceum*, *G. barbasense,* and *G. hirsutum* in particular highlight a commercial importance, with *G. hirsutum* that results being the most cultivated of the others and from which most of the fiber supplied by the modern textile industry comes. In recent years, it is the growing demand for natural fibers that has led in the Mediterranean area, and in particular in Sicily, to a renaissance of the cultivation, where it represented a widely cultivated species until the middle of the last century. On the basis of the renewed interest, in this work we wanted to investigate the current varietal landscape with a view to a possible resettlement of the crop in the Sicilian cultivation systems. In two different environments of the Sicilian region (Trapani and Catania), the agronomic response of 13 different genotypes belonging to the species of *Gossypium hirsutum* L., *Gossypium barbadense* L., and hybrids of *G. hirsutum* x *G. barbadense*, grown under organic farming were valued. The trial was carried out during the spring and summer of 2023 at the Campo Carboj experimental farm (University of Palermo) located in the province of Trapani and at the University of Catania experimental farm, adopting a randomized block design with three replications. The factors under study, environment and genotype, showed highly significant differences ($p \leq 0.001$) for raw fiber yield, percentage of lint and percentage of seeds. The raw fiber yield and the higher percentage of lint was achieved at the Campo Carboj experimental farm, while the higher percentage of seeds was achieved at the University of Catania experimental farm. The highest raw fiber yield was obtained in the variety Armonia (3.88 t ha^{-1}) and the lowest yield in the variety PHY983 (1.50 t ha^{-1}). Both varieties belong to the *G. hirsutum* species and come from Greece. The highest percentage of lint was found in the Concha variety (46.28 %) of *G. hirsutum* from Spain. For the same parameter, the lowest value was found in the hybrid HA1432 (35.82 %) from the USA. The results of this study are promising for a possible reintroduction of cotton in the Sicilian cultivation systems. All 13

genotypes showed a specific ability to adapt to Sicilian climatic conditions, and some of them stood out in terms of productivity.

Effect of two different protein hydrolysates on chemicals and yield parameters of three Mediterranean medicinal and aromatic plants

by Davide Farruggia | Mario Licata | Salvatore La Bella | Giovanni Urso | Francesco Salamone | Johannes Novak | Department of Agricultural, Food and Forest Sciences, Università degli Studi di Palermo | Department of Agricultural, Food and Forest Sciences, Università degli Studi di Palermo | Department of Agricultural, Food and Forest Sciences, Università degli Studi di Palermo | Department of Agricultural, Food and Forest Sciences, Università degli Studi di Palermo | Department of Agricultural, Food and Forest Sciences, Università degli Studi di Palermo | Clinical Department for Farm Animals and Food System Science, University of Veterinary Medicine, Vienna

Abstract ID: 129
Topic: Crop
Presenter Name: Davide Farruggia
Contribution: Post

In recent decades, an increasing interest on medicinal and aromatic plants (MAPs) has been observed. MAPs show several properties such as antioxidant, antimicrobial, and antiseptic due to the presence in plant tissues of various secondary metabolites. The biosynthesis and accumulation of phytochemicals is greatly affected by abiotic and biotic factors, providing effects on the qualitative and pro-healthy value of produced raw materials. The choice of good agricultural practices represents a crucial aspect in MAPs cultivation to obtain plant materials with high-quality standard in terms of chemical compounds and active components. In this scenario, the use of biostimulants can be an efficient practice for MAPs cultivation allowing for reduction of agronomic inputs and increase in crop yield and quality. Foliar or root biostimulants have been successfully using on various crops for last decade but nowadays there is a lack of information in the application of biostimulants on MAPs. Biostimulants contain substances that can allow to obtain raw material with higher levels of bioactive compounds due to the elicitation phenomenon. Humic acids, protein hydrolysates, nitrogen-containing compounds, seaweed extracts, chitosan, inorganic chemicals, mycorrhizal fungi, and rhizobacteria are only few examples of substances and microorganisms that are considered biostimulants. Protein hydrolysates (PHs) are amino acid combinations made from the hydrolysis of plant and animal protein by-products. A number of studies have showed the benefits of PHs application in a wide range of plant species. The amino acids included in the PHs solutions, a part their biostimulant properties, provide nitrogen supply to plants and might potentially be just as successful fertilizers as inorganic nitrogen. Based on that, the aim of this study was to assess the effect of foliar application of two different type of protein hydrolysates, one plant-derived and one animal-derived, on chemical and yield parameters of three perennial MAPs (oregano, rosemary, and sage) cultivated in a Mediterranean environment. For each product, three foliar applications were performed during the vegetative stages of each species. Water was used as the control. At harvest, fresh and dry biomass yields, essential oil (EO) content and yield were determined. EOs were analysed with Gas Chromatography-Mass Spectrometry to assess the

effect of foliar application on the EOs composition. Chemical and morphological parameters were significantly affected by biostimulant application. The highest values of biomass yield, EO content and EO yield were observed in plants treated with plant-derived PHs. When considering the most represented EOs compounds, the application of the protein hydrolysates produced contrasting response in the EOs composition of the three species. This study demonstrates that foliar application of protein hydrolysate permits to obtain significant increase in biomass yield and EOs content in MAPs grown in a Mediterranean environment. Furthermore, plant-based PHs consents to obtain the highest yields in biomass and EOs. These results are of interest to companies that produce biomass and EOs obtained from MAPs.

Time series of yield data for wheat in continuous cropping or different rotation systems

by Michela Farneselli | Umberto Bonciarelli | Andrea Onofri | Stefano Cimarelli | Euro Pannacci | Marcello Guiducci | Francesco Tei | Dip. di Scienze Agrarie, Alimentari e Ambientali, Univ. Perugia | Dip. di Scienze Agrarie, Alimentari e Ambientali, Univ. Perugia | Dip. di Scienze Agrarie, Alimentari e Ambientali, Univ. Perugia | Dip. di Scienze Agrarie, Alimentari e Ambientali, Univ. Perugia | Dip. di Scienze Agrarie, Alimentari e Ambientali, Univ. Perugia | Dip. di Scienze Agrarie, Alimentari e Ambientali, Univ. Perugia | Dip. di Scienze Agrarie, Alimentari e Ambientali, Univ. Perugia

Abstract ID: 130
Topic: Crop
Presenter Name: Michela Farneselli
Contribution: Post

In Southern Italy, rainfed farming systems are often based on continuous winter wheat cropping, that may not be a rational practice, leading to decreased yield levels, low resilience to climate changes and decreased soil health in the long run. Unfortunately, studying long-term effects for farming systems is not an easy task and requires long-term experiments, which need to be run for very long periods of time. In this research-study we have exploited the data from a Long-Term Experiment (LTE), that was started in 1971 in the medium Tiber Valley. This LTE is based on 13 different farming systems, that are: continuous wheat with three N-fertilisation levels (fn150, fn200, fn250), 5 maize-wheat rotations, with different frequencies of wheat (f-m, f-f-m, f-f-f-m, f-f-f-f-m e f-f-f-f-f-m) and 5 biennal rotations (wheat-grain sorghum, wheat-faba bean, wheat-pea/chickpea, wheat-sunflower, wheat-oiseed rape/sugarbeet). All the 13 farming systems are run either under the removal or under the burial of crop residues; for all rotations, all crop phases are contemporarily present in the field in each year and the experimental design is a split plot with crop residues management in the main-plots and farming systems/phases in the subplots, 3 replicates and 24.5 m2 plots. We have considered and analyzed yield data and weather data from 1971 to 2023, with the aim of determining long-term averages and time series, in relation to the rotation type and residue management method. Results show that crop rotation produced better long-term beneficial effects on yield level and stability, with respect to continuous cropping, the proved to be at risk of low resilience and prone to long-term yield decreases. The burial of crop residues has always proved to produce beneficial effects on long-term yield levels with all rotation systems. In the end, our analyses showed that resilient farming systems require long rotations with several different crops and a high degree of biodiversity.

A Multi-Criteria Decision Framework for Nitrogen Fertilization Optimization in Agrivoltaics

by Michele Croci | Davide Berardi | Tommaso Carlini | Giorgio Impollonia | Yuri Bellone | Manuele Ragazzi | Riccardo Panigada | Chiara Nigro | Christian Giorgi | Lorenzo Repetti | Michele Vaghini | Simone Macetti | Luca Martullo | Giulia Milcovich | Stefano Amaducci | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore | Università Cattolica del Sacro Cuore

Abstract ID: 135
Topic: Crop
Presenter Name: Michele Croci
Contribution: Post

Agrivoltaic (AV) systems, which integrate agricultural production with solar energy generation, present unique challenges and opportunities for optimizing crop yields and resource management. Nitrogen (N) fertilization, a key factor influencing crop growth, is particularly complex in AV environments due to altered microclimates, shading patterns, and potential competition for resources between crops and photovoltaic panels. This study, conducted during the crop modeling laboratory, addresses these challenges by developing a comprehensive multi-criteria decision analysis (MCDA) framework to evaluate and compare diverse agromanagement strategies, with a specific focus on optimizing N fertilization, under various AV configurations. The research leverages a combination of advanced modeling techniques, including radiation models to simulate light availability under solar panels and the DAISY crop growth model to predict crop responses to different management practices. This integrated modeling approach enables a detailed assessment of the complex interactions between AV infrastructure, crop physiology, and N fertilization regimes. The study focuses on an experimental overhead bi-axial (OBA) AV system located at Università Cattolica del Sacro Cuore (UCSC) in Piacenza, Italy. Maize, a staple crop with significant N requirements, was selected as the model crop to investigate the effects of varying N fertilization rates and timings under the OBA system. Simulations were conducted for ten growing seasons to capture the long-term dynamics of crop growth and N uptake under the AV environment. The MCDA framework integrates multiple key performance indicators (KPIs) derived from the simulations, including crop yield ratio (the ratio of crop yield under the AV system to yield in open field conditions), nitrogen use efficiency (NUE, a measure of how effectively crops utilize applied N), and water use efficiency (WUE, reflecting the amount of biomass produced per unit of water consumed). These KPIs were carefully selected to reflect the agronomic, environmental, and economic dimensions of sustainable AV production systems. The MCDA approach was applied to evaluate agromanagement scenarios for five distinct positions within the OBA system, each characterized by different

shading patterns and microclimatic conditions. By ranking the scenarios based on their performance across the multiple KPIs, the framework identifies optimal N fertilization strategies that balance productivity, resource efficiency, and economic viability for each specific location within the AV array. This research not only provides valuable insights into optimizing N management in AV systems but also offers a versatile framework for assessing the sustainability and resilience of different AV designs and agromanagement practices. The MCDA approach can be readily adapted to incorporate additional KPIs and constraints, such as economic profitability, soil health, and greenhouse gas emissions, to guide decision-making towards more sustainable and profitable AV systems. By integrating scientific modeling, data-driven analysis, and a multi-criteria decision-making approach, this study contributes to the growing body of knowledge on AV systems and their potential to revolutionize sustainable agriculture and renewable energy production.

Weed perception and crop competitiveness as critical traits for breeding new wheat lines based on sustainability principles

by Nausicaa Pollaro | Valerio Cirillo | Claudio Russo | Michela Terrecuso | Marco Cepparulo | Eugenio Cozzolino | Albino Maggio | Dipartimento di Agraria, Università degli Studi di Napoli Federico II | Dipartimento di Agraria, Università degli Studi di Napoli Federico II | Dipartimento di Agraria, Università degli Studi di Napoli Federico II | Dipartimento di Agraria, Università degli Studi di Napoli Federico II (IT) | Dipartimento di Agraria, Università degli Studi di Napoli Federico II | Council for Agricultural Research and Economics (CREA)—Research Center for Cereal and Industrial Crops | Dipartimento di Agraria, Università degli Studi di Napoli Federico II

Abstract ID: 136
Topic: Crop
Presenter Name: Nausicaa Pollaro
Contribution: Post

With the Green Revolution have been selected wheat varieties with a mutation of Reduced Height (*Rht*) dwarfing genes, allowing the intensive use of fertilizers with low risk of lodging for yield maximization. A drawback of this mutation is the lower tolerance to weed competition, an aspect linked with the perception of changes in light quality and quantity mediated by complex hormonal cross-talks. Since herbicide efficacy is threatened due to resistant weeds, it is crucial to find new strategies that minimize herbicide use. One promising approach is to develop more competitive crops, and local varieties can represent an important source of tolerance traits for this competitiveness-oriented breeding. The aim of this study was to identify the traits linked with wheat tolerance to weed competition in a modern *vs.* a local wheat variety. The experiments were performed at the Department of Agricultural Sciences of UNINA in Portici (Italy). The modern variety of wheat (*Triticum aestivum* L.) was Rebelde, while the local accession was Frassineto. The two wheat varieties were grown under weed-free and weedy conditions. Weed-free plots were obtained by spraying a post-emergence herbicide selective for wheat. At the tillering stage, wheat height was evaluated in the two varieties. At the end of the growth cycle, wheat has been harvested to evaluate yield. To understand the effect that the alteration of light quality induced by weeds in absence of competition for water and nutrients, the two wheat varieties were grown in pots surrounded by other pots with *Brassica juncea* seedlings. After 25 days of growth, plant height, and tiller angle were evaluated on wheat plants. In a separate experiment, the two wheat varieties were grown on styrofoam trays and sprayed with 100 µmol of gibberellin (GA_3) at the first true leaf stage. After five days after the treatment, it was evaluated the response to gibberellins in terms of plant height. In the field, Frassineto showed higher tolerance to weed competition compared to Rebelde, as indicated by the higher Yield Stability Index. This result was in line with the elongation phenotype found in Frassineto in response to weed presence, that was absent in Rebelde. The presence of *B. juncea* plantlets surrounding wheat that reduced the red:far-red ratio by -~70% induced the elongation of Frassineto plants, while Rebelde confirmed its lack of weed perception.

This result was in line with a different response of Frassineto and Rebelde to light quality alterations induced by weeds. Moreover, the involvement of GA_3 in the differential response to neighbours observed in Frassineto vs Rebelde was verified. Exogenous applications of GA_3 induced the elongation of Frassineto while it was ineffective on Rebelde, which confirmed our hyopthesis. In conclusion, higher tolerance to weed seemed to be mediated by the ability to sense and respond to weeds, a trait retained in Frassineto and lacking in Rebelde. This can be a pivotal aspect to consider to increase the crop competitiveness *vs*. weeds as a strategy to reduce use of herbicides for weed control.

Screening hard common wheat varieties for shade tolerance within an alley-cropping systems with poplar

by Anna Panozzo | Simone Piotto | Emanuele Lodo | Giuseppe Barion | Lorenzo Furlan | Federico Correale Santacroce | Teofilo Vamerali | Dep. of Agronomy, Food, Natural Resources, Animals and the Environment, University of Padua | Dep. of Agronomy, Food, Natural Resources, Animals and the Environment, University of Padua | Dep. of Agronomy, Food, Natural Resources, Animals and the Environment, University of Padua | Dep. of Agronomy, Food, Natural Resources, Animals and the Environment, University of Padua | Veneto Agricoltura | Veneto Agricoltura | Dep. of Agronomy, Food, Natural Resources, Animals and the Environment, University of Padua

Abstract ID: 137
Topic: Crop
Presenter Name: Anna Panozzo
Contribution: Post

Current agricultural systems are suffering from the increased frequency of extreme climatic events that negatively affect growth and productivity of field crops. The implementation of silvoarable agroforestry is recognised as a strategy to buffer the climate conditions, thanks to the shading and windbreak effects of trees. The beneficial effect of trees is also related to improvements of soil structure and organic matter deposition, and soil water conservation, which are recognised by the current CAP 2023-27 The implementation of high-productive alley-cropping systems requires a deep knowledge on the multiple tree-crop interactions, and the choice of suitable crop species and varieties. In this framework, this study aimed at investigating (i) the impact of an alley-cropping system with poplar trees on microclimatic parameters, and (*ii*) the growth and yield response of hard common wheat. The trial was carried out during 2022-23 at the “Sasse Rami” pilot farm of Veneto Agricoltura, at Ceregnano (Rovigo). Wheat was sown in the interrow of an alley-cropping system with N-S oriented, 40-m apart rows of 5-year old poplar trees. Five hard common wheat (*Triticum aestivum* L.) varieties were cultivated: ACA 360, Aurelius, Criterium, Garbino, and Rebelde. Vegetational indexes, morpho-physiological parameters, productivity and quality of grains were assessed along transects (n = 3) orthogonal to the tree rows, at distances of +3m, +6m and +12m, both at east and west sides of the poplar rows, and in the centre of the alley that was considered as control (C). From April to June, the average daily PAR was reduced by 8% and 4% at +6m and +12m, respectively, vs. C. From the beginning of May until the half of June, a higher leaf greenness and chlorophyll content (i.e., NDVI and SPAD) were observed in the interaction zone with poplars in all the wheat varieties, allowing a longer stay green and photosynthetic activity. At flowering, the leaf-to-culm biomass and surface ratios were generally increased in the neighboring of trees vs. C ($p \leq 0.05$), except for +3m East, particularly in var. Garbino and Criterium. No significant increases of the plant height were instead observed under shaded positions. The resulted grain yield was slightly improved close to the trees, with the major increments in the east side (afternoon shading: +11% vs. C, $p \leq 0.05$). Accordingly with shoot plasticity, the largest yield increases in the interaction zone with trees were revealed in the Austrian var. Aurelius and the

recently released var. Criterium, with respectively +13% and +17% vs. C. Protein and gluten contents of grains were also increased by ∼+8% in the neighbouring of poplars. It is concluded that in a silvoarable system with widely-spaced rows of poplar the competition with wheat is mild at the middle of commercial tree lifespan, but the screening of suitable wheat varieties is essential for maximising yield performances of the intercrop. Specifically for hard varieties of common wheat, the moderate shading can also be exploited for increasing furtherly the grain quality, that is increasingly requested by baking industries for high-leavened products.

Evaluating crop yield dynamics in Italy: a multi-model simulation study using multiple LTEs

by Matteo Longo | Ilaria Piccoli | Antonio Berti | Michela Farneselli | Andrea Fiorini | Vincenzo Tabaglio | Domenico Ventrella | Francesco Morari | Department of Agronomy, Food, Natural Resources, Animals and Environment, Agripolis, University of Padova | Department of Agronomy, Food, Natural Resources, Animals and Environment, Agripolis, University of Padova | Department of Agronomy, Food, Natural Resources, Animals and Environment, Agripolis, University of Padova | Department of Agronomy, Food, Natural Resources, Animals and Environment, Agripolis, University of Padova | Department of Sustainable Crop Production, Università Cattolica del Sacro Cuore | Department of Sustainable Crop Production, Università Cattolica del Sacro Cuore | Council for Agricultural Research and Economics, Research Centre Agriculture and Environment (CREA-AA) | Department of Agronomy, Food, Natural Resources, Animals and Environment, Agripolis, University of Padova

Abstract ID: 139
Topic: Crop
Presenter Name: Matteo Longo
Contribution: Post

Agricultural system models are widely acknowledged as essential tools for identifying optimal management practices and addressing the challenges posed by climate change. Recent recommendations advocate the use of model ensembles due to their improved performance and accuracy. However, comprehensive evaluations of their effectiveness at large geographical scales, such as the national level, remain limited. This study simulates crop yield response to the Genotype x Environment x Management interaction using an ensemble of four process-based models: DSSAT, CropSyst, EPIC, and APSIM. Five Long-Term Experiments (LTEs) located in Padova, Piacenza, Perugia, and two sites in Foggia, spanning a north-to-south pedoclimatic transect in Italy, were considered. This area is of particular importance as it represents a significant hotspot for climate change. A total of 68 unique experimental protocols, incorporating variations in fertilization rates, cropping rotations, residue management, and tillage practices, were simulated based on LTE data, resulting in a total of 3402 years replicated with each model. The dataset included crop yield and residue data, which was split into calibration and validation datasets. Models underwent independent calibration, with crop parameters selected based on expert knowledge. Main crop cultivars (i.e., maize, soybean, sugar beet, winter wheat, and durum wheat) were further categorized and calibrated, resulting in 74 unique cultivar calibrations. A similar approach was used for cover crops (i.e., vetch, rye, and oat), where planned. This comprehensive dataset enabled an in-depth analysis of the ensemble performance across a wide range of agro-ecological contexts. The ensemble mean demonstrated a high level of accuracy in simulating the diverse pedo-climatic conditions found throughout the Italian peninsula. Among the crops simulated, maize and soybean had the best performance, while durum wheat and sugar beet showed lower accuracies. These findings underscore the value of model ensembles in enhancing our understanding of crop yield dynamics and highlight the need for continued refinement of agricultural models to address the complex challenges

posed by climate change effectively. Acknowledgements. This research 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).

Threshold value of chlorophyll meter and sap test for the optimization of nitrogen supply in processing tomato

by Beatrice Falcinelli | Michela Farneselli | Francesco Tei | University of Perugia | University of Perugia | University of Perugia

Abstract ID: 140
Topic: Crop
Presenter Name: Beatrice Falcinelli
Contribution: Post

Optimal nitrogen (N) fertilization management both from an environmental and economical purposes can be carried out also by monitoring the crop N status trough the growing season. The tools used for measuring the N nutritional status should be cheap and able to produce rapid and accurate values to suggest recommendations for fertilization. This is extremely crucial for processing tomato (*Lycopersicon esculentum* Mill.) for which a correct N fertilization would reduce the risk of N leaching without compromising the crop yield. Among the available possibilities, chlorophyll meter and petiole sap (SAP) test represent the most suitable tools to obtain quick and cheap measures for monitoring N crop status. The aim of this research was to identify threshold values of chlorophyll meter and SAP test measures, which would be able to support decisions in the management of N fertilization. Four field experiments were carried out on processing tomato (cv. Perfectpeel) at the FieldLab of the University of Perugia (Papiano, PG) comparing different N sources (mineral/organic fertilization; green manuring; cover crops), doses (0 to 300 kg N ha^{-1}) and method of N application (fertigation; broadcast). Each experiment was repeated in two years: 2006-2007 (exp#1); 2008-2009 (exp#2); 2011-2012 (exp#3); 2013-2014 (exp#4), corresponding to a total of eight crop cycles. In each experiment, growth analysis was performed by sampling plants every 10-14 days from about 30 days after transplanting (DAT) until the final harvest (for a total of 4-5 sampling dates per year). N crop status was monitored at each sampling date by a chlorophyll meter (SPAD-502, Minolta) and a sap nitrate meter (LAQUAtwin, Horiba) to obtain SPAD values and mg N-NO_3 L^{-1} in the petiole sap, respectively. The total N% of plant tissue was measured by laboratory analyses (%Na). Aboveground biomass (dry weight basis, DW) were used to calculate the critical N % (%Nc) according to the equation: $\%Nc = 4.53\ DW^{-0.327}$. %Na and %Nc were used for calculation of Nitrogen Nutrition Index (NNI = %Na/%Nc). Regression relationships between %Na and NNI, and sensor-based measurements (SPAD and SAP test measures) were carried out i) on the whole set of data (all the combination exp x year x N treatments x sampling dates), and ii) within each phenological phase (exp x year x N treatments). Results showed that, considering the whole data set of data, no significant correlations were found between %Na or NNI, and SPAD or SAP test measurements confirming that it was not possible to find a single threshold value (for both tests) as a reference for the entire tomato crop cycle. On the other hand, significant correlations were found both between %Na or NNI, and SPAD or sap test measurements within each phenological phases. Generally, the R Pearson's coefficient

was higher for SAP test than SPAD readings (as an overall average), and increased during the crop cycle, reaching the highest values at maximum leaf development. Threshold values of SPAD values and SAP test measurements were carried out for each phenological phase.

Different Fertilization Strategies and Mulching affect the Yield, Quality, and Physiology Traits of Eggplant (Solanum melongena L.)

by Luca Vitale | Lucia Ottaiano | Eugenio Cozzolino | Nunzio Fiorentino | Mauro Mori | Ida Di Mola | CNR-ISAFoM | Dipartimento Agraria, Università di Napoli Federico II | CREA-CI | Dipartimento Agraria, Università di Napoli Federico II | Dipartimento Agraria, Università di Napoli Federico II | Dipartimento Agraria, Università di Napoli Federico II

Abstract ID: 141
Topic: Crop
Presenter Name: Luca Vitale
Contribution: Post

Eggplant is a high-fiber and low-calorie food that is rich in nutrients and has many potential health benefits, among these the reducing the risk of heart disease to helping with blood sugar control and weight loss. To increase eggplant production, it is necessary to use fertilizers including nitrogen, phosphorus, and potassium (N, P, K) but the continued use of mineral fertilizers - the most frequently used by vegetable producers - may ultimately cause injury to the soil chemical, biological, and physical characteristics, other than to produce environmental pollution through groundwater and air contamination. For these reasons it is necessary to find alternatives to mineral fertilizers, and the use of organic fertilizers could be a valid alternative to improve eggplant yield and quality and, at the same time, to limit the negative effects of cropping on the environment (Hoque et al., 2022). The organic fertilizers improve the soil characteristics such as architecture, drainage, aeration, organic matter content, and nutrient availability that, in turn, improve the soil fertility also through an enhancement of microbial activity. Among organic fertilizers, the compost and vermicompost are known for supplying nutrients for plants. Plastic mulches are used in horticulture and their benefits consist in preventing the direct evaporation, playing a positive role in water conservation in the soil, and in helping to increase soil temperature, this latter deeply related by the plastic film color. In the present research, we analyze the combined effects of colored plastic film mulches and organic amendments such as compost and vermicompost on plant growth and physiology, and on eggplant yield and quality. Because the color of mulch alters the soil radiative budget and thus the microclimate around root, we expect a different response of eggplants to different colored mulches used in this study.

Oenotrace – A data-driven approach to trace sustainable practices in wine-growing

by Davide Cammarano | Andreas Heiß | Nikolaos Tsoulias | Dimitrios Argyropoulos | Dimitrios T. Davarakis | Marco Moriondo | Cristina Balaceanu | George Suciu | Marco Bignardi | Dimitrios S. Paraforos | Department of Agroecology, iClimate, CBIO, Aarhus University | Department of Agricultural Engineering, Geisenheim | Department of Agricultural Engineering, Geisenheim, Germany | School of Biosystems and Food Engineering, Agriculture and Food Science, Dublin | School of Biosystems and Food Engineering, Agriculture and Food Science, Dublin | CNR-IBIMET | BEIA Consult International, R&D Department, Bucharest | BEIA Consult International, R&D Department, Bucharest | Department of Agricultural Engineering, Von-Lade-Straße 1, 65366 Geisenheim, Germany | Hochschule Geisenheim University, Department of Agricultural Engineering, Von-Lade-Straße 1, 65366 Geisenheim, Germany

Abstract ID: 142
Topic: Crop
Presenter Name: Davide Cammarano
Contribution: Post

The wine-making industry plays a significant role in the agri-food sector and numerous studies based on life cycle assessments (LCAs) have demonstrated the substantial environmental impact of cultivation operations. However, the estimation of emissions from field operations is not easy and it may lead to inaccurate analysis due to the lack of site-specific data, resulting in under- or overestimation. It is important to evaluate the factors contributing to the environmental impact of grapevine cultivation, particularly as it is vulnerable to the effects of climate change but, at the same time, it has potential to mitigate it by acting as a C sink. Oenotrace is a European project that aims to establish a data-based infrastructure for tracing sustainable practices in grapevine growing. A major challenge within the project is to quantify the environmental impact of grapevine cultivation comprehensively. The project aims to provide sustainability metrics that can be used by various stakeholders within the wine-making sector and communicated to customers. In the initial phase of the project, the prevailing aspects that contribute to the environmental impact have been identified in two different territories, Italy and Germany. To estimate the balance in the CO_2 fluxes from anthropogenic and natural origins observable during the growing season, an experimental sensor-based data acquisition architecture has been designed. Process-based modeling, coupled with remote and proximal sensors and machine telemetry module will be used. The latter allows for monitoring the machine-related emissions during field operations. A further IoT-architecture will be designed to transfer this monitoring approach to a use case on a commercial winery in Germany. This architecture encompasses the entire value chain up to the distribution of the wine in order to transfer the vineyard-related sustainability metrics to the customers. A thorough mapping of the actual state at the use case winery highlighted significant technical challenges, such as the considerable diversity in farming practices and organizational structures that can affect the impact factors or the absence of compatibility among the existing production management software. These will be overcome by means of IoT technology and a data

platform, which will serve as a pivotal point for automated data aggregation and management, as well as the involvement of stakeholders. These first results propose a starting point for developing precise data-driven environmental impact analysis approaches for future viticulture.

Implementation, calibration and validation of the EPIC model for predicting the fate of Glyphosate and AMPA across agroecosystems of the Veneto region

by Giovanna Piazzon | Matteo Longo | Sebastiano Rocco | Francesco Morari | Nicola Dal Ferro | DAFNAE, University of Padova | DAFNAE, University of Padova | DAFNAE, University of Padova | DAFNAE, University of Padova | DAFNAE, University of Padova

Abstract ID: 146
Topic: Crop
Presenter Name: Giovanna Piazzon
Contribution: Post

Crop protection through using plant protection products (PPPs) raises concerns due to their potential environmental impacts, particularly on the soil and water within agroecosystems. Understanding the fate of PPPs in the environment is challenging, as various and inter-related processes influence their degradation, adsorption, or surface and movement through leaching or preferential pathways. The aim of this study was to implement, calibrate and validate the biogeochemical model EPIC (Environmental Policy Integrated Climate) to describe the fate of glyphosate (GLY) and AMPA across different agricultural systems and pedo-climatic conditions of the Veneto Region, using a series of data collected in the field that showed some preferential flow movements. The EPIC implementation was carried out with regard to optimizing: i) the preferential flow of GLY and AMPA movement down to the water table bypassing the soil profile, thereby describing the fast movement of the solute that often occurs in the field; ii) the half-life of PPPs in the soil, whose algorithm estimated the degradation based on environmental conditions (e.g., temperature, soil moisture); iii) the adsorption coefficient in the soil all along the soil profile, which was able to describe the non-linear repartition of the molecule between soil and water. The EPIC calibration and validation were performed thanks to previously collected field data that came from different experiments across a range of agroecosystems in the Veneto region, where GLY and its metabolite AMPA were used as tested molecules. In the low-lying Venetian plain (Legnaro municipality), conventional and conservation agriculture were tested on crops (i.e. maize and sorghum) in a silty loam soil under shallow water table conditions. In two additional foothill areas in Conegliano and Valdobbiadene municipalities, where vineyards are cultivated extensively, GLY and AMPA were monitored under free drainage conditions in silty and sandy loam soils originated from gravelly and calcareous high plains and terraces, and fluvioglacial deposits respectively. In all three sites, soil temperature and moisture dynamics were monitored, and pore water (15, 30, 60 cm) and groundwater were sampled to describe solutes dynamics. Results showed that EPIC model was able to simulate well the crop growth, as well as describe water and solute dynamics in the different agroecosystems. In particular, EPIC correctly described the GLY degradation dynamics in the surface layer, which was estimated to be faster in croplands (about 15 days) than in vineyards (in the range of 28 to 43 days). Regarding the vertical movement, the implementation of the

preferential flow algorithm was able to predict the preferential pathways along the soil profile and down to the water table (<1%). This overcomes the limitations of the original EPIC that prevented GLY movement in the deeps layer (<20cm) due to the high adsorption coefficient. The new model will enable the identification of most susceptible agroecosystems to PPPs contamination at the regional scale, driving farmers and policymakers towards management practices that best combine crop protection and environmental issues.

Cultivation and Weed Management in Traditional and Innovative Systems: Comparing Tractor and Robot

by Nebojsa Nikolic | Marco Sozzi | Luigi Sartori | Francesco Marinello | Roberta Masin | DAFNAE, University of Padova | TESAF, University of Padova | TESAF, University of Padova | TESAF, University of Padova | DAFNAE, University of Padova

Abstract ID: 147
Topic: Crop
Presenter Name: Nebojsa Nikolic
Contribution: Post

Weed management is crucial in agricultural production due to weeds being a primary constraint for plant growth. Conventional agriculture relies heavily on herbicides, which, despite their effectiveness, pose significant risks to ecosystems and human and animal health. Additionally, the development of herbicide resistance and challenges in producing new formulations necessitate alternative weed control methods. National and international regulations also call for reduced pesticide use, underscoring the urgent need for innovative solutions in the face of a growing global population and increasing food demand. This study explores mechanical weed control using the precision weeder Rotosark (OliverAgro s.r.l., Verona, Italy), paired with either a standard tractor or the autonomous agricultural robot 'Robotti 150 D' (Agrointelli, Aarhus, Denmark). Given that robotic systems can perform multiple agricultural tasks, this study also examines operational differences between these systems. The experiment was conducted in a maize field at the University of Padova's experimental farm ‘Lucio Toniolo.’ Field parcels were divided into two groups: one managed by a tractor and the other managed by the robot. Both groups were maintained separately from sowing to harvest. Weeding was performed at speeds of 5 km/h and 3 km/h, with weed presence monitored through ground surveys. Results demonstrated that both the robot and tractor achieved approximately 95% weed control efficiency, with no significant differences observed between methods or speeds. Species-level analysis also showed no significant differences. Furthermore, final weed biomass was comparable between the robot- and tractor-managed plots. Notably, the use of the robot facilitated a reduction in soil compaction, with average bulk density measured at 1.35 g cm^{-3} in robot-managed plots compared to 1.39 g cm^{-3} in those managed by the tractor. Additionally, volumetric water content was higher in robot-managed plots (0.168 cm^3 cm^{-3}) compared to tractor-managed plots (0.159 cm^3 cm^{-3}), which can be attributed to the lighter weight and reduced soil disturbance by the robot. This improvement is attributed to fewer passes and optimized driving routes, facilitated by controlled traffic farming techniques. In conclusion, the study indicates that autonomous robotic weeding is as effective as traditional tractor-based methods, highlighting the potential for autonomous systems to achieve comparable weed control results to conventional practices with added benefits in soil health and moisture retention. The reduction in soil compaction underscores the significant potential for advanced mechanization to enhance sustainability in agricultural practices, further mitigating the environmental impact of traditional farming methods.

Exploring the potential of genotypes and innovative agronomic techniques to enhance the productivity and sustainability of durum wheat farming

by Antonio Favara | Silvia Zingale | Giuseppe Indovino | Valentina Formica | Sebastiano Infantino | Paolo Guarnaccia | Nino Virzì | Antonino Zappalà | Antonio Leonardi | Stefania Licciardello | Fabiola Sciacca | Antonio Carlo Barbera | Department of Agriculture, Food and Environment - University of Catania | Department of Agriculture, Food and Environment - University of Catania | Department of Agriculture, Food and Environment - University of Catania | Department of Agriculture, Food and Environment - University of Catania | Department of Agriculture, Food and Environment - University of Catania | Department of Agriculture, Food and Environment | CREA - Centro di ricerca Cerealicoltura e Colture Industriali (CI), sede di Acireale (CT) | CREA - Centro di ricerca Cerealicoltura e Colture Industriali (CI), sede di Acireale (CT) | CREA - Centro di ricerca Cerealicoltura e Colture Industriali (CI), sede di Acireale (CT) | CREA - Centro di ricerca Cerealicoltura e Colture Industriali (CI), sede di Acireale (CT) | CREA - Centro di ricerca Cerealicoltura e Colture Industriali (CI), sede di Acireale (CT) | Department of Agriculture, Food and Environment - University of Catania

Abstract ID: 149
Topic: Crop
Presenter Name: Silvia Zingale
Contribution: Post

Durum wheat (DW), the main cereal staple crop of the Mediterranean region, is currently in crisis. Traditionally grown using conventional tillage methods under rain-fed conditions, its production and quality are threatened by environmental stresses such as drought and high temperatures. In addition, concerns about the impact of durum wheat supply chains on climate change, mineral resource depletion, land occupation, and biodiversity loss are rising. In response to these challenges, various adaptation strategies are being explored to maximize yield potential and quality while ensuring long-term environmental sustainability. This study assessed the impact of different wheat genotypes and sustainable agronomic techniques on DW's main bio-agronomic and productive traits. The trials were carried out during the 2022/2023 growing season at the experimental field of ‘Azienda Libertinia’ of the Council for Agricultural Research and Economics (Ramacca CT, 37°32’ N; 14°34’ E; 189 m a.s.l.), as well as in pots at the Department of Agriculture, Food, and Environment of the University of Catania. A three-factorial experimental for each experiment with Genotype (two durum wheat genotypes, including the landrace ‘Margherito’ and the modern variety ‘Antalis,’ and one bread landrace ‘Maiorca’), Arbuscular Mycorrhizal Fungi (AMF) field-inoculation, and Intercropping with *Trifolium repens,* were carried out in a split-plot design. The genotype's main bio-agronomic traits, plant heading period, plant height, SPAD readings, grain yield, and its components and quality traits (thousand kernel weight, hectoliter weight, protein content) on harvested grains were evaluated. Data were subjected to statistical analysis through a three-way analysis of variance (ANOVA) and the Tukey test with a significance level set at $p<0.05$. The results from the field experiment showed that the genotype factor significantly affected grain yield, plant height, days to heading,

chlorophyll content (SPAD), thousand kernel weight, and protein content. In particular, the modern variety 'Antalis' performed better in grain yield and SPAD readings, while the landrace 'Margherito' stood out for having higher thousand kernel weight and protein content. As expected, significant differences were found in plant height and days to heading, with the landraces being taller and later. Concerning the investigated agronomic techniques, neither intercropping nor the field inoculation with AMF played a significant role in any assessed traits, nor did the interaction among the factors. These results were confirmed also by those from the experiment in pots, except for the AMF inoculation's significant effect on the SPAD readings. In the latter case, the mycorrhized plants constantly showed significantly higher values than the non-treated plants throughout the crop cycle. Overall, this study’s findings highlight the potential for improving durum wheat production and quality through genotype selection while calling for further research on sustainable agronomic practices for ensuring eco-efficiency.

Cover cropping strategies for the sustainable weed management in a Mediterranean citrus grove

by Salvatore Alfio Salicola | Alessia Restuccia | Cristina Abbate | Gaetano Pandi no | Aurelio Scavo | Giovanni Mauromicale | Sara Lombardo | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Veterinary Sciences, University of Messina | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Agriculture, Food and Environment (Di3A), University of Catania

Abstract ID: 150
Topic: Crop
Presenter Name: Sara Lombardo
Contribution: Post

Grown as a single crop or in combination, cover crops offer several ecosystem services to reach the sustainable development goals of the United Nations. In particular, the ability of cover crops to control weeds is one of their main advantages, representing them a valuable alternative to conventional tillage and herbicide use for weed suppression in annual and perennial agricultural system. In this framework, a 2-year study, funded within the PNRR 'National Research Centre for Agricultural Technologies (Agritech)' Project, was performed on blood orange (*Citrus sinensis* L. Osbeck) cv. Moro, in a Mediterranean environment (Sicily, South Italy), to evaluate cover crop biomass production and the effects on weed soil seed bank, aboveground biomass, species richness and association between communities. The experiment was arranged as a completely randomized block design with three replicates and included three cover cropping treatments: (i) *Trifolium subterraneum* L. cover cropping (TS); (ii) *T. subterraneum* + *Festuca arundinacea* Schreb. cover cropping (TS+FA); (iii) unweeded control (UC). The experimental size was about 200 m^2 per treatment. In particular, the area of each plot was 14 × 5 m, with a distance of 2 m between treatments. Cover crop seeding was performed on Nov. 2022 and 2023 by hand, at 2–3-cm depth, using 2,000 germinable seeds m^2 of *T. subterraneum* (cv. Seaton Park) for the TS treatment or 1,400 and 1,600 germinable seeds m^2 of *T. subterraneum* and *F. arundinacea* (cv. Kora), respectively, for the TS+FA treatment. Monitoring of floristic indicators was carried out through field scouting to select, per each treatment, the sampling zones, where permanent 0.25 m^2 quadrats were randomly placed and soil vegetation coverage was estimated according to Braun-Blanquet scale. The aboveground biomass of both weeds and cover crops was carried out by clipping at soil surface from 0.25 m^2 patches per quadrat. In the laboratory, for TS and TS+FA treatments, cover crop biomass was separated from weed species and samples were dried at 55 °C up to constant weight for dry biomass determination. In addition, clipped weeds were identified. Our results highlighted the good soil coverage obtained with the selected cover crops, although *T. subterraneum* showed a faster growth and soil coverage rate when mixed with *F. arundinacea*, as a consequence of the positive competitive stimulus provided by *F. arundinacea*. The adoption of TS and

TS+FA cover crops effectively controlled weeds than the control, as expressed by the values of weed aboveground biomass. In particular, both TS and TS+FA were able to suppress some of the most present weed species, e.g. *Oxalis pes-caprae* L., *Medicago sativa* L. and *Polygonum aviculare* L. However, it appeared necessary to corroborate the present results through further experimental trials already planned.

The cover crops selection for the agroecological weed management in Southern Italy vineyards

by Salvatore Alfio Salicola | Aurelio Scavo | Modaffari Antonino | Stefano Bortolussi | Cristina Abbate | Umberto Anastasi | Alessia Restuccia | Giovanni Mauromicale | Alexandros Tataridas | Helena Freitas | Sara Lombardo | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Veterinary Sciences, University of Messina | Italian Association for Organic Agriculture (AIAB) | Italian Association for Organic Agriculture (AIAB) | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Agriculture, Food and Environment (Di3A), University of Catania, 95123 Catania, Italy, | Department of Agriculture, Food and Environment (Di3A), University of Catania | Laboratory of Agronomy, Department of Crop Science, Agricultural University of Athens | Centre for Functional Ecology, Department of Life Sciences, University of Coimbra | Department of Agriculture, Food and Environment (Di3A), University of Catania

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Topic: Crop
Presenter Name: Sara Lombardo
Contribution: Post

The sustainability of farming systems in the European Union (EU) is adversely affected by weeds, so relying to a large extent on herbicides. In order to support the shift to resilient and sustainable agricultural systems, the EU Farm to Fork strategy has made reducing the use of herbicides and associated risks one of its main policy goals. In this view, the Horizon Europe 'Agroecology for weeds – GOOD' project aspires to create and evaluate Agroecological Weed Management (AWM) systems in several European Countries, based on a proper choice of the cover crops species for the specific pedoclimatic conditions of the involved cultivation areas. In this view, the present study was directed to highlight the impact of three cover crops (*Vicia faba* L. *minor*; *Trifolium alexandrinum* L.; *Vicia villosa* Roth. + *Avena sativa* L.), in comparison with a control (unweed), on weed aboveground biomass, species richness and association between communities. The experimental trials, through a living lab approach, were established in Calabria (South Italy) in two private vineyards under either organic (ORG; 37° 56' 27" N, 16° 00' 01" E) or conventional (CON; 37° 56' 32" N, 15° 59' 54" E) crop management system. The zone is subjected to a semiarid-Mediterranean climate, characterized by mean annual precipitations of about 500 mm, hot-rainless summers and mild winters. For each crop management system, the experiment was set-up in a randomized block design with three replicates. After seedbed preparation through soil tillage, cover crops seeding was handly performed on December 2023 at the following doses: 180–25 and 25+30 kg ha^{-1} for *V. faba* L. *minor*, *T. alexandrinum* L. and mixture of *V. villosa* Roth. and *A. sativa* L., respectively. Crop management in the ORG vineyard was provided according to EU regulation, whereas in the CON ones as usual local practices. In March monitoring of floristic indicators was performed by field scouting to obtain a representative view of the weed flora and locate the sampling units. Within the latter, permanent 0.25 m^2 quadrats were randomly placed and soil vegetation coverage was estimated according to Braun-Blanquet scale. The aboveground biomass of both weeds and

cover crops was obtained by clipping at soil surface from 0.25 m^2 patches per quadrat. In the laboratory, cover crop biomass was separated from weed species and samples were dried at 55 °C up to constant weight for dry biomass determination. For the weed flora analysis, clipped weeds were identified. On the whole, the cover crops treatments reported a major soil coverage in the ORG cropping system, with *V. faba* L. *minor* and mixture of *V. villosa* Roth. and *A. sativa* L. relying better performances. All the cover crops under study had an effective control of the main weeds present [e.g. *Cynodon dactylon* (L.), *Senecio vulgaris* L. and *Brassica fruticulosa*] with higher performances by adopting *V. faba* L. *minor*. These preliminary results also suggested that, considering the drought local climate, a timely establishment of cover crops is needed for an effective control of the main weeds present in the geographical area.

Reduction of N input using seed treatment and foliar fertilisation: impact on yield and quality of barley

by Lucia Ottaiano | Ida Di Mola | Eugenio Cozzolino | Gregory Mazzarelli | Sabrina Nocerino | Fabio Brancato | Giovanni Salzano | Enrica Buonocore | Roberto Frusciante | Mauro Mori | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | CREA, Research Center for Cereal and Industrial Crops | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II

Abstract ID: 153
Topic: Crop
Presenter Name: Lucia Ottaiano
Contribution: Post

This study was aimed to evaluate the effect of seed treatment and foliar fertilization of barley in Mediterranean cropping systems, for limiting the direct nitrogen input. The study was carried out in Frignano (68 m a.s.l., Campania region, Italy) at the private farm "D' Amore Francesco". The soil had sandy clayey loam texture and a good fertility (OM=1.81%, total N= 0.11%). The sowing was made on February 24 2023, with a density of 400 seeds per square meter. Two varieties of Barley (Extase and Laureate) were cultivated under 5 different nitrogen (N) management strategies: the ordinary farm fertilization as Control (Conv)= 120 kg N ha^{-1}; 75%Conv = 90 kg N ha^{-1}; 75%Conv + seeds tanning (75%Conv-S); 75%Conv + foliar fertilizer (75%Conv-F); 75%Conv + seeds tanning + foliar fertilizer (75%Conv-S-F). Each treatment was replicated three times and each plot was 10 m^2 (2 x 5 m). The two products were supplied by AGRIGES srl; the seed tanning product was Biosemina PW PRO N BIO 8.1% (ST), a powder product containing different microorganisms, including plant growth promoting rhizobacteria (PGPR) and phosphate-solubilizing bacteria (applied to sowing); the second one was Cynoil z Special, an algae-derived product (distributed on March 30 and May 3). At harvest (July 7st), the following measurements were made: total biomass, number of spikes per square meter, grain yield and protein content of kernels. It was also calculated harvest index (HI) by dividing grain yield per total biomass. Between the two varieties, Laurate showed the best productive performance (2.3 vs. 2.0 t ha^{-1} grain yield, and 838 vs. 762 spikes m^{-2}); it also had the highest value of total biomass and HI: +8.0 and 2.8% compared to Extase. Instead, as regards the fertilization strategies, our findings indicate that the combination of seed tanning and foliar fertilization was able to compensate the reduced N dose; in fact, the highest grain yield was recorded in the 75%Conv-S-F treatment that elicited a 74.6% increase compared to the mean value of the all-other treatments. Similarly, it also showed the highest values of total biomass, number of spikes m-2, and HI: +67.5, 13.6, and 5.7% compared to the average value of the other four treatments. Finally, grain protein content was higher in Laurate compared to Extase and in plant of Con75%, probably also due to lower production. According to our results, a reduction of N inputs can be a sustainable option for barley cultivation if coupled with biostimulants applications. This can allow a

reduction of costs associated to N inputs limiting also N dispersion to the environment but preserving yield and quality of barley.

FORAGE-MED: Sustainable intensification of legume-based forage systems in semi-arid Mediterranean areas

by Antonio Pulina | Alice Palimodde | Davide Fois | Teresa Murgia | Aurora Maio | Francesca Calderone | Aurelio Scavo | Danilo Scordia | Fabio Gresta | Antonella Iurato | Alessandra Piccitto | Paolo Caruso | Giorgio Testa | Giovanna Seddaiu | Department of Agricultural Sciences, University of Sassari | Department of Agricultural Sciences, University of Sassari | Department of Agricultural Sciences, University of Sassari | Department of Agricultural Sciences, University of Sassari | Department of Veterinary Science, University of Messina | Department of Veterinary Science, University of Messina | Department of Veterinary Science, University of Messina | Department of Veterinary Science, University of Messina | Department of Veterinary Science, University of Messina | Department of Agriculture, Food and Environment, University of Catania | Department of Agriculture, Food and Environment, University of Catania | Department of Agriculture, Food and Environment, University of Catania | Department of Agriculture, Food and Environment, University of Catania | Department of Agricultural Sciences, University of Sassari

Abstract ID: 154
Topic: Crop
Presenter Name: Antonio Pulina
Contribution: Post

There is considerable emphasis on low input and efficient agricultural systems that reduce costs, promote environmental production policy, and promote the self-sufficiency of farms. The sustainability of agri-livestock farms can be facilitated by enhancing the role of forage legumes, which contribute to the N economy through N fixation, their high feeding value and their ability to improve and maintain soil fertility. The sustainability of these systems requires practices leading to a sustainable intensification aiming to reverse the abandonment and degradation trends in marginally productive areas and to address the main limiting factors that burden organic Mediterranean cropping systems. The FORAGE-MED project (PRIN2022, Italian Ministry for University and Research, 2023-2025) aims to fill the knowledge gaps on the effectiveness of sustainable intensification strategies for legume-based forage systems in the Mediterranean environments of Sicily and Sardinia. The research activities will be carried out using an on-farm approach that integrates field experiments, crop modelling, and remote sensing. The project's specific objectives are: i) to assess the impacts of both intercropping and rotation with legume species in the Mediterranean forage cropping systems on forage yield and quality and some associated ecosystem services (i.e., weed control, N and C cycling); ii) to assess the impacts of legume species overseeding in the Mediterranean extensively managed grasslands on forage yield and quality and some associated ecosystem services (i.e., N and C cycling); iii) to assess the mid and long-term impacts of legume oversowing in the Mediterranean extensively managed grasslands through the integration of remote sensing and crop modelling approaches; iv) to disseminate results and build concrete actions to promote the capacity building of young researchers, students, technicians, and farmers. All the research activities will be carried out using an on-farm research approach that integrates field experiments, crop modelling, and remote sensing. The scales of the investigation will be mainly the plot

and the cropping systems at the farm scale. For this reason, much of the baseline information is already available on these private farms. Field studies will be carried out through randomised plot studies within private farms, introducing experimental factors and an observational approach. The introduction of practices integrating innovative legume-based farming systems with conservation agriculture systems can play a pivotal role in marginal Mediterranean areas and organic farming systems because they can strongly support local economic growth based on typical food products. The ambition of FORAGE-MED is to offer a valuable perspective for satisfying the general expectations of agricultural systems for enhancing food and feed quality reducing inputs, costs, and impacts on the environment.

Seeds tanning with four different organic products: effect on yield and kernels quality of common wheat

by Eugenio Cozzolino | Ida Di Mola | Lucia Ottaiano | Maria Eleonora Pelosi | Antonio Minoliti | Ferdinando Esposito | Giovanni Salzano | Mohamed Houssemededine Sellami | Roberto Frusciante | Mauro Mori | CREA-CI | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II | DIA, Università di Napoli Federico II

Abstract ID: 155
Topic: Crop
Presenter Name: Eugenio Cozzolino
Contribution: Post

The aim of this research was to evaluate the effect of seeds tanning, using four different organic products, yield and kernels quality of common wheat. The test was carried out at the Gussone Park, an experimental site of the Department of Agricultural Science (Portici - Naples). Four organic products for tanning seeds were compared: 1) Coveron (Hello Nature srl), a liquid formulate with Glomus spp., Trichoderma atroviride and rhyzoshere bacteria - Cov; 2) Bio-Semina PW (Agriges srl), a microbial powder product containing plant growth promoting rhizobacteria (PGPR), phosphate-solubilizing bacteria, and mycorrhizal fungi - PW; 3) Bio-Semina LQ Plus (Agriges srl), a microbial liquid product with mycorrhizal fungi, beneficial microorganisms of the rhizosphere, and PGPR -LQ; 4) Aquamin (Hello Nature srl), a plant biostimulant with amino acids and peptides -AQM. They were compared to a not treated control (CTR). Each treatment was replicated three times. Common wheat cv. "*SY Cicerone*" was sowed at December 22, 2022 with a density of 400 seeds m^{-2} and harvested at July 04, 2023. Before the sowing, the seeds were tanned according to the indications of manufacturers. Only nitrogen was added as urea (46%N) at a dose corresponding to 150 kg ha^{-1} while pest and weed control was managed according to ordinary practices. At the harvest, per each replicate, a 1 m^2 sampling area was cut in order to determine total biomass, grain yield, and number of spikes per square meter; then, the following qualitative traits of kernels were assessed: 1000 seed weight, percentage of humidity, shrinking, protein, gluten, and Zeleny value. The mean value of total biomass and grain yield were 21.9 and 9.7 t ha^{-1}, respectively; as expected, the lowest value of both parameters was recorded for Control plants (18.9 and 8.8 t ha^{-1}, respectively). All four treatments elicited an increase in total biomass and grain yield but, for the first one, only LQ was different from Control (+27.6%) while, for grain yield, LQ and AQM was statistically higher than CTR (+18.6%). LQ showed the highest value of spikes per square meter (802.7) contrarily to Aquamin that had lowest value (631.1) but not different from CTR. Among the qualitative traits, only protein and gluten percentage, and Zeleny were significant. The mean values of kernels shrinking, 1000 seeds weight, and humidity were 0.87%, 35.8 g, and 11.6%, respectively. All seeds tanning treatments increase the percentage of protein and gluten (+16.1 and 19.7%; on average, compared to Control) without differences among them; for the protein

percentage, AQM was not different from CTR. Finally, the protein quality (Zeleny value) was improved by all seed tanning (on mean, +39.9% compared to Control) but, again, AQM was not different from CTR. Overall, all seed tanning improved yield and some qualitative traits of kernels except for Aquamin that improved only yield, probably due to its different composition.

Low-Input Fertilization Of Corn: Effect Of Organic soil improvers And Microbial Biostimulants On Crop Growth In Soils With Different Textures

by Eugenio Cozzolino | Ida di Mola | Lucia Ottaiano | Carlotta Falco | Maria Eleonora Pelosi | Antonio Minoliti | Ferdinado esposito | Nunzio Fiorentino | Anna Verde | mauro.mori | Crea di Caserta | DiA Università Federico II | DiA Università Federico II | DiA Università Federico II | DiA Università Federico II | DiA Università Federico II | DiA Università Federico II | DiA Università Federico II | DiA Università Federico II | DiA Università Federico II

Abstract ID: 158
Topic: Crop
Presenter Name: Eugenio Cozzolino
Contribution: Post

The aim of the current research was to verify the agronomic response of grain maize to two different organic soil improvers of zootechnical origin in combination with a microbial-based biostimulant, on soils with different textures. The test was carried out from March to August 2023 at the experimental site of the Department of Agricultural Science, in Portici (Naples, Italy). The experimental design was a factorial combination between three types of soil (clay, sandy and loamy-soil), four fertilization strategies (not fertilized -CTR; treated with vermicompost –VCM; treated with digestate –COM; treated with mineral -Min), and two biostimulant strategies (application of Lifestrong VAM Superb -Bio and not-treated -NoBIO). The dose of nitrogen was calculated according to the balance method and it was 130 kg ha –1 . The vermicompost and digestate were entirely distributed at the pre-sowing. Instead, the mineral fertilizer was distributed as ammonium nitrate (26% N) in two times (at the fourth and eighth leaf stage). The application of the biostimulant "Lifestrong VAM SUPERB" based on mycorrhizal fungi and beneficial rhizosphere bacteria, was carried out in a single application at the fourth leaf stage, with a dose corresponding to 5L per hectare. The harvests were made on August 4 on clayey and loam soil plots, and August 10 on sandy. Six plants for each replicate were harvested, the biomass was cut and its components(stalks, leaves, and ears) were separately weighed and then oven-dried at 60 °C until reaching constant weight. In sandy soil, mineral fertilization elicited the highest value of total biomass; differently, in clay and loamy soils, there were no significant differences between the fertilization strategies (organic and mineral) which also were not different from the unfertilized control. In sandy soil, the application of biostimulants prompted an increase of approximately 21% in total biomass production. Similarly, in sandy soil, the highest value of grain yield was recorded when plants were treated with biostimulant (+36.3% compared the mean value of the other treatments). Finally, as regards the protein content of grain, the lowest values were recorded in sandy soil; irrespective of soil texture, the vermicompost and mineral fertilization elicited the highest protein content. The biostimulant application also determined an increase in protein content but significant only in sandy soil. Our results provide specific information regarding the possibility of applying organic soil improvers and

microbial biostimulants in a combined way to manage corn nutrition. This information is fundamental with a view to valorize waste zootechnical products and to reduce N inputs from synthetic fertilizers.

Effect of different doses of chitosan application on lettuce Cappuccia yield and quality

by Maria Eleonora Pelosi | Eugenio Cozzolino | Ida Di Mola | Lucia Ottaiano | Enrica Buonocore | Fabio Brancato | Mohamed houssemeddine Sellami | Mauro Mori | DIA, Univ di Napoli, Federico II | DIA, Univ di Napoli, Federico II | DIA, Univ di Napoli, Federico II | DIA, Univ di Napoli, Federico II | DIA, Univ di Napoli, Federico II | DIA, Univ di Napoli, Federico II | DIA, Univ di Napoli, Federico II | DIA, Univ di Napoli, Federico II

Abstract ID: 159
Topic: Crop
Presenter Name: Maria Eleonora Pelosi
Contribution: Post

In a sustainable perspective, it is essential to use scientific progress to reduce the environmental impact due to excessive fertilizer and pesticide use. The application of chitosan-based biostimulants, governed by the 456 of 2022 (EU), is an alternative agronomic method. Its main application is associated with plant defense, mitigating the negative effects of abiotic stress and improving soil properties and preventing nutrient leaching. The aim of the current research was to evaluate the biostimulating effect of chitosan at different concentrations on lettuce typology “Cappuccia” (Lactuca sativa L.) yield and quality. The trial was carried out at the Gussone Park, an experimental site of the Department of Agricultural Science, in Portici (Naples, Italy). The lettuce plants were transplanted in pots, located under a plastic greenhouse, on February 2023, and harvested after 60 days. The experimental design was completely random design; two different concentrations of chitosan were applied: 50% (BIO50), and 25% (BIO25) and they were compared to a not-treated Control. Each treatment was replicated three times for a total of 18 pots. The chitosan was applied as a foliar spray after transplanting, and then every fifteen days per a total of four applications. At harvest, the lettuce heads were cut and weighed, then they were cleaned and again weighed in order to obtain the marketable yield. A representative sample per each treatment, was frozen and, then, lyophilized in order to assess the following qualitative traits of lettuce head: ascorbic acid, antioxidant activity, phenols and chlorophyll. The BIO50% treatment boosted the lettuce yield (+37% vs. Control and +27% vs BIO25%). As regards the quality characteristics, the BIO50% and BIO25% treatments elicited a higher ascorbic acid content compared to the control (+57%). The value of lipophilic antioxidant activity reached the highest value in BIO50%, while phenols was higher in the BIO25% treatment compared to the other two treatments. As regards the other analyzed parameters, they were not significantly affected by the chitosan application. By our preliminary findings, this study shows a positive effect of the BIO50% treatment on yield and of the BIO50% and BIO25% treatments on some quality aspects of the lettuce.

Effect of different seed dressing solutions on durum wheat root system and chlorophyll content

by Angelo Rossini | Roberto Ruggeri | Francesco Rossini | Department of Agriculture and Forest Sciences, University of Tuscia | Department of Agriculture and Forest Sciences, University of Tuscia | Department of Agriculture and Forest Sciences, University of Tuscia

Abstract ID: 162
Topic: Crop
Presenter Name: Angelo Rossini
Contribution: Post

Seed treatment with biostimulants appears to be a sustainable and economically valid option to ensure a good plantings establishment in different conditions and to promote crop yield as well. However, the limited literature describing the industrial seed application of plant biostimulants evidenced contrasting results, caused by the plethora of active compounds used and the interactions among them and with the different growing conditions and crop species. To explore better the effect of different seed coating products on durum wheat response, a field experiment was conducted under rainfed conditions in Viterbo (central Italy), during 2023-2024 season. The following hypotheses were tested: (i) when compared to untreated seeds, biostimulant seed dressing significantly improves root development as well as chlorophyll content of plants; (ii) the effect is improved by combining different products. A randomized complete block design with three replicates was used. Viable seeds of durum wheat (*Triticum turgidum* L. subsp. *durum* (Desf.) Husn) cultivar ‘Odisseo’ were treated with the application of four different seed dressings. More in detail, the following solutions were applied: (i) a commercial fungicide (control) containing difenoconazole (25 g/L), fludioxonil (25 g/L) and tebuconazole (10 g/L) with a dose of 200 ml per 100 kg of seeds; (ii) the control treatment mixed with an extract of *Codium fragile* (Suringar) Hariot and an extract of *Opuntia ficus-barbarica* A. Berger (hereinafter referred to as A), with a dose of 300 ml per 100 kg of seeds; (iii) commercial fungicide mixed with an inoculum of mycorrhizal fungi (hereinafter referred to as M), at the dose of 100 g per 100 kg of seeds; (iv) a combination of seaweed extracts, mycorrhizal fungi and the commercial fungicide (hereinafter referred to as AM). All plots were subjected to the following fertilization strategy: one pre-sowing application of 200 kg ha^{-1} of commercial Diammonium Phosphate (NP 18–46), and 300 kg ha^{-1} of Urea (N 46), split in two times, the first one at tillering (150 kg ha^{-1}), and the second at the beginning of the stem elongation (150 kg ha^{-1}). For each treatment, the following traits were recorded at different growth stages: Length (cm), area (cm^2), volume (cm^3), and diameter (mm) of roots using WinRHIZO software; chlorophyll content using the spad meter. Results indicated that, at plant emergence, all biostimulant seed dressings significantly outperformed the control treatment for both root length (from +85% of AM treatment to +94% of A treatment) and coleoptile length (from +12% of AM treatment to +36% of M treatment). However, proceeding with the growing season, only the AM treatment constantly showed a significant better response in terms of both root development and chlorophyll content. Specifically, during grain filling,

root length and chlorophyll content of AM treated plants were 80% and 52% greater than those of control ones.

Phytomanagement of a site contaminated by Pb, As and Sb by using fuel crops.

by Donato Visconti | Linda Carrino | Nunzio Fiorentino | Daniele Todisco | Massimo Fagnano | Department of Agricultural Sciences - University of Naples Federico II | Department of Agricultural Sciences - University of Naples Federico II | Department of Agricultural Sciences - University of Naples Federico II | Department of Agricultural Sciences - University of Naples Federico II | Department of Agricultural Sciences - University of Naples Federico II

Abstract ID: 166
Topic: Crop
Presenter Name: Donato Visconti
Contribution: Post

With the world's rising population, the demand for cropland for both food and energy production is growing, thereby increasing competition between these two land uses. In this context, marginal and contaminated soils, which are not suitable for food crops, are becoming valuable resources to mitigate threats to food security. Although these soils often present challenges for cultivation, phytoremediation with the proper approach can be a viable management option. Linking phytoremediation with economic benefits through the production of valuable biomass and bioenergy crops can provide even greater advantages. This approach, known as phytomanagement, combines targeted site management with gentle remediation options —low-cost, plant-based methods for soil restoration, often facilitated by microorganisms and soil amendments. This study presents the phytomanagement of a former shooting range by using castor bean (*Ricinus communis* L.), a perennial, unpalatable crop, combined with organic amendments and arbuscular mycorrhizal fungi. The soils in the experimental area were contaminated with various potentially toxic elements (PTEs) such as Pb, As, and Sb, the main components of bullets. *Ricinus communis* L. has demonstrated the ability to produce similar biomass and seed yields in both contaminated and uncontaminated soils, regardless of fertilization, indicating its high resistance to abiotic stresses. Biostimulation with arbuscular mycorrhizal fungi reduced contaminant accumulation in the plant. According to the translocation factor, *Ricinus communis* L. primarily accumulated Pb, As, and Sb in the roots, making it a good candidate for the phytostabilization of shooting ranges. As an unpalatable plant, cultivating castor bean in PTE-contaminated soils can reduce contaminant mobility, thereby lowering the risk of these contaminants moving toward other environmental compartments (e.g., air and groundwater) and entering the food chain. Simultaneously, this crop is suitable for producing renewable energy (e.g., biodiesel) on marginal soils, thus avoiding competition with land for food crops and proving to be a strong candidate for sustainable phytomanagement.

The BioAltilis Project: optimizing a sustainable cropping model for producing bioactive compounds in Cynara carduncului var. altilis

by Claudia Formenti | Francesco Pio Bruno | Gaetano Pandino | Corrado Lazzizera | Sara LOmbardo | Giancarlo Patanè | Giulia Conversa | Giovanni Mauromicale | Sergio Lanteri | Lorenzo Barchi | Antonio Elia | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Agriculture, Food, Natural Resources and Engineering (DAFNE), University of Foggia | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Agriculture, Food, Natural Resources and Engineering (DAFNE), University of Foggia | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Agriculture, Food and Environment (Di3A), University of Catania | Department of Agriculture, Food, Natural Resources and Engineering (DAFNE), University of Foggia | Department of Agriculture, Food and Environment (Di3A), University of Catania | DISAFA, Plant Genetics, University of Turin | DISAFA, Plant Genetics, University of Turin | Department of Agriculture, Food, Natural Resources and Engineering (DAFNE), University of Foggia

Abstract ID: 169
Topic: Crop
Presenter Name: Sara Lombardo
Contribution: Post

The cultivated cardoon (*Cynara cardunculus* L. var. *altilis*) is a crop well-suited to the arid and semi-arid regions of the Mediterranean areas. Its cultivation requires minimal external inputs thanks to its deep root system, ability to photosynthesize during wintertime and high capability of nutrient uptake. Alongside the traditional food utilization, the cultivated cardoon is exploited for the extraction of natural bioactive compounds (NBCs), such as polyphenols and sesquiterpene lactones. However, the synthesis and accumulation of NBCs in plants is modulated by environmental conditions, edaphic features and biotic stressors (such as arbuscular mycorrhizal fungi -AMF- colonization). In this view, the aim of this research, performed within the PRIN project 'Tuning of a sustainable cropping model for the production of bioactive compounds in *Cynara cardunculus* var. *altilis* (BioAltilis)', was to set up an eco-friendly cropping model to promote high leaf biomass production and content of NBCs. The field trials carried out in two environments (Sicily and Puglia regions), consisted of a randomized split-plot experimental design, with three replicates, including two soil AMF inoculum applications (mycorrhized, Myco+, *vs*. not-mycorrhized, Myco-), as the main plot, and two planting density (4 *vs*. 2 plants m^{-2}, D_2 and D_1), as sub-plot. For Myco+ treatment, a commercial AMF inoculum (AEGIS IRRIGA®, Italpollina S.p.A., Italy) was applied at the substrate of plantlets before transplant to stimulate the production of NBCs and the growth of the plant, while reducing the need for irrigation and fertilization. At each growing environment, four-week-old seedlings of 'Altilis 41' were transplanted in September 2023. It was selected as a reference genotype due to its known NBCs profile, high level of biomass production and high adaptability to Mediterranean environments. The crop, with the plants still at a rosette stage and with ~20 adult leaves, was subjected to three cuttings of shoots in winter, early and late spring. At each cutting time, determination

of the AMF root colonization indices [frequency (F, %) and intensity (M, %) of root mycorrhizal colonization, and the arbuscule abundance (A, %) in the root system] were performed. In addition, basal and fully developed whole leaves from a sampling area per replicate were collected to determine the leaf fresh biomass, dry matter concentration and dry biomass. At both growing environments, AMF root colonization indices (F, M, and A) were higher in Myco+ than in Mico- treatment. The effects of soil AMF inoculum application on leaf growth seem to be affected by the growing environment and planting density. In both growing environments, the low planting density (D_1) was able to enhance leaf fresh biomass production to be destined for NBCs extraction.

Weed-suppressive ability of selected wheat genotypes with contrasting morpho-phenological traits

by Francesco Tridentino | Fabio Fania | Patrizio Spadanuda | Ivano Pecorella | Salvatore Esposito | Giuseppe Longo | Libutti Angela | Pasquale De Vita | Dipartimento di Scienze Agrarie, Alimenti, Risorse Naturali e Ingegneria (DAFNE) - Università di Foggia | 1 Dipartimento di Scienze Agrarie, Alimenti, Risorse Naturali e Ingegneria (DAFNE) - Università di Foggia | 1 Dipartimento di Scienze Agrarie, Alimenti, Risorse Naturali e Ingegneria (DAFNE) - Università di Foggia | 2 Centro di Ricerca Cerealicoltura e colture Industriali (CREA-CI) | 2 Centro di Ricerca Cerealicoltura e colture Industriali (CREA-CI) | 1 Dipartimento di Scienze Agrarie, Alimenti, Risorse Naturali e Ingegneria (DAFNE) - Università di Foggia | 1 Dipartimento di Scienze Agrarie, Alimenti, Risorse Naturali e Ingegneria (DAFNE) - Università di Foggia | 2 Centro di Ricerca Cerealicoltura e colture Industriali (CREA-CI)

Abstract ID: 171
Topic: Crop
Presenter Name: Pasquale De Vita
Contribution: Post

Weed management is one of the key factors for improving wheat productivity and grain quality in agricultural systems. The rapid expansion of herbicide resistance and the lack of new modes of action require adopting an integrated weed control strategy, including competitive crop varieties. Effectively, crop shading ability may improve weed control without extra costs and negative environmental impacts. Wheat traits such as early vigour, tillering, plant height, flag leaf angle and phenological stage length, which are important for increasing crop yield potential, are also functional in determining the competitiveness against weeds. In the present study, six bread wheat (*Triticum aestivum* L.) genotypes, contrasting for growth habit (spring *vs* winter) and plant height (semi-dwarf *vs* medium-tall), were selected to investigate the relationships among morpho-phenological traits and weed-suppressive ability. The study was conducted at CREA Cereal and Industrial Crops (Foggia) during the 2023-24 growing season by adopting a split-plot design with three replicates. Weed treatment (weed-free and weedy) was the main plot effect and wheat genotypes were the subplot. Weed-free plots were maintained by daily hand-weeding throughout the wheat growing seasons to avoid soil surface disruption, while no weed control was applied in the weedy treatment. The number of weeds and their dry matter production were assessed twice in the growing seasons: at the tillering stage (BBCH 22–31) and in the dough stage (BBCH 85–87) using the weight-counting method, on an area of 0.5 × 1 m in each plot. During the earlier pre-harvest sampling periods, crop canopy measurement was undertaken including normalized difference vegetation index (NDVI) using a GreenSeeker® device, RGB-derived indices using images captured by drone, and leaf area index (LAI). Genotypic differences in the morpho-phenological traits ($P \leq 0.05$) of the selected bread wheat genotypes were detected. The growth habit strongly differentiated the ability to reduce the development of both autumn-winter and spring-summer weeds. The early spring genotypes showed a greater ability to reduce the number of weed species and their dry biomass, probably favoured by the climatic conditions of the experimental site,

even though ~ 70% of the variation in weed-suppressive ability was explained by the final plant height and either canopy height or plant vigour at late tillering. In conclusion, our results showed that genotypes could play an important role in the integrated weed management strategy, paving new ways for breeders to improve weed-suppressive ability using weighted index selection for tall or vigorous genotypes during tillering and showing medium or medium-tall final plant height.

Quinoa (Chenopodium quinoa Willd.) grown in conventional and organic systems: evaluation of genotypes of a breeding program for the Mediterranean environment

by Giuditta De Santis | Francesco Ciavarella | Agata Rascio | Carmen Manganiello | Leonardo Morcone |
Council for Agricultural Research and Economics - Research Centre for Cereal and Industrial Crops |
Council for Agricultural Research and Economics - Research Centre for Cereal and Industrial Crops |
Council for Agricultural Research and Economics - Research Centre for Cereal and Industrial Crops |
Council for Agricultural Research and Economics - Research Centre for Cereal and Industrial Crops |
Council for Agricultural Research and Economics - Research Centre for Cereal and Industrial Crops

Abstract ID: 174
Topic: Crop
Presenter Name: Michele Rinaldi
Contribution: Post

Quinoa (*Chenopodium quinoa* Willd.), a pseudocereal of the Amaranthaceae family, is a seed crop of Andean origin, of considerable scientific and commercial interest, thanks to its high content of high quality proteins (14-20%), unsaturated fatty acids and antioxidants, 5 times higher than those of cereal flours. It is also a gluten-free product, used for years as a new functional food for the production of pasta, bread, biscuits, etc. The growing interest among farmers and agro-industries for quinoa is due to the attractive economic prospects. Quinoa is a rustic plant, capable of adapting to different types of soil, even very saline ones, and to hot-arid environments thanks to its reduced water requirements. However, the lack of varieties selected specifically for Italian environments has led us to start a breeding program to obtain "Made in Italy" quinoa varieties superior in terms of seed production and quality, with low saponin content which reaches complete maturation and has a sustainable yield from an economic point of view. Most of the quinoa in the Italian food market has the "organic" brand and sometimes also the “fair trade” brand. Traditionally in Bolivia, quinoa has always been used in a cultivation system that involved a "quinoa-bare fallow" rotation. Today, however, to increase production, agronomic techniques have become more intensive, in particular for weed control. At now in Italy there are no pesticides registered for quinoa either for the control of parasites or for the weeds control: in this last regard, for example, it is necessary to sow quinoa at spaced rows for weeds mechanical control, both in conventional and biological regimes. Technically, therefore, the cultivation of quinoa with the conventional method is not very different from the organic one, except for the fertilization, mineral and organic products, respectively. To evaluate the differences between conventional and organic cropping systems, 4 quinoa lines, already selected in a previous breeding program and 2 commercial varieties (Regalona Baer and Titicaca), were evaluated for seed yield and its components. The test was conducted at the experimental farm of CREA-CI in Foggia (Southern Italy), for 2 years (2018 and 2019), with sowing in April and harvesting in September, in elementary plots of 20 m2 (4 rows 10m long and 50cm apart), with 3 replicates, in two distinct fields, one of which has been organically managed for 12 years. The obtained data highlighted significant differences between the two cropping systems, for almost all the examined traits. In particular, in organic, the average seed production was almost double in organic compared to conventional, with a range between the genotypes between 60 and 150 g m^{-2}, and 33 and 80 g m^{-2} , respectively, in organic and in conventional. The quinoa lines already previously selected recorded higher seed yields than the group average and the two comparison varieties, in both treatments and in the two years of testing. One of these lines is at now on valuation for at community plant variety office for following registration.

Seaweed extract biostimulant to improve growth and post-harvest quality of spinach

by Giancarlo Pagnani | Afsaneh Nematpour | Silvia Cantalamessa | Lisa Antonucci | Michele Pisante | Università degli Studi di Teramo | Università degli Studi di Teramo | Università degli Studi di Padova | Università degli Studi di Teramo | Università degli Studi di Teramo

Abstract ID: 175
Topic: Crop
Presenter Name: Giancarlo Pagnani
Contribution: Post

Leafy vegetables are highly perishable and affected by pre-harvest and post-harvest conditions. Biostimulants can be used to improve germination, growth, yield and quality of crops. In this study, the effect of a plant biostimulant, Ascophyllum nodosum extract (ANE) on improving growth and minimizing postharvest losses in spinach was evaluated. *Ascophyllum nodosum* extract was used as a concentrated suspension consisting of a high concentration of natural compounds. Foliar application of the biostimulant was made in two treatments of 1 and 1.5 L ha^{-1}. The biostimulant was applied 3 times during the experiments. The first time was at the 3-4 leaf stage, while the others were applied with a time interval of about 10 days. Two open field experiments , with the same treatments, was carried in a randomized complete block design with three replications, in different season. Biostimulant was applied three times from 3-4 leaves stages, with a time interval of approximately ten days. Each time in the period of nearly ten days after using the biostimulant application, one linear m in each replication was harvested for measuring crop growth parameters. Canopy reflectance was measured for each experimental unit with a Spectroradiometer. A one-way analysis of variance was conducted using the general linear model procedure in SAS, on the experimental field data, which followed a randomized block design with three replications. Results show that in both experiments till the 3rd sampling, there was no significant difference between the treatments in terms of fresh weight. While after that, biostimulants application significantly increased fresh weight compared to the control. The highest and lowest fresh weight at the harvest time were recorded on 1.5 L ha^{-1} (3562 g m^{-2}), and control (2292 g m^{-2}), respectively, in experiment A. A similar trend was observed on dry weight and leaf area index. The effects of biostimulants on dry weight were the highest at the 5th sampling (harvest time). For example, changes in the dry weight were the highest (41%) and lowest (26%) in 1.5 L ha^{-1} compared to the control. Furthermore, the amount of pigments at harvest was affected by the biostimulants, with a significant increase in total chlorophyll observed after three treatments compared to the control ($p < 0.01$). This increase was due to the concurrent rise in both Chla and Chlb in both experiments. In addition, carotenoids in 1.5 L ha^{-1} showed a significant increase at harvest in the experiment A compared to the control (35%). NDVI assessments confirmed the positive impact of biostimulants on the physiological traits of spinach. Observed trends indicated that the use of biostimulants after the third application resulted in notable changes. Specifically, the application of biostimulants significantly increased the fresh and dry

biomass and the leaf area index of spinach compared to the control. The trends observed on traits, indicated that the use of biostimulants after the third application led to noticeable changes. The application of biostimulants significantly increased the fresh and dry biomass and the leaf area index of spinach compared to the control.

Assessing the herbicidal activity of some Mediterranean Thymus sp. pl. essential oils

by Rym Boukhalfa | Claudia Ruta | Saida Messgo-Moumene | Generosa Jenny Calabrese | Giuseppe De Mastro | Department of Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro | Department of Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro | University Saad Dahleb- Blida1- Algeria | Centre for Advanced Mediterranean Agronomic Studies (CIHEAM) | Department of Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro

Abstract ID: 177
Topic: Crop
Presenter Name: Claudia Ruta
Contribution: Post

The genus *Thymus* consists of 400 species of herbaceous or sub-shrubs aromatic perennial plants, and it is endemic, widespread and grows wild in the Mediterranean area. Given its different biological activities, *Thymus* species has been largely studied in terms of phytochemistry and several studies revealed that thyme extracts contain different chemical compounds such as phenolic compounds, terpenoids, flavonoids, steroids, alkaloids, tannins, saponins and most of them are volatile compounds extracted from plant essential oil. However, even with proven allelopathic properties, few studies focused on the herbicidal activity of *Thymus* species. Indeed, weeds are the major threat for crop production. Their control is mostly based on the use of synthetic herbicides that pose environmental risks and result in herbicide-resistant weeds. Natural compounds with herbicidal activity could provide suitable solutions. In this sense, our study evaluated the herbicidal activity of four Mediterranean *Thymus* species essential oils, *T. algeriensis* Boiss. et Reut., *T. ciliatus* Desf. subsp. *coloratus* (Boiss. et Reut.) Batt., *T. vulgaris* cultivar Varico 3 and T. *vulgaris* ecotype Fasano, to identify allelopathic or bioactive compounds that may be considered new sources of active ingredients in bioherbicide formulations. The bioassays considered the effect of five concentrations of essential oils (0.1%, 0.25%, 0.5%, 0.75% and 1%) on the inhibition of the germination and seedlings growth of *Lolium perenne* and *Amaranthus retroflexus* under in vitro conditions. The results showed a total inhibition of seed germination and an important reduction of the seedling growth under the effect of 0.75% and 1% concentrations, arguing a strong herbicidal potential of the four Mediterranean studied *Thymus* species. These preliminary results will be confirmed under in vivo conditions and open the way to further research and applicative investigations of the selected species to confirm the feasibility of the approach for sustainable weed control.

Innovative cropping systems on industrial globe artichoke

by Rocco Pierpaolo Germano | Claudia Ruta | Giovanni Manolio | Vincenzo Tommaseo | Alessandro Camarda | Nevio Pasquini | Nicola Secchi | Francesco Alfano | Gianmario Massocchi | Giuseppe De Mastro | Department of Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro | Department of Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro | Department of Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro | X-FARM – Milano | X-FARM – Milano | EurovixS.p.A. – Entratico (BG) | EurovixS.p.A. – Entratico (BG) | Soc. Coop Arl ARPOR – OROGEL-Policoro | Soc. Coop Arl ARPOR – OROGEL- Policoro | Department of Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro

Abstract ID: 178
Topic: Crop
Presenter Name: Rocco Pierpaolo Germano
Contribution: Post

Globe artichoke (*Cynara cardunculus* var*. scolymus* L.*)* is a food plant that is gaining increasing interest due to its commercial, nutritional and therapeutic value. Traditionally, artichoke cultivation in the Mediterranean basin has been based on monoculture and towards the fresh market. Recently, there has been a growing interest in the industrial use of artichokes, which has required a revision of cultivation techniques. Firstly, the choice of variety, with the use of hybrids, followed by irrigation and nutrition, for which there is a lack of studies on their management, which is still based on the empirical experience of farmers. In order to make the industrial artichoke supply chain sustainable, the research aims to compare two management protocols based on the use of biostimulants and the application of irrigation plans based on different percentage of crop evapotranspiration (ETc) replenishment compared to traditional irrigation. The experiment was carried out in the period September 2023 – May 2024 at the experimental teaching centre "E. Pantanelli" of University of Bari in Policoro, Italy. Two Artichokes hybrids were compared, "Capriccio" and "Madrigal" as an industrial variety. The nutritional status of the culture was analyzed using multi-spectral camera installed on Drone. Irrigation was managed by applying three different volumes to evaluate yield and quality of the production. The irrigation volumes were monitored using soil temperature, humidity and water potential sensors. The data acquired will be the basis for the development of a decision support system (DSS) for managing artichoke cultivation with the aim of providing useful tools to help make the industrial artichoke supply chain sustainable. An experiment was conducted based on 80% ETc replenishment (thesis 1) and 95% ETc replenishment (thesis 2) compared to local irrigation management (thesis 3). Within the three irrigation theses, two nutrition plans were tested, one spread across the artichoke district of Basilicata region and the other based on a protocol using commercial biostimulants (Eurovix). The results showed interesting differences comparing the nutritional protocols and irrigation thesis. Capriccio showed an increasing in yield per hectare using biostimulant protocol; different results were observed with Madrigal where biostimulant protocol didn't increase yield per hectare but

significantly increased the number of artichokes harvested. The correlation between the nutritional protocols and the irrigation thesis showed interesting results comparing the thesis 1 of water reduction with the traditional one. Thesis 1 combined with the biostimulant protocol showed an increasing of artichoke harvested per plant in both Madrigal and Capriccio hybrids. Interesting in terms of sustainability were the results relating to the contraction of irrigation volumes and the supply of fertilizers, particularly nitrogen.

Agrobiodiversity and agronomic performance of chickpea field trials in the Apulia Region

by Claudio Calia | Claudia Ruta | Cataldo Pulvento | Diego Antonio Zullo | Michele Antonio Roncetti | Giannicola Caione | Giuseppe De Mastro | Department of Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro | Department of Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro | Department of Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro | Con.Cer. Organisation of cereal producers | Con.Cer. Organisation of cereal producers | Con.Cer. Organisation of cereal producers | Department of Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro

Abstract ID: 179
Topic: Crop
Presenter Name: Claudio Calia
Contribution: Post

Legumes are essential for addressing various social challenges related to agriculture, including climate change mitigation, agrobiodiversity conservation, food security and human health. However, less than 4% of the area in Europe is dedicated to the cultivation of these species. Moreover, monocultures and the cultivation of only commercial varieties further reduce agricultural biodiversity. Climate change and the challenges of intensive agriculture are better managed with genetic diversity. Pulses diversify agricultural production and support the plant-based food supply. Transforming agri-food systems and agricultural value chains is essential to achieve future sustainability goals. Biodiversity-based agriculture aims to redesign agricultural systems by sustainably diversifying biological components and their interactions to improve fertility, productivity and resilience. However, agriculture has not yet achieved its full environmental benefits, particularly in the Mediterranean, where innovation in traditional smallholder farming is urgently needed to ensure stable ecosystem services and resilience to climate change. Legumes can: improve water use efficiency, reduce anthropogenic inputs while maintaining soil fertility, improve ecosystem services, provide healthier and safer protein-rich foods. Moreover, the transition to plant-based diets offers significant opportunities both environmentally and in terms of human health. The field experiment of this study was carried out over two crop cycles (2020-2021 and 2021-2022) and focused on the cultivation of chickpeas. In particular, seven landraces and three commercial varieties were compared in two different growing environments in Apulia, namely Capitanata and Alta Murgia. The experimental design used was a randomized block design. The genetic material used was recovered thanks to small local farmers who self-produced the seed over time. The main areas of origin of the recovered seed is Bari, Valle d'Itria and Salento. The parameters measured were: the height of the first pod, the number of pods, the weight of thousand seeds, yield and protein quantity. The preliminary results showed that the Grumo Appula chickpea (2.3t/ha) and the Muro Leccese chickpea (2.5t/ha) were significantly more productive than the commercial varieties. Moreover, the Muro Leccese had the highest protein value of around 26%. The Capitanata areal was more productive than the Alta Murgia areal even though the latter

gave a higher thousand-seed weight value. The difference in production can be explained by the more extreme soil and climate conditions of the Alta Murgia compared to the Capitanata area. The most productive white local variety in both areas and in both years was the white chickpea of Grumo appula (thousand-seed weight >355g). The white chickpeas with the highest protein value comprise the Locorotondo smooth chickpea in the Murgia area and the Cisternino chickpea in the Capitanata area. In conclusion, from initial research it is possible to note how biodiversity is a resource not only from a genetic point of view but also from an economic and industrial point of view, with the added value of having legumes with a heterogeneous nutritional profile and at the same time preserving local biodiversity.

Oregano and Rosemary as potential source of antimicrobial agents of livestock interest

by Giuseppe Natale Basile | Claudia Ruta | Francesca Maggio | Annalisa Serio | Giuseppe De Mastro | Department of Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro | Department of Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro | Department of Bioscience and Technology for Food, Agriculture and Environment, University of Teramo | Department of Bioscience and Technology for Food, Agriculture and Environment, University of Teramo | Department of Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro

Abstract ID: 180
Topic: Crop
Presenter Name: Giuseppe Natale Basile
Contribution: Post

This research activity focuses on investigating the efficacy of antimicrobial activity of essential oils obtained from the oregano hybrid "Carva" (*Origanum vulgare* L. ssp. *virilidum* x *O. vulgare* L. ssp. *hirtum* (link) Iestwart), and three *Salvia Rosmarinus* L. chemotypes, to be used as feed additives as environmentally sustainable alternative to traditional antimicrobials. At the Experimental Educational Center "E. Pantanelli," University of Bari, samples were collected for each species and cultivar in order to obtain a preliminary assessment of oil yield and subsequent chemical characterization. Samples of flowering shoots were dried in a thermo-ventilated stove at 45 °C, then leaves and flowers were separated and submitted for steam distillation with Clevenger-type apparatus at DiSSPA laboratories. The resulting essential oil samples were stored under refrigeration at 4°C in amber glass containers. Distilled essential oil was analyzed by gas chromatography/mass spectrometry on an HP 6890 coupled to an HP 5972 MSD and equipped with an HP 30 m x 0.25 mm capillary column coated with HP-5MS (film thickness 0.25 (µm)). The analytical conditions were: helium as carrier gas, injector temperature 250 °C, split ratio 50:1, temperature program 60-110 °C with 2 °C/min and 110-220 °C with 10 °C/min. The analyzed components were then identified by the HP Enhanced ChemStation G1701BA Version B.00.00 system by comparing their mass spectra with data in the literature and confirmed by their gas chromatographic retention indices. The activity of the essential oils was determined through the broth microdilution method against 5 microbial strains of livestock interest: *Campylobacter coli, Escherichia coli, Listeria monocytogenes, Staphylococcus aureus and Salmonella enterica* subsp. *enterica* ser. Enteritidis. On the essential oils resulted more effective in terms of MIC were determine the inhibitory capacity against microbial species through in vitro Time Kill Kinetics (TKK) analysis. The percentage yield (w/v) in essential oil of the species of interest were: 2.65% for the oregano Carva, for *S. Rosmarinus* respectively 3.33% (chemotype 1 – Sr1), 2.71% (chemotype 2 – Sr2) and 2.25% (chemotype 3 – Sr3). Characterization of the phytochemical compounds showed that the essential oil of oregano Carva was rich in carvacrol, while *S. rosmarinus* were rich in α-pinene, 1,8 cineol and camphor. The results obtained showed the best antimicrobial efficacy in terms of minimum inhibitory concentration (MIC) and minimum bactericidal

concentration (MBC) against the assayed strains by Carva and Sr2. These two essential oils exhibited the antimicrobial activity at lower use concentration, compared with the other selected ones. The MICs and MBCs detected for Carva corresponded to a range of <0.1 to 6.25 µL/mL. A similar result was obtained for the essential oil Sr2, ranging from <0.1 to 10 µL/mL. The highest activity performed was recorded after incubation for 24 h at 37 °C, after which total inhibition was observed, with a microbial load below the detection limit of the method (<1.99 Log UFC/ml). Therefore, it can be concluded that oregano carva and *S. rosmarinus* Sr2 may be an excellent source of essential oils with good efficacy against selected microbial species of interest to livestock.

Session: SOIL

Phosphorus uptake facilitation in wheat intercropped with legumes implies a great change in root-rhizobacteria-soil interactions.

by Emilio Lo Presti | Tim H. Mauchline | Vanessa N. Kavamura | Michele Monti | Department AGRARIA, University Mediterranea of Reggio Calabria | Rothamsted Research, Harpenden | Rothamsted Research, Harpenden | Department AGRARIA, University Mediterranea of Reggio Calabria

Abstract ID: 43
Topic: Soil
Presenter Name: Emilio Lo Presti
Contribution: Oral

The intercropping of two crops belonging to different functional groups provides certain ecosystem services that increase the agroecosystem multifunctionality, reducing the anthropogenic input and maintaining reasonable yields. Multifunctionality requires knowledge of how service interactions are influenced by species identity and diversity. For this purpose, we focused on the legumes as a functional group which facilitates phosphorus (P) uptake by the intercropped wheat. The greater P uptake observed in intercropping is mostly attributed to legumes' root exudation of organic acids and phosphatases, which modify rhizosphere chemistry. Since the rhizosphere modification drives the selection of specific bacterial communities by providing carbon sources such as organic acids and other metabolites, we hypothesised that there is a contribution of the bacterial community to facilitate the use of sparingly available P by the plants. This study aimed to further understand the influence of P bioavailability on bacterial community selection and whether this can be extended to other crops through intercropping. Pea, lupin and wheat were grown as intercrops and as sole crops at different P availability levels, using a low-P soil from the long-term experiment at Rothamsted Research, amended with available and low-available forms of P. After 62 days of growth, 16S rRNA gene amplicon sequencing was performed from rhizosphere samples, and acid and alkaline phosphomonoesterase (PME) activity was measured. The plant species was the main factor determining the structure of the bacterial community followed by P availability. When P was unavailable or depleted, legume monoculture as well as intercropping, was associated with reduced bacterial species richness and diversity, which was partly explained by an increased relative abundance of *Variovorax*, *Pseudomonas* and *Bradyrhizobium* spp. The complexity and interconnections of the bacterial community were increased in intercropping when P was unavailable as was alkaline PME activity, while the acid PME activity was more affected by the plant. In conclusion, wheat intercropping can generate a more complex and interconnected root-associated bacterial community, which can potentially contribute to the facilitation of P uptake.

LCA methods for soil CO2 emissions in crop-livestock systems

by Pietro Goglio | Simone Pelaracci | Simon Moakes | Marie Trydeman Knudsen | Klara Van Mierlo | Nina Adams | Maxime Fossey | Alberto Maresca | Manuel Romero-Huelva | Muhammad Ahmed Waqas | Laurence Smith | Frank Willem Oudshoorn | Thomas Nemecek | Camillo De Camillis | Giampiero Grossi | Ward Smith | Fracnesco Tei | University of Perugia | university of Perugia | University of Aberyswyth, UK | Aarhus University, Denmark | Wageningen University & Research, The Netherlands | University of Reading, UK | IDELE, France | SEGES, Denmark | CSIC, Spain | Aarhus University, Denmark | University of Reading, UK | ICOEL, Denmark | Agroscope, Switzerland | FAO, Rome | University of Tuscia | AAFC AAC, Canada | University of Perugia

Abstract ID: 96
Topic: Soil
Presenter Name: Pietro Goglio
Contribution: Oral

Accounting of soil carbon is essential to understand and mitigate the impacts of climate change and has been recognized to play an important role in life cycle assessments (LCA) of agricultural systems. In particular, soil CO_2 emissions due to crop and grassland management affect the overall environmental performance of crop-livestock systems as enhanced soil management can have a mitigation potential of 0.3-1.5 Mt of CO_2 worldwide. Several models have been developed and used in agricultural LCA to estimate the amount of carbon stored in the soil, responsible for soil CO_2 emissions. This study evaluates models used for soil carbon accounting in LCA of agricultural systems, using a modified Delphi method to harmonize LCA method for agricultural. A systematic review was conducted with an iterative screening to select relevant literature. The final selection of 63 papers from which 20 methods were further identified and analysed. The identified methods are discussed with a tiered approach similar to the Intergovernmental Panel on Climate Change (IPCC) and the Food and Agriculture Organisation (FAO) Livestock Environmental Assessement and Performance (LEAP) frameworks: Land management (simple empirical) based models (Tier 1); Basic process or complex empirical models (Tier 2); Complex simulation models and direct measurement (Tier 3). From the results obtained from the evaluation, we can observe how Tier 1 models resulted in a higher completeness, Transparency and Reproducibility, Adaptability to different land uses, but mainly achieve low applicability. Tier 2 models try to replicate the complex processes of how plants and carbon inputs such as manure interact with the soil, but with a limited requirement for input data. Often these models already split the soil into different compartments, to try and reflect the behaviour of soil components and functions. Generally, Tier 2 models exhibit high completeness but low Applicability and Accuracy. Tier 3 models aim at replicating soil processes and crop growth interactions to provide the most accurate representation of flows and fluxes. Whilst the most accurate, these types of models are also the most demanding for data input variables such as climatic and soil variables, and usually require thorough calibration to achieve satisfactory results. These models are process-based and require a

high degree of modeller expertise and large data requirements. For a site-specific assessment (such as one livestock farm), the methodology preferred include the agroecosystem models (DNDC, DAYCENT) or long term direct measurement (where available and carried out with the appropriate protocol), or with less detailed input data this could be followed by IPCC 2019 Tier 2 steady state methodology. Whenever this level of accuracy cannot be achieved (e.g. site-dependent or site-generic assessment, large scale assessment), the following Tier 2 methodology should be employed. IPCC 2019 Tier 2 steady state method or simple carbon models (e.g., C-tool). With very limited data quality or with limited expertise, IPCC Tier 1 methodology can be used. Further soil C assessment in agricultural should be undertaken with at least 20 years time horizon due to slow C dynamics.

On-farm experimentation of anaerobic digestate distribution methods for advancing precision agriculture and circular economy in the agroecosystem

by Ilaria Piccoli | Federico Grillo | Ivan Furlanetto | Francesca Ragazzi | Silvia Obber | Tiziano Bonato | Francesco Meneghetti | Luca Saccardo | Francesco Morari | Department of Agronomy, Food, Natural Resources, Animals and Environment, University of Padova | Department of Agronomy, Food, Natural Resources, Animals and Environment, University of Padova | Agricola Sant'Ilario - Societa' Agricola a r.l. | Unità Organizzativa Qualità del Suolo, Agenzia Regionale per la Protezione Ambientale del Veneto (ARPAV) | Unità Organizzativa Qualità del Suolo, Agenzia Regionale per la Protezione Ambientale del Veneto (ARPAV) | Società Estense Servizi Ambientali | Confagricoltura Veneto | ITPhotonics S.r.l. | Department of Agronomy, Food, Natural Resources, Animals and Environment, University of Padova

Abstract ID: 133
Topic: Soil
Presenter Name: Ilaria Piccoli
Contribution: Oral

This study investigates the agronomic performance and environmental sustainability of applying solid and liquid digestate fractions as organic fertilizers to silage winter wheat (*Triticum aestivum* L.) in Northern Italy. The research employed variable rate application (VRA) of organic and mineral fertilizers and the use of nitrification inhibitors. Conducted over two cropping seasons (2019-2020 and 2020-2021), the field experiments spanned approximately 47 hectares across two farms with varying soil textures. Various fertilization treatments were compared, including uniform application of mineral fertilizer, VRA of mineral fertilizer, uniform application of liquid digestate with a nitrification inhibitor, VRA of liquid digestate, uniform application of liquid digestate with a nitrification inhibitor in VRA, and solid digestate. Key findings from the study include the solid and liquid digestate fractions achieving satisfactory agronomic outcomes, with wheat dry biomass yields exceeding 15 t ha^{-1} and protein contents over 5%, comparable to those obtained with mineral fertilizers. A significant interaction between nitrogen use efficiency (NUE) and soil texture was observed. This interaction highlighted that the combination of VRA and nitrification inhibitors was the only organic treatment capable of achieving NUE between 50% and 90% in fine-textured soils. In contrast, solid digestate exhibited lower NUE, often below 50%, across different soil types. The spatial evaluation of wheat yield and NUE indicates that liquid digestate could serve as a viable and environmentally friendly substitute for mineral fertilizers in fine-textured soils when VRA and nitrification inhibitors are used. However, further research is needed to evaluate the long-term sustainability of solid digestate applications.

Modeling inter-row grass growth, soil water content and carbon cycle in vineyard

by Luisa Leolini | Marco Moriondo | Lorenzo Brilli | Marcella Biddoccu | Margherita Coli | Riccardo Rossi | Marco Bindi | Nicolina Staglianò | Giorgio Capello | Simone Bussotti | Elisa Paravidino | Sergi Costafreda-Aumedes | University of Florence | CNR-IBE | CNR-IBE | CNR-STEMS | University of Florence | University of Florence | University of Florence | University of Florence | CNR-STEMS | AGRION | AGRION | University of Florence

Abstract ID: 18
Topic: Soil
Presenter Name: Luisa Leolini
Contribution: Pitch

The agriculture sector plays a contrasting role in climate change mitigation, which results from the balance between carbon sequestration capacity of soil and perennial crops (e.g. vine) and, the negative impact of the highly productive cropping systems characterized by elevated greenhouse gases (GHGs) emissions. In the Mediterranean agricultural sector, viticulture represents a widely spread activity, which may partially contribute, if sustainably managed, to carbon sequestration and to the challenge against climate change. However, the high inputs and some agronomic practices may potentially increase GHGs emissions, by converting this activity from carbon sink to carbon source. In this context, crop models implemented for describing biogeochemical cycles (carbon, nitrogen, water, etc.) may provide an overview of the GHGs mitigation potentiality of these systems. However, to our best knowledge, no crop models were so far developed for assessing the entire vineyard agro-ecosystem carbon emissions considering also the role of management in the carbon cycle. With these perspectives, the original UNIFI.GrapeML model (Leolini et al., 2018) was improved by coupling it with the soil carbon module RothC (Coleman & Jenkison, 1996; Sierra et al., 2012), in order to estimate the soil water content (SWC), the gross primary production and the respiration of vine and grass components jointly with the soil respiration. In this work, we present the new integrated model architecture and the preliminary calibration results for the inter-row grass growth and SWC of a 'Barbera' vineyard located in Northern Italy (Lat: 44°40' N; Long: 8° 37'' E) in order to assess the contribution of the grass cover to carbon and water cycles. The preliminary results showed satisfactory performances at simulating inter-row grass dry matter under grass cover (GC: r = 0.68; RMSE = 76.33 g m^{-2} d.m.) and conventional tillage (CT: r = 0.60; RMSE = 60.58 g m^{-2} d.m.), as well as to reproduce SWC for both managements (GC: r = 0.79; RMSE = 0.06; CT: r = 0.70; RMSE = 0.06). These results lay foundations to test the multi-layer vineyard model for carbon and water fluxes in other vineyards, in the perspective to provide a new accurate tool for improving carbon footprint and life cycle assessment analysis with estimates of carbon emissions from cropping systems. Acknowledgements. The publication was made by researcher Luisa Leolini with a research contract co-funded by the European Union - PON Research and Innovation 2014-2020 in accordance with Article 24, paragraph 3a), of Law No. 240 of December 30, 2010, as amended and Ministerial Decree No. 1062 of

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Use of a small rain simulator to evaluate the effects of Nature-Based Solutions on soil erosion in a reclaimed area of central Italy

by Nicola Grossi | Leonardo Ercolini | Silvia Pampana | Lorenzo Gabriele Tramacere | Daniele Antichi | Nicola Silvestri | Dipartimento di Scienze Agrarie, Alimentari e Agro-Ambientali, Università di Pisa | Dipartimento di Scienze Agrarie, Alimentari e Agro-Ambientali, Università di Pisa | Dipartimento di Scienze Agrarie, Alimentari e Agro-Ambientali, Università di Pisa | Dipartimento di Scienze Agrarie, Alimentari e Agro-Ambientali, Università di Pisa | Dipartimento di Scienze Agrarie, Alimentari e Agro-Ambientali, Università di Pisa | Dipartimento di Scienze Agrarie, Alimentari e Agro-Ambientali, Università di Pisa

Abstract ID: 28
Topic: Soil
Presenter Name: nicola.grossi@unipi.it
Contribution: Pitch

Cover-crops (CC) and vegetative buffer-strips (VBS) are considered two of the most promising and feasible Nature-Based Solutions (NBSs) to mitigate the intensity of erosion phenomena. However, their effectiveness is strongly driven by the interaction with several site-specific conditions such as soil nature, rainfall pattern, soil tillage method, and vegetation growth-cycle. Therefore, the evaluation of the effects of CC and VBS soil and nutrient losses from cultivated fields should be subjected to repeated monitoring campaigns on field plots before deciding on their introduction in the local cropping systems. Since this kind of research activity results extremely expensive and time-consuming, the use of small-size rainfall simulators, which can be transported and operated easily, is a suitable alternative methodology to test different combinations of environmental and agronomic factors regardless of weather conditions. The aim of this work is to evaluate the capability of CC and VBS to limit soil erosion in comparison with a control (CO) by using a mini rainfall simulator manufactured by Eijkelkamp Agrisearch Equipment, Netherlands (Parlak, 2012). It consists of a sprinkler with a built-in pressure regulator, a support for the sprinkler and a stainless steel bottom frame with gutter. The field experiment was carried out in the coastal plain of Central Italy (43°49′N and 10°19′E) characterized by large-scale agriculture and the presence of a vulnerable receiving water body (the Lake of Massaciuccoli). The NBSs (CC and VBS) were realized on two different fields cultivated with a two-year rotation (sunflower – durum wheat) by introducing a cover-crop (a mix of oats and broad bean) after the wheat harvest and by implanting a 3 m wide vegetative buffer strip (a mix of perennial grass species), along the edges of the field. The control (CO), tailor-made on the conventional farming practices, occupied an adjacent field without any NBSs. In each season, the rainfall simulator was used under standardized setting (rainfall height and intensity, soil slope and humidity) and run-off and sediments produced were collected to be analyzed. Run-off volume (RO), total solids (TS), and dissolved nutrients (nitrates and soluble reactive phosphorous) were determined. The nitrogen and phosphorous losses (NL and PL) were also calculated (RO x nutrient concentration). At the beginning of the experimentation (October

2020), three experimental fields were surveyed under bare soil conditions to verify that there were no significant differences about the soil erodibility. Here, the results of the first year are reported. The results confirmed the importance of vegetation cover in soil protection from erosion phenomena. As average of the four seasons surveyed, VBS compared to CO reduced RO, TS, NL and PL by 63%, 96%, 93%, 56%, respectively. A weaker protection effect was observed for CC, which resulted in a reduction of 33% (RO), 51% (TS), 66% (NL) and 55% (PL) respect to the control. Furthermore, the percentages of reduction for VBS were rather constant among seasons, whereas CC showed greater variability due to growing cycle, lasting only from fall to spring (after the wheat harvest of and before the sunflower sowing).

Replacing peat in organo-mineral fertilizers to enhance agro-environmental sustainability

by Andrea Alpigiano | Tomas Javier Sitzmann | Barbara Moretti | Cristina Lerda | Carlo Grignani | Laura Zavattaro | DISAFA and DSV, University of Turin | DISAFA, University of Turin | DISAFA, University of Turin | DISAFA, University of Turin | DISAFA, University of Turin | DSV, University of Turin

Abstract ID: 72
Topic: Soil
Presenter Name: Andrea Alpigiano
Contribution: Pitch

Organo-mineral fertilizers (OMF) are a mixture of a small amount of an organic fraction and mineral fertilizers, in order to obtain a single product with a minimum C_{org} content of 7.5% for solid OMFs. OMFs with 7.5% C_{org} have been associated with a higher mineral nutrient use efficiency, especially for phosphorus (P) and nitrogen (N), when compared with mineral fertilizers. Many commercial OMFs with low C_{org} content use peat as an organic matrix because of its physico-chemical stability, high content of humic C and cheapness. Nevertheless, peat is a non-renewable resource, whose extraction undermines long-term organic carbon storage. Peat replacement with renewable organic materials in OMFs offers a viable opportunity for organic wastes derived from agro-food chains, emphasizing the biowaste materials reuse and the agro-environmental sustainability. Manure-based vermicompost (VC), municipal solid waste compost (MSWC), green compost from pruning residues (GC) and peat as control (Peat) were the organic matrixes of four neo-synthesized granular OMFs, produced in collaboration with SCAM S.p.A. The organic materials were blended with ammonium sulphate and urea, while coating granules of diammonium phosphate, maintaining 7.5% of total C_{org} content in all OMFs. Two concentrations of nutrients with different C:N ratios were tested: 7.5% $C_{org,}$ 20% mineral N, and 10% mineral P_2O_5 ($OMF_{20\text{-}10}$) for the four organic materials and 7.5% C_{org}, 10% mineral N, and 5% mineral P_2O_5 ($OMF_{10\text{-}5}$) only for MSWC and peat. The novel fertilisers were evaluated in a pot experiment on tomato, and compared to the equivalent OMFs with peat, with mineral control (MF_{NP}) and unfertilised control (N_0P_0). A 75-day tunnel trial was conducted under semi-controlled conditions with four repetitions organized in a randomized block design. Tomato (*Solanum lycopersicum* L.) plants were transplanted in pots containing 12 kg of soil and fertilized with an equivalent of 81 mg N kg^{-1} soil and 18 mg P kg^{-1} soil, supplied as OMF or MF_{NP}. Plant measurements included SPAD, BBCH indexes, number of shoots and berries evaluated over time, as well as total below and aboveground biomass, N and P uptakes, and N and P use efficiencies (NUE and PUE, respectively) at the end of the experiment. Results indicated renewable organic matrices VC and MSWC as valid alternatives to peat, as demonstrated by the above and belowground biomass and yield. Also, physiological and phenological measurements, PUE and NUE did not show differences among treatments, except for GC, whose P efficiency and root biomass were significantly lower. The second comparison revealed that different C/N ratios of granules did not influence nutrient

availability over time, as phenological, physiological and biomass measurements of MSWC and peat showed no significant differences between the two ratios $20N:10P_2O_5$ and $10N:5P_2O_5$. This research provides reassuring evidence of the effectiveness of biowaste OMFs, offering a positive outlook for a sustainable approach to fertilisation management.

Regenerative Organic Agriculture, soil health and ecosystem services: a literature review

by Greta Colombi | Enrico Martani | Dario Fornara | Management Institute, Scuola Superiore Sant\'Anna di Pisa | Davines Group - Rodale Institute European Regenerative Organic Center | Davines Group - Rodale Institute European Regenerative Organic Center

Abstract ID: 9
Topic: Soil
Presenter Name: Enrico Martani
Contribution: Post

Despite there is no agreement on a single definition of ROAg, in this study we based ROAg definition on the one provided by the guidelines of the Regenerative Organic Alliance (https://regenorganic.org/why-regenerative-organic/), following an agrological approach, for the research through algorithms and keywords of English written peer-reviewed scientific papers on the main academic databases and their subsequent selection. In the resulting 20 articles, all data related soil health parameters measured to describe the effect of regenerative organic practices on ecosystem services were extracted and classified according to the methodology proposed by Soto el al. (2020). Given the wide range of research methods, variety of soil parameters and ecosystem services found in the selected literature, the standard vote counting procedure was adopted (Graham et al., 2018; Paiola et al., 2020) to summarize observations that demonstrate a positive, negative or neutral (non-significant or uncertain) effect on soil ecosystem services. While for the experimental studies comparing regenerative organic practices with the conventional ones, an impact index was calculated to determine the direction and magnitude of the effect of ROAg on each soil health parameter and on ecosystem services, following the approach proposed by Ferrarini et al. (2017) and Harrison et al. (2014). The calculated indices show that ROAg has generally a positive impact on all the ecosystem services investigated except for food and fiber production. However, although the productivity of ROAg is lower than the one of conventional agriculture, the data indicates that the nutritional quality of products increases with the adoption of regenerative organic practices. The data also confirms that the adoption of ROAg also impacts positively most of the soil health parameters investigated (SOM, organic carbon, microbes and nutrients).

Conservative corn (Zea mays L.) silage production by means of cover crops to improve soil conditions

by Borgatti Daniele | Quintarelli Valentina | Radicetti Emanuele | Mancinelli Roberto | Ben Hassine Mortadha | University of Ferrara | University of Ferrara | University of Ferrara | University of Tuscia | University of Ferrara

Abstract ID: 10
Topic: Soil
Presenter Name: Ben Hassine Mortadha
Contribution: Post

Conventional agriculture has caused alteration of agroecosystems by going so far as to change soil health and fertility. Therefore, is essential to investigate innovative agronomical techniques that can ensure crop production in a sustainable way. Cover crops (CCs) are one of the key-stones of regenerative agriculture, and it is well-know that their adoption in crop rotation allows to improve soil characteristis. This study aims to evaluate the potential benefits of CCs in terms of response of corn (*Zea mays* L.) and soil characteristics to develop a sustainable production strategy. Field trial was carried out at Fondazione per l'Agricoltura "F.lli Navarra" located in Ferrara, Italy (44°5'52"N, 11°38'24"E) during the 2022/2023 growing season. The treatments were: three CCs [hairy vetch (*Vicia villosa* Roth., HV), black oat (*Avena strigosa* L., BO), and a mixture of hairy vetch + black oat (HV+BO)]. In addition, a control treatment without CCs has been adopted (CK). These treatments were laid out in a complete randomized block design with three replicates. CCs were sown on October 4, 2022. The sowing rate was 60 and 100 kg ha^{-1}, and 30 + 50 for hairy vetch, black oat, and the mixture of hairy vetch + black oat, respectively. All CCs were left to grow undisturbed during winter and spring seasons until their termination on March 22, 2023. Bare soil plots were managed in a similar manner and were kept weed-free throughout the cover crop growing season. The above-ground biomass of cover crops was suppressed under no-tillage practices by using roller crimper applied a couple of hours before the maize sowing. Fertilization had been performed only on the control, corn harvesting occurred the July 26, 2023. Measurements of soil CO_2 emissions, temperature and moisture were determined every 10 days throughout the growing season. At the same time, SPAD and NDVI readings were measured to assess corn plant response, respectively. Soil compaction had been measured at 30-days intervals. Throughout the growth cycle, soil moisture resulted low in CK, while all CCs treatments, because of their mulching effect, improved water retention, mostly in the driest periods. Moreover, under CCs plots, due to their roots action, soil compaction resulted decreased indicating a well-structured soil profile, while CK reported the highest soil compaction. Regarding the plant response, SPAD and NDVI tended to be higher in the CK treatment, nevertheless, it can be observed that CCs treatments (unfertilized), especially under HV, values that did not deviate that much from the control indicating a satisfactory response of the legume in term of nitrogen supply. The results reported for the highest value of yield production and morphophysiological parameters of corn in the CK (fertilized), respect the CCs treatments (CK>V>AV>A). This study marks the

starting point to better understand CCs management to optimize corn silage yield. The results show a positive response from soil characteristics. In terms of corn response, hairy vetch turns out to be the cover crop capable of providing higher nutrient content and it is conceivable to adopt for reducing the amount of synthetic fertilizers.

Exploring the impact of intercropping camelina-pea on soil and rhizospheric microbiome dynamics and crop productivity

by Elena Pagani | Federica Zanetti | Daniel Scicchitano | Marco Candela | Andrea Monti | Erika Facciolla | Sara Berzuini | Maria Giovanna Sessa | University of Bologna | University of Bologna | University of Bologna | University of Bologna | University of Bologna | University of Bologna | University of Bologna | University of Bologna

Abstract ID: 13
Topic: Soil
Presenter Name: Elena Pagani
Contribution: Post

Currently, intercropping systems, involving the simultaneous growth of two crops together in the same piece of land, have gained considerable attention from farmers and researchers due to their potential to enhance agricultural productivity and improve soil fertility via root exudates and key taxa. Legumes are frequently included in intercropping systems due to their capacity to fix nitrogen and facilitate the uptake of other nutrients. In this context, the present study aimed to compare camelina (*Camelina sativa* L.) intercropped with pea (*Pisum sativum*) versus sole-camelina in terms of productivity, nutrient uptake, and soil microbial diversity. A field trial was established at the experimental organic farm of the University of Bologna in Ozzano dell'Emilia, adopting a randomized complete block design with four replicates. Shortly before crop harvest, soil and rhizosphere samples were collected from 24 plants per treatment. At harvest, straw and seed yield were determined, and N and P uptake in each plant organ (straw and seed) were analyzed. Results showed that intercrop-camelina produced greater straw yield than sole-camelina, but significant differences in seed yield were not observed. Similarly, in terms of N and P uptake, the statistical results mirrored those of straw and seed yield: nutrient uptakes were greater in the straw when camelina was intercropped compared to sole-camelina, but no significant differences were found for seeds. Unexpectedly, the collected soil of the intercropping system showed lower alpha-diversity compared to sole-camelina soil, while no significant variations were found at the rhizospheric level. However, peas altered the rhizosphere population of camelina, leading to a significant increase in *Gemmatimonadaceae*, a slight increase in *Solilubrobacteriales* ($0.05 < P < 0.1$), and a significant decrease in *Oxalobacteriaceae*. The present research demonstrated that camelina-pea intercropping caused significant shifts in nutrient uptake and bacterial diversity. The benefits, such as nutrient use efficiency, derived from intercropping should be closely tied to alterations in soil microbial functions, and changes in crop communities could stimulate specific traits in soil microbial communities.

Soil Biological Quality Index (QBS-ar) to assess agronomic management in the coastal wetlands of King's Lagoon

by Anna Rita Bernadette Cammerino | Lorenzo Piacquadio | Michela Ingaramo | Maurizio Gioiosa | Massimo Monteleone | Dipartimento di Scienze Agrarie, Alimenti, Risorse Naturali e Ingegneria (DAFNE) - Università di Foggia | Dipartimento di Scienze Agrarie, Alimenti, Risorse Naturali e Ingegneria (DAFNE) - Università di Foggia | Dipartimento di Scienze Agrarie, Alimenti, Risorse Naturali e Ingegneria (DAFNE) - Università di Foggia | Dipartimento di Scienze Agrarie, Alimenti, Risorse Naturali e Ingegneria (DAFNE) - Università di Foggia | Dipartimento di Scienze Agrarie, Alimenti, Risorse Naturali e Ingegneria (DAFNE) - Università di Foggia

Abstract ID: 21
Topic: Soil
Presenter Name: Anna Rita Bernadette Cammerino
Contribution: Post

The Soil Biological Quality Index (QBS-ar) (Parisi 2001, 2005) assesses the biological quality of a soil by estimating the biodiversity of micro-arthropods. These organisms have a complex adaptation to life in the edaphic environment and are sensitive to the state of distress of a soil that may result from agricultural practices. In this study, we report the results obtained for the QBS-ar on 2 sites located in the “King’s Lagoon”, a coastal wetland of about 40 hectares within the Gargano National Park, recently restored through the reconstruction of channels and flooded areas. Wetlands and agriculture, although historically seen as antagonistic environments, are still closely linked and in many cases agriculture in wetlands remains a persistent human activity. Agriculture can be a risk factor for the conservation of wetland ecosystems or a stabilizing factor. It all depends on the agricultural model applied.

Using the application of the QBS-ar we compared the soil quality of a natural synanthropic meadow (site 1) with an experimental field of *Beta* intercropped with *Salicornia* (site 2) to assess the effect of management practices on the edaphic communities as compared to natural conditions. Both sites were originally covered by natural meadows, mostly characterised by synanthropic grass-dominant species until spring 2023. In summer 2023, site 1 was maintained as a spontaneous meadow, while site 2 underwent a light surface tillage (with prior mowing and shredding of the cover vegetation), in preparation for the planting of *Beta* and *Salicornia* (AGRITECH project). Following the transplanting of *Beta* and *Salicornia*, site 2 was treated with manual application of compost, drip irrigation with brackish water, hoeing and pyrethrum application. *Beta* and *Salicornia* were finally harvested at the end of August 2023. Soil samples were collected in autumn 2023 (19 October 2023). At both sampling sites, 3 soil replications with a volume of 1 dm^3 were taken along the diagonal of a square of 10 m side length. All replications were placed in the Berlese-Tullgren selector for 10 days. The resulting arthropod selector, fixed by means of a collection fluid, was then analysed under a stereomicroscope. For each organism, the Biological Form (BF) was defined, and each BF was assigned its Eco-Morphological Index (EMI), which varied from a minimum value of 1 to a maximum of 20, depending on whether the form in question was very poorly or very well adapted to the soil. The sum of the EMI of

all Arthropod BFs determines the QBS-ar index. It can be preliminary state that management of *Beta* and *Salicornia* (site 2), do not negatively affected the biological quality of the soils, although the overall index was low for both the sites. The surveys will be repeated in June 2024 to check whether the same cultivation design applied in site 2 can improve or not the QBS-ar index value as compared to site 1.

Potato (Solanum tuberosum, L.) crop as influenced by the interaction effect of tillage and fertilization practices in the Mediterranean environment

by Mariam Atait | Mohamed Allam | Roberto -Mancinelli | Emanuele Radicetti | Dipartimento di Scienze Agrarie e Forestali (DAFNE), Università degli Studi della Tuscia | Dipartimento di Scienze Agrarie e Forestali (DAFNE), Università degli Studi della Tuscia | Dipartimento di Scienze Agrarie e Forestali (DAFNE), Università degli Studi della Tuscia | Dipartimento di Scienze Chimiche, Farmaceutiche e Agrarie (DOCPAS), Università degli Studi di Ferrara

Abstract ID: 25
Topic: Soil
Presenter Name: Roberto Mancinelli
Contribution: Post

The sustainable production of potato in the Mediterranean environment is a way forward to overcome challenges related to population, environment, and food security. The soil fertilization and tillage methods adopted for potato cultivation are the key elements for improving crop production and conserving the environment. The excessive use of pesticides, mineral fertilizers and the intensive soil tillage practices have already caused serious damage to agroecology. Contrarily, the reduced tillage techniques and organic fertilizers application are considered to be the most effective way of producing high quality potatoes without damaging the agroecosystem. Therefore, the present study was designed to investigate the efficacy of different soil tillage and fertilization methods on potato production and soil health. The tillage method used in the study included: plowing as conventional tillage and sub soiling and spading as conservation tillage practices. Moreover, the mineral and organic fertilizers were compared. To reduce the application of pesticides, the resistant varieties (Levante and Agata) were adopted. The comparison between traditional and sustainable agronomic practices was studied in detail. The obtained results showed a significant effect on soil N% and C% along with the production rate of commercial potato and seed tubers. According to the results, the soil health was improved using sustainable agronomic methods of fertilization and tillage. The use of sub-soiling tillage and organic fertilizer increased the soil N% to maximum level of 0.16% followed by spading at the level of 0.15%. Sub-soiling and organic fertilization also positively affected the soil C% and C/N ratio but didn't show any improvement in potato yield of commercial tubers. However, spading and organic fertilization had significantly improved seed tubers. The more sequestration of carbon and nitrogen in soil negatively affected the potato yield because of more soil N and C, increased soil bulk density which hinders the growth of potato root and decreased the water stress tolerance. More soil N and C also helped the potato in improving its vegetative growth and reduced the mineralization of soil organic matter. As a result, the process of tuberization is slowed down which resulted in lower yield quality. Whereas the potato yield for commercial tubers was observed to be maximum under plowing tillage (27.352 N m^{-2}) and mineral fertilization (33.8441 N m^{-2}) applications. The

lower soil C/N ratio, less weed competition, more nutrient mineralization, and more nutrient use efficiency significantly improved the quality and quantity of commercial tubers. Levante variety was more resistant to early blight and wilting. To conclude, Levante is the stress resistant potato variety that can be grown to get maximum yield in vulnerable conditions. The use of sub-soiling and spading tillage along with organic fertilizer significantly improve soil health and potato seed production. Whereas, for commercial seed production plowing tillage, spading tillage and mineral fertilization could be a useful method. Thus, the integrated use of conservation tillage and fertilization techniques can be an effective agronomic practice to improve sustainable potato production.

Increasing the sustainability of Grana Padano production by using NIR spectroscopy to map soil variability for Precision Agriculture proposes

by Andrea Lazzari | Andrea Gasparini | Fabio P. Abeni | Angelo Stroppa | Giovanni Cabassi | CREA - Research Centre Animal Production and Aquaculture | CREA - Research Centre Animal Production and Aquaculture | CREA - Research Centre Animal Production and Aquaculture | Consorzio per la Tutela del Formaggio Grana Padano DOP | CREA - Research Centre Animal Production and Aquaculture

Abstract ID: 31
Topic: Soil
Presenter Name: Andrea Lazzari
Contribution: Post

At least 75% of the fodder's dry matter in the daily ration must come from foodstuff produced in the milk production area of GRANA PADANO P.D.O. cheese, as required by the product specification rules (clause 4). Precision Agriculture (PA) is a valid technique to increase sustainability in the management of farm slurry. Near-infrared spectroscopy (NIR) is a possible way to reduce technical costs for soil analysis to map in-field variability and create fertilizer prescription maps. This study presents the results of applying NIR technology for PA purposes in Northern Italy across three silage maize fields selected for the MOREGRANA project, which aims to increase the sustainability of Grana Padano production. Soil samples were collected in each field according to a regular grid (20 samples per field) in the topsoil at a depth of 0-30 cm. These samples were analysed using standard wet reference methods and a FOSS NIRSTM DS3 spectrometer (soil texture, Organic Carbon and Total Nitrogen). The NIR analysis, conducted on spectra obtained in diffuse reflectance within the 400-2500 nm range, used the LOCAL calibration technique (US Patent # 5,798,526) using a database of more than 1000 samples, constantly implemented with deep learning technology. This method, a locally weighted calibration approach, selects samples from a large database with spectra similar to those under examination. It utilizes principal component analysis (PCA) on soil spectral data, creating for each unknown sample local models from the reference dataset to overcome nonlinearities due to the high spectral variability of soils. The NIR-based estimations for clay content, clay+silt, organic carbon and total nitrogen content were evaluated using Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and bias metrics. The coefficient of determination (R^2) correlated the actual, laboratory-measured values with the NIR-predicted values (0.57, 0.85, 0.92, 0.76 respectively). A thorough analysis was conducted to evaluate the minimum number of samples per field required for analysis using reference methods to obtain an accurate estimate of the systematic error component (bias) of the prediction. This estimate is necessary to ensure the accuracy of the predictions. Bias correction was found to be necessary for organic carbon in two fields and for the clay+silt parameter in another field. Results displayed good ability in the NIR calibrations to estimate field averages of the parameters under analysis with sufficient precision. Moreover, the

Range/MAE allowed the identification of in-field variation gradients useful for PA purposes. For clay, the ratios ranged from 3.2 to 7.0, for clay+silt from 4.0 to 9.5, and organic carbon, the ratio ranged from 3.0 to 6.2, depending on the variability of the field. Results showed that, after adjusting for bias, which was estimated successfully from only a few samples analysed with reference techniques, NIR predictions with LOCAL calibration can also achieve accurate results for both the mean-field values and the in-field variation of soil texture and organic carbon. Therefore, using NIR technology to create a prescription map for PA management of fertilisation using slurry manure and chemical fertilisers is possible.

Model-based comparison of alternative management strategies to increase soil carbon sequestration.

by Domenico Caterino | Livia Paleari | Pietro Crudele | Daniela Famulari | Roberto Confalonieri | Università degli Studi di Milano, ESP, Cassandra lab | Università degli Studi di Milano, ESP, Cassandra lab | CONSERVE ITALIA, ufficio Sostenibilità Ambientale e Certificazioni | Consiglio Nazionale delle Ricerche - Istituto per i Sistemi Agricoli e Forestali del Mediterraneo | niversità degli Studi di Milano, ESP, Cassandra lab

Abstract ID: 48
Topic: Soil
Presenter Name: Domenico Caterino
Contribution: Post

The EU soil strategy for 2030 aims at defining concrete measures to protect and restore soils, ensuring their health in the coming decades. Soils may act as both sink – CO_2 sequestration as soil organic carbon (SOC) – and source for greenhouse gases (GHG), thus generating for them the potential to mitigate or exacerbate climate change dynamics. SOC also plays a key role in soil fertility, influencing crop nutrition, soil structure, water availability, and erosion dynamics. In a variety of contexts, widely adopted management strategies are leading to a steady decline in SOC content, endangering agroecosystem productivity and sustainability. Although alternative management practices able to reduce or invert this decline are available and their effectiveness has been demonstrated, it is hard to identify the one most suited for specific production contexts. The difficulties in the quantification of the specific cost-benefit ratio and the slow dynamics of SOC accumulation represent crucial challenges towards the definition of credible solutions targeting mid-term SOC increase. This, together with a possible decrease in yields, discourages farmers from abandoning management strategies they are familiar with. Simulation models are increasingly used to support cropping systems management in a variety of ways, one of the most popular deriving from their capability to quantitatively evaluate alternative management scenarios to identify the best site-specific compromise between environmental and economic sustainability. In this study (Carbon Control; PSR Emilia-Romagna 2014-2020; 16.2; 2286), the STICS model was used to compare three different management scenarios for tomato crops in Emilia-Romagna for their effects on SOC dynamics, GHG emissions, and productivity over 10-year time frames. An agro-climatic zonation based on the SAM indicator (-1 [arid] to +1 [humid]) allowed the identification of 11 areas differing for the relationship between rainfall and reference evapotranspiration during the cropping season. For each area, 10-year weather data from the 2 km × 2km centroid cells were used, and the analysis was performed for three different soil types (sandy, loam and clay) and for three transplanting periods. The compared management scenarios were: the one currently adopted in the area, the use of vetch or ryegrass as cover crops, and cover crops coupled with minimum tillage. Parameters defining morphological and physiological crop features were calibrated using data from dedicated field campaigns, whereas default parameters involved with SOC dynamics were refined using data collected by Eddy Covariance systems.

The alternative practices led to 18% average SOC increase without any decrease in yields, although, in some cases, the C/N ratio of the ryegrass biomass led to the need of a supplementary N fertilisation. The lowest and highest percentage increases were obtained, respectively, (i) for mid transplanting, semi-arid, clay soil and vetch cover cropping and (ii) for mid transplanting, mildly humid, sandy soil and ryegrass cover cropping. This study demonstrated the potential of cropping system simulation models to identify site-specific management strategies able to contribute to global mitigation targets.

Optimizing Nutrient Management with Nanofertilizers: A Run-Off Experiment in a Model System

by Laura Pilotto | Christian O. Dimkpa | Jason C. White | Luca Marchiol | Francesca Scalera | Clara Piccirillo | Guido Fellet | DVS Dipartimento di Scienze della Vita, Università di Trieste; DI4A Dipartimento di Scienze Agro-Alimentari, Ambientali e Animali, Università di Udine | Department of Analitycal Chemistry, The Connecticut Agricultural Experiment Station | Department of Analitycal Chemistry, The Connecticut Agricultural Experiment Station | DI4A Dipartimento di Scienze Agro-Alimentari, Ambientali e Animali, Università di Udine | Consiglio Nazionale delle Ricerche, Istituto di Nanotecnologia Monteroni (Lecce) | Consiglio Nazionale delle Ricerche, Istituto di Nanotecnologia Monteroni (Lecce) | DI4A Dipartimento di Scienze Agro-Alimentari, Ambientali e Animali, Università di Udine

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Presenter Name: Laura Pilotto
Contribution: Post

Phosphorus is often poorly available to plants despite its high soil concentration. It is mainly administered via fertilizer or manure, with low efficiency (18-20%). Losses contribute to many environmental impacts. Mitigating P losses in agriculture involves improving fertilization. Nanofertilizers could serve as a tool to optimize it through the controlled release of nutrients. One type of nanofertilizer is nano-hydroxyapatite (nHAP, Ca10(PO4)6(OH2), Ca/P molar ratio = 1.67), which can be used as a P source for crops. nHAP can be extracted from biological wastes such as animal and fish bones, recovering P with a circular economy approach. Many studies have evaluated the effects of nHAP on crops. This study aims to quantify the P losses through run-off, using a run-off simulator, comparing soil treated with nHAP with soil treated with a conventional fertilizer. The experiment setup followed the methodology outlined by Sigmon et al., 2023, with modifications. A plastic construction inclined at an angle of 2.65° (Fig. 1) was utilized. 2.4 kg of air-dried agricultural soil was placed on a stainless-steel plate (24.5x30.5x3 cm) and lightly pressed. A cutout was incorporated at the top of the plastic casing to insert a perforated plastic tray to simulate rainfall. Four P treatments were administered: (i) control (CTRL), untreated soil; (ii) dicalcium phosphate (DCP, Fisher Scientific); (iii) synthetic nHAP (SnHAP, SkySpring Nanomaterials); (iv) nHAP derived from chicken bones (BnHAP). The treatment ratio was 0.1 g of P per soil kg. Each treatment was applied in a line at the top of the soil plate. A total of 2 liters of ultrapure water was dispensed: 1.0 L on the first day (D0), 0.5 L after 24 hours (D1), and 0.5 L after 48 hours (D2). Run-off water was collected from each washout using a bin placed beneath the construction. Liquid volumes were recorded, filtered, acidified, and analyzed with an ICP-OES to determine P losses. The remaining slurry on the filter paper was mineralized and analyzed to quantify the P content.
The obtained results suggest that P from BnHAP is significantly less mobile in soil than P from DCP, and SnHAP, although in the latter case. the difference is not significant. Specifically, while the total P leached in the DCP treatment is 5.38±1.28 mg, the leached P in the SnHAP treatment is 2.90±1.52 mg, and in the BnHAP treatment is 1.40±0.63 mg.

These data are expressed as the sum of P in the slurry and the water. The study showed that P from nano-hydroxyapatite (nHAP) moves less in soil than traditional fertilizer DCP. This highlights the potential of nHAP, especially from biological sources, in reducing P run-off and promoting sustainable agriculture. Further research is needed to investigate its long-term effects and scalability in agricultural contexts.

Soil organic carbon stocks in European croplands and grasslands: How much have we lost in the past decade?

by Daniele De Rosa | Cristiano Ballabio | Emanuele Lugato | Matteo Fasiolo | Arwyn Jones | Panos Panagos | School of Agriculture, Forestry, Food and Environmental Sciences (SAFE), University of Basilicata, Potenza | European Commission, Joint Research Centre (JRC), Ispra | European Commission, Joint Research Centre (JRC), Ispra | School of Mathematics, University of Bristol | European Commission, Joint Research Centre (JRC), Ispra | European Commission, Joint Research Centre (JRC), Ispra

Abstract ID: 57
Topic: Soil
Presenter Name: Daniele De Rosa
Contribution: Post

The EU Soil Strategy 2030 aims to increase soil organic carbon (SOC) in agricultural land to enhance soil health and support biodiversity as well as to offset greenhouse gas emissions through soil carbon sequestration. Therefore, the quantification of current SOC stocks and the spatial identification of the main drivers of SOC changes is paramount in the preparation of agricultural policies aimed at enhancing the resilience of agricultural systems in the EU. In this context, changes of SOC stocks (Δ SOCs) for the EU + UK between 2009 and 2018 were estimated by fitting a quantile generalized additive model (qGAM) on data obtained from the revisited points of the Land Use/Land Cover Area Frame Survey (LUCAS) performed in 2009, 2015 and 2018. The analysis of the partial effects derived from the fitted qGAM model shows that land use and land use change observed in the 2009, 2015 and 2018 LUCAS campaigns (i.e. continuous grassland [GGG] or cropland [CCC], conversion grassland to cropland (GGC or GCC) and vice versa [CGG or CCG]) was one of the main drivers of SOC changes. The CCC was the factor that contributed to the lowest negative change on Δ SOC with an estimated partial effect of -0.04 ± 0.01 g C kg^{-1} year^{-1}, while the GGG the highest positive change with an estimated partial effect of 0.49 ± 0.02 g C kg^{-1} year^{-1}. This confirms the C sequestration potential of converting cropland to grassland. However, it is important to consider that local soil and environmental conditions may either diminish or enhance the grassland's positive effect on soil C storage. In the EU + UK, the estimated current (2018) topsoil (0–20 cm) SOC stock in agricultural land below 1000 m a.s.l was 9.3 Gt, with a Δ SOC of −0.75% in the period 2009–2018. The highest estimated SOC losses were concentrated in central-northern countries, while marginal losses were observed in the southeast.

Using (Brady)Rhizobium bacteria to enhance root nodulation and biomass yield in forage legumes

by Tommaso La Malfa | Aurora Maio | Francesca Calderone | Marianna Oteri | Aurelio Scavo | Danilo Scordia | Fabio Gresta | University of Messina | University of Messina | University of Messina | University of Messina | University of Messina | University of Messina | University of Messina

Abstract ID: 60
Topic: Soil
Presenter Name: Tommaso La Malfa
Contribution: Post

The main objective of the present study was to investigate the effectiveness of forage legumes inoculated with different (*Brady*)*Rhizobium* bacteria, with the aim to enhance root nodulation. Rhizobium inoculant is a practical field use to actively promote soil fertility through the ability of legumes to fix atmospheric N, reducing the need for external inputs and improving the soil fertility in the long run and to increase crop yield. The preliminary trial was conducted in pots of 20 cm diameter, filled with a commercial substrate on a farm located in Milazzo under open field conditions (Messina, 38°11'25“N 15°14'28”E). (*Brady*)*Rhizobium* bacteria, namely a peat and a granular (from Visjon Exceed, USA), and an Australian peat (kindly provided by Murdoch University, Australia), and legume species (*Vicia villosa* Roth.; *Medicago polymorpha* L.; *Trifolium michelianum* Savi; *Trifolium subterraneum* L.) were combined in a complete randomized experimental design with three replications per treatment and compared with non-inoculated species as control. After emergence, seedling thinning was performed to ensure a constant number of plants per pot. Inoculation with specific strains of bacteria was performed on 19 September 2023 following modality and dose reported in the label. Aboveground and belowground biomass were harvested on 27 December 2023. Roots were washed and fresh weighed, then root nodule fresh weight and count were measured. Aerial part was measured for average height and fresh weight. Both aboveground and belowground parts were dried at 65°C to a constant weight. The inoculum showed a significant effect on the number of root nodules (on average 383 vs 286 of the control) and nodule weight per root (on average 0.89 g vs 0.47 g of the control). Across species, the granular from Visjon Exceed outperformed the Australian peat, the peat from Visjon Exceed, and the control in root nodule dry weight (1.05 g, 0.93 g, 0.72 g and 0.47 g, respectively). No differences were found on plant height, above and belowground dry biomass as compared with the respective control. Belowground dry biomass, nodule number and nodule weight per root were highest in *T. subterraneum* (16.6 g, 551 nodules per root and 1.01 g, respectively), while the lowest values were recorded in *M. polymorpha* (2.7 g, 97.6 nodules per root and 0.23 g, respectively). The present research showed that the inoculum with (*Brady*)*Rhizobium* bacteria had a significant impact on root nodule formation and nodule weight per root, with higher mean values in the treated group than in the control. However, neither aboveground dry biomass nor root dry weight were positively affected. Although inoculum positively influenced root nodule formation and nodule weight per root, further studies are needed to fully understand the effects of

inoculum on different plant species under varying environmental conditions.

Business models for soil health: the Novasoil Project

by Silvia Tavarini | Daniele Vergamini | Luciano Pagano | Francesco Riccioli | Roberta Moruzzo | Barbora Nohlova | Daniele Antichi | Luciana G. Angelini | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa | Department of Agriculture, Food and Environment, University of Pisa

Abstract ID: 62
Topic: Soil
Presenter Name: Silvia Tavarini
Contribution: Post

Soils underpin value chains by supporting crop productivity, biodiversity and livelihoods and they play a crucial role in water crises and climate change mitigation. Globally, one-third of soils are moderately too highly degraded, a situation worsening with increased land use for food, fibers, and biofuels. Climate change, deforestation, urbanization, and poor agricultural management contribute to degrading soils. Soil degradation destroys ecosystems and the services they provide to societies and economies, leading to fertility loss, livelihood disruptions, and water stress, necessitating operational shifts and supply chain adaptations. The importance of soil health and the consequences of land degradation are increasingly recognized across society (e.g. local farmers, businesses including the financial and insurance sectors, local authorities and citizens overall). In this context, the EU-funded NOVASOIL (Innovative Business Models for Soil Health) project will highlight the benefits of investing in soil for society and the environment. NOVASOIL's objectives include developing case studies on soil health investments, analyzing business models for new incentives, evaluating current policies that promote best practices, and formulating recommendations for their enhancement. The main expected outcomes are the building of a Community of Practice around project objectives to co-develop soil health business models and a toolbox for the analysis of suitability of different business cases that promote soil health. This toolbox will be based on a set of good examples from Europe and other countries and the needs and demands from the society. NOVASOIL includes 13 Case Studies with business models that promote soil quality and products based on sustainable crop and soil management. Among these, UNIPI identified two case studies focused on value chain and products based on sustainable land/crop management. The first case study – namely “A model for multifunctional and sustainable local development of marginal areas” – focuses on the soil and agroecosystem benefits deriving from the transition from traditional cropping systems based on annual cereal crops, conventionally grown, to multi-annual cropping systems based on aromatic and medicinal crops, organically managed, in the hilly areas of Pisa province (Tuscany). The second case study – namely “CiRAA LTEs” – focuses on the

benefits for soils deriving from the transition from conventional agricultural systems, based on plowing and simplified crop rotation, to systems based on reduced tillage, conservative farming techniques and organic farming. These practices were tested since 1986 in a series of long-term field experiments (LTEs) carried out at the Centre for Agri-environmental Research “Enrico Avanzi” (CiRAA) of the University of Pisa, mostly on real field size plots. The knowledge gained from these case studies will represent the tool for evaluating the efficiency of the actions undertaken, in terms of improvement of soil fertility, provision of ecosystem services, increase in productivity and resilience of the agroecosystem, reduction of reliance on external inputs, valorization of the landscape, and to develop business models aimed at adding value to agronomic management aimed at conserving soil health.
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Improving manure nitrogen use efficiency by means of biochar as an alternative to chemical fertilization

by Lamberto Borrelli | Daniele Cavalli | Massimo Valagussa | Alessandra Lagomarsino | Carla Scotti | Alberto Tosca | Council for Agricultural Research and Economics - Research Centre for Animal Production and Aquaculture | Council for Agricultural Research and Economics - Research Centre for Animal Production and Aquaculture | Laboratorio MAC - Minoprio | Council for Agricultural Research and Economics - Research Centre for Agriculture and Environment | Council for Agricultural Research and Economics - Research Centre for Animal Production and Aquaculture | Fondazione Minoprio - Minoprio

Abstract ID: 66
Topic: Soil
Presenter Name: Lamberto Borrelli
Contribution: Post

Maximizing nitrogen (N) use efficiency of animal manures and reducing environmental pollution, requires optimal management during both manure storage and field application. In anaerobic digestion plans, biochar could be used to cover storage tank of the liquid fraction to contain ammonia emissions, and to increase the carbon (C) content of soils, especially when repeatedly applied to the same field. However, biochar could affect soil nutrient turnover and crop yield. This study investigates the effect of biochar application on the N use efficiency of digestates for forage production in a maize (*Zea mays* L.)-Italian ryegrass (*Lolium multiflorum* Lam.) cropping system, and on the accumulation of C in soil. A two-year field experiment was established in spring 2023, in Lodi (45°17’27”N, 9°29’50”E). The soil was sandy loam, with sub-acid reaction, 0.12% total N, and 1.10% organic C. The climate is sub-continental, with 12.5 °C mean air temperature, and 750 mm of yearly rainfalls. The results of the first year (spring 2023–spring 2024) are reported. The biochar treatment is expected to provide 4 t DM ha^{-1} $year^{-1}$, i.e. 12 m^3 corresponding to the volume needed to cover a tank with a diameter of 15 m, and distributed with digestate, for a final biochar supply of 20 t ha^{-1} in five years. One treatment represented the field at year 1 and 2 of biochar accumulation (BDigI), the other (BDigF), the field at year 4 and 5. A treatment fertilized with digestate (DigLF), ammonium sulphate (AS) and an unfertilized control (Ctrl) were also considered. The experiment was designed as a randomized complete block (three replicates), with plots of 8 m (W) × 10 m (L). The liquid fraction of digested pig slurry and ammonium sulphate (250 N kg ha^{-1}) were incorporated prior maize sowing (June 21 2023). The field was irrigated four times (June–August) and harvested for silage on October 3 2023; N concentration of chopped maize was determined. Italian ryegrass was sown on November 14 2023, without applying fertilization, and harvested on May 10 2024. Topsoil (0–30 cm) was sampled prior maize sowing and after maize harvest and analyzed for total N and organic C content. Silage maize production did not significantly differ among treatments; however, the unfertilized Ctrl and BDigI (16.2 and 16.1 t DM ha^{-1}, respectively) were less performing than BDigF, DigLF and AS (18.5, 18.3 and 18.0 t DM ha^{-1}, respectively) and this trend was confirmed by the significantly higher N uptake of BDigF and DigLF (242 and 232 kg N ha^{-1}, respectively) compared to Ctrl and BDigI treatments (194 and 203 kg N ha^{-1},

respectively). The soil analysis showed an increase in organic C equal to 11.4% for BDigF, 4.9% for BDigI, 1.1% for DigLF, 0.3% for AS and a decrease of –3% for Ctrl treatment while the corresponding results for total N were –0.3% for BDigF, 2.6% for BDigI, 9.3% for DigLF and AS and –2.8% for Ctrl.

Adaptability of castor to heavy metals polluted soil

by Barbara Rachele Ciaramella | Valeria Cafaro | Alessio Scandurra | Carmela Patania | Cristina Patanè | Salvatore Luciano Cosentino | Giorgio Testa | Università degli Studi di Catania- Dip. di Agricoltura, Alimentazione e Ambiente | CNR- IBE | Università degli Studi di Catania - Dip. di Agricoltura, Alimentazione e Ambiente | Università degli Studi di Catania- Dip. di Agricoltura, Alimentazione e Ambiente | CNR -IBE | Università degli Studi di Catania- Dip. di Agricoltura, Alimentazione e Ambiente | Università degli Studi di Catania- Dip. di Agricoltura, Alimentazione e Ambiente

Abstract ID: 71
Topic: Soil
Presenter Name: Barbara Rachele Ciaramella
Contribution: Post

The European Green Deal constitutes a comprehensive roadmap for the European Union with the aim of facilitating the transition towards a sustainable, resource-efficient and low-carbon economy. The initiative is centered on the commitment to combat climate change, protect biodiversity and promote a circular economy. One of the key challenges addressed by the European Green Deal is the remediation of contaminated lands and the promotion of sustainable land use practices. Phytoremediation, a cost-effective and environmentally friendly approach to remediate contaminated soils using plants, has increasingly been recognized as a sustainable remediation strategy and one of the plants used for phytoremediation, the castor bean (*Ricinus communis* L.) has particular value for two reasons. First, it thrives in a wide variety of soil conditions, which allows its use in remediation projects across a wide range of locations. Second, it can accumulate high concentrations of heavy metals and organic pollutants, making it an effective choice for the remediation of contaminated sites. The integration of phytoremediation practices with castor bean plants on contaminated land represents an innovative solution that simultaneously addresses environmental remediation and biofuel production. The castor bean is renowned for its high oil content, making it an invaluable feedstock for biofuel production. By cultivating the castor bean for phytoremediation purposes, a double benefit is achieved. Firstly, contaminated soils can be successfully remediated. Secondly, biofuels are generated, thereby contributing to the transition towards a more sustainable energy system. In this study, castor bean was tested in soils contaminated with different levels of cadmium and lead. The trial was conducted in 30L pots with a diameter of 45cm. A block randomized experimental design, involving three replications, was used in order to evaluate the tolerance of castor bean in soil contaminated by two heavy metals (Cd and Pb). The heavy metals were applied to the soil in the form of $Cd(NO_3)$ and $Pb(NO_3)$. The concentrations of the single contaminant in the soil were determined to be 1000 mg kg^{-1}, 1500 mg kg^{-1} and 2000 mg kg^{-1} of lead in the soil, while the concentrations of cadmium were determined to be 60, 90, 120 and 150 mg kg^{-1} of cadmium in the soil. Moreover, untreated soil as a control group was also used. Throughout the experimental period, the plants were subjected to optimal watering conditions and biometric and physiological measurement were conducted every 20 days. At the end of the seeds ripening stage, the harvested plants were dried in a ventilated oven at a consistent temperature of 70° C until they achieved a constant weight. The result shows that castor bean is capable of tolerating the presence of heavy metals in soil. Furthermore, it was observed that the presence of cadmium in soil had the most adverse effect on productivity.

Impact of different cover crops on soil chemical and physical properties in maize cropping systems

by Octavian Chiriac | Barbara Moretti | Paolo Colombatto | Massimo Blandino | Laura Zavattaro | DSV, University of Turin | DISAFA, University of Turin | DISAFA, University of Turin | DISAFA, University of Turin | DSV, University of Turin

Abstract ID: 73
Topic: Soil
Presenter Name: Octavian Chiriac
Contribution: Post

Cover crops (CC) are widely recognized for their positive effects on soil physical and chemical properties. However, soil health benefits of CC in the arable cropping systems may require several years before a significant change is evidenced and results could be varied in dependence on CC species. The knowledge of the diversified soil benefits is necessary for choosing the right species to target specific soil health objectives, such as soil organic matter increase, soil structure improvement, or soil life enhancement. In a three-year field trial (2020-2023), we evaluated the impact of three different winter cover crop species—ryegrass (*Lolium multiflorum*), vetch (*Vicia villosa*), and white mustard (*Sinapis alba*)— compared to a control with spontaneous flora (including *Lamium purpureum*, *Stellaria media*, and *Centaurea spp.*) on maize (*Zea mays*) crop. The maize was cultivated for grain production on sandy loam soil in Northern Italy. We monitored the development, yield, biomass production, and nutrient uptake of both CCs and maize. In spring 2023, after three years of treatments, some soil physical and chemical parameters were measured: bulk density at different depths (0-15 cm, 15-30 cm, and 30-45 cm), penetration resistance along the profile, water infiltration rate at soil surface, soil organic C and N, and available P and K. The dry biomass production of CC was higher in ryegrass (3 t/ha), followed by vetch (2.5 t/ha) and mustard (2.1 t/ha). However, the N, P, and K uptakes of vetch (84.6, 20.1, and 51.5 kg/ha respectively) were double those of the other CCs (ryegrass 42.3, 9.3, and 45.8 kg/ha and mustard 42.2, 12.9, and 33.8 kg/ha). Maize grain yield in vetch treatment was 17% higher, which were not different from the control. Compared to the control, penetration resistance was 12% higher in vetch and ryegrass, while it was 7% lower in mustard. In addition, water infiltration rates showed 80-100% lower values in ryegrass alone than in the other treatments. No differences were measured in soil bulk density among the treatments. Similarly, soil chemical analysis did not highlight significant differences. Variations in physical aspects are strictly linked to CCs root traits and structure, and measurable in the short term. Depending on the type of CC, they can effectively reduce the risks of soil compaction and improve water infiltration rates during the growing season. Conversely, the changes in chemical parameters need longer time to be detected by a standard soil analysis.

A coupled system that combines a cropping system model and a software tool to optimized manure redistribution

by Mara Gabbrielli | Marco Botta | Marco Acutis | Giorgio Ragaglini | Marina Allegrezza | Alessia Perego | Department of Agricultural and Environmental Sciences, Università degli Studi di Milano | Department of Agricultural and Environmental Sciences, Università degli Studi di Milano | Department of Agricultural and Environmental Sciences, Università degli Studi di Milano | Department of Agricultural and Environmental Sciences, Università degli Studi di Milano | Department of Agricultural and Environmental Sciences, Università degli Studi di Milano | Department of Agricultural and Environmental Sciences, Università degli Studi di Milano

Abstract ID: 80
Topic: Soil
Presenter Name: Mara Gabbrielli
Contribution: Post

The increasing intensification of livestock farming raises increasing difficulties in managing N-manure meeting both economic and environmental sustainability. In this context, an integrated system combining a tool for optimising the redistribution of manure between farms (M-TOOL) and a cropping system model (ARMOSA) has been developed to support stakeholders in identifying feasible solutions to maintain crop productivity and reduce environmental impact on a local or regional scale. We developed the M-TOOL to minimise the costs (either money or CO_2 emission) of transporting manure from N-surplus farms to a range of N-deficit farms, on which crop N requirements are currently met through the purchase of mineral fertilisers. The optimisation algorithms perform a multi-criterion balancing that considers the distances between N-surplus sources and N-deficit destinations, as well as the costs and CO_2 emissions associated with the transport of manure and the purchase and production of mineral fertilisers. To apply M-TOOL, it is necessary to estimate the manure-N balance of the spatial units between which flows are to be optimised. Spatial units can correspond to farms or administrative areas such as municipalities. The manure-N balance is calculated as the difference between the produced manure and the N currently applied, so spatial units with a positive balance are classified as surplus N sources, while those with a negative balance are classified as deficit N sources. The user provides the tool with the N balance values and the distances between spatial units as input. In the Lombardy case study, the M-TOOL was applied within each province considering the N-balance aggregated at the municipality level using the regional database. In the estimate of the distance trade-off threshold, determining manure transport convenience for N-deficit destinations, the relative weight of costs and emissions can be modified by the user.

ARMOSA, a process-based dynamic model [1], was then applied in 30 manure-N deficit farms to assess the effects of the manure fluxes optimization. For each farm, two main crop rotations, derived from the crop data included in the regional database, were simulated for 22 years. On each farm of the region, 3 scenarios were simulated: a current scenario, with mineral fertilizer application only, an alternative scenario with manure application (set according to the outcome of M-TOOL and the EU nitrate directive), and a second alternative scenario with optimized management (reduced fallows, residue management, cover crops). Mineral fertilizer replacement with manure leads to variable effects on nitrate leaching in the simulated areas. With respect to the current scenario leaching levels, in the first alternative scenario were simulated both increased and decreased leaching rates depending on manure type, soil texture and crop rotation type. The third scenario allowed us to strongly reduce the leaching given the increased soil cover and litter input. A positive effect was also estimated on SOC stock. The presented integrated system allows the evaluation of the environmental and agronomic effects of the optimized manure fluxes redistribution. Further applications are currently ongoing in Danish and Catalan case studies (PROENV, ERAnet EU project).

Assessing the effect of cropping system, soil properties and climate on N2O emission through the use of the simulation model ARMOSA on a regional scale

by Giorgio Ragaglini | Mara Gabbrielli | Marco Perfetto | Marco Botta | Nicola Alessi | Marco Acutis | Alessia Perego | Leonardo Vario | Department of Agricultural and Environmental Sciences - Università degli Studi di Milano Milano | Department of Agricultural and Environmental Sciences - Università degli Studi di Milano Milano | Department of Agricultural and Environmental Sciences - Università degli Studi di Milano Milano | Department of Agricultural and Environmental Sciences - Università degli Studi di Milano Milano | Department of Agricultural and Environmental Sciences - Università degli Studi di Milano Milano | Department of Agricultural and Environmental Sciences - Università degli Studi di Milano Milano | Department of Agricultural and Environmental Sciences - Università degli Studi di Milano Milano | Department of Agricultural and Environmental Sciences Università degli Studi di Milano Milano

Abstract ID: 84
Topic: Soil
Presenter Name: Giorgio Ragaglini
Contribution: Post

The assessment of greenhouse gases emissions (GHG) from cropping system is assuming increasing relevance in the evaluation of mitigation potential of alternative soil and crop management practices (Chataut et al., 2023). The main GHG emitted from non-flooded soils are carbon dioxide (CO_2) and nitrous oxide (N_2O). N_2O, in particular, being an undesired co-product of nitrification and denitrification processes occurring in the soil and due to its radiative forcing, is considered a key indicator of the environmental sustainability of managed soils. The IPCC has proposed a simple methodology to estimate N_2O emission from managed soil, based on a linear relationship between nitrogen inputs to soil and emissions, that relies on the so-called Emission Factors (EF). This method, developed to support the emission inventory at country level, is often used also to estimate the impacts associated to agricultural production, even when it is unsuited to represent site specific environmental and management conditions. EF are empirically calculated as the slope of the linear regression between measured emissions and increasing levels of mineral N availability in the soil along the cropping season. A metanalysis of Kim et al. (2011) evidenced that direct N_2O EF are not constant, but they can vary with increasing N input showing both linear and non-linear response depending on the experimental conditions. The estimation of EF is largely affected by the uncertainty of measured N_2O soil fluxes. Measuring, N_2O soil fluxes is extremely challenging due to the spot nature of emission peaks, usually associated with events causing an increase of mineral nitrogen availability in the soil and a number of environmental and management factors directly and indirectly effecting the production of N_2O. Within the LIFE + project AGRESTIC, we aimed at analyzing the pattern of EF under a range of pedo-climatic and management conditions in the plain area of Emilia Romania using the cropping-system simulation model ARMOSA, calibrated on measured N_2O fluxes of a four-year field experiment. N_2O soil fluxes were measured in two different cropping systems (CCS and ECS) in continuous (9 measures per days per replicate per system) by means of four flow-through non-steady-state automatic chambers per system and the optical analyzer (Teledyne XXX), in a pilot farm located in northern Italy (Ravenna). The two cropping systems were managed according to conventional (CCS) and low-input (ECS) approaches. They employed the following crop rotation: maize, durum wheat, processing tomato, durum wheat (CCS); pea, durum wheat + alfalfa, processing tomato, durum wheat + alfalfa (ECS). N_2O daily fluxes, together CO_2 fluxes, soil moisture and temperature, crop aboveground biomass, yield and nitrogen uptake allowed the calibration and validation of ARMOSA simulation model (Perego et al., 2013, Gabbrielli et al. 2023). The regional up-scaling was performed by running the validated model on the Agri4Cast climate grid (1979 to 2022) according with a factorial design including: 2 management systems, 7 soil texture classes and 3 SOC levels. Our results figure out that the N_2O EF respond to increasing levels of nitrogen non-linearly and differently according with the soil texture and the SOC level.

Summarising soil organic carbon changes from scientific literature using natural language processing

by Luca Bechini | Alfio Ferrara | Università degli Studi di Milano | Università degli Studi di Milano

Abstract ID: 89
Topic: Soil
Presenter Name: Luca Bechini
Contribution: Post

Field experiments measure the agronomic and environmental effects of crop and soil management practices. When doing a literature review using common citation databases, identifying the effect A caused by practice B and its direction (increase, stability, or decrease) is very difficult because A can be found in the same text with B, even if the text does not describe their cause-effect relationship. The aim of this work was to use natural language processing (NLP) to count the number of abstracts which report an increase, a decrease, or a lack of effect of several agricultural management practices on soil organic carbon (SOC). We worked on a corpus of about 200,000 sentences from 17,842 abstracts of the Scopus database (1912-2019) containing a reference to SOC and to one or more of these practices: tillage, cover crops, fertilisation, residue management, crop rotation, intercropping. Using NLP, from that corpus we extracted a set of causal statements, that is a set of triples of the form <A, P, T> where: A is a concept representing a practice that is intended as the Agent of the causal statement; P is a concept representing the causal action due to the Agent (i.e., increase, decrease, no effect); T is a concept representing the target (i.e. the effect) of the causal action due to the Agent (e.g. <organic fertilisation, increment, SOC> coming from the sentence “The application of rice straw residue and organic manure increased organic carbon, total nitrogen and NH_4^+). We manually validated this procedure on 258 sentences, obtaining 23.6% false positive results (i.e. the triple was not present in the sentence but was considered present by our procedure) and 18.1% false negative results (i.e. the triple was present in the sentence, but was not recognised by our procedure). We finally used this procedure to automatically summarise the effects of management practices on SOC found in the entire corpus. From the whole set of abstracts, we found 6460 triples describing the effect of management practices on SOC. Most of the triples (53%) dealt with fertilisation, 18% on conservation agriculture, 12% on crop residue management, 7% on conventional tillage, and 6% on cover crops. As expected, cover crops increase SOC more frequently (109 triples) than bare soil (75), and so do organic (1422) vs. inorganic (219) or no (22) fertilisation, crop residue addition (254) vs. removal (20), crop rotation (136) vs. monocropping (17), conservation (603) vs. conventional agriculture (216). Thanks to our ontology, we could also detail the specific practices of each category, e.g. manure increased SOC in more triples (462) compared to slurry (24) and digestate (4). While these results may seem obvious given that they report evidence that is already known, this technique has demonstrated to have a great potential to quickly provide a qualitative summary of the impact of agricultural practices and to automatically identify relevant papers in a given scientific domain, thus speeding up document search for meta-analyses and systematic reviews.

Exploring the impact of tillage and nitrogen fertilization on acrylamide risk in durum wheat products

by Luigi Tedone | Teresa Sardone | Giovanna Marta Fusco | Rosalinda Nicastro | Annalinda Capone | Giuseppe De Mastro | Biagio Morrone | Petronia Carillo | Dep. of Soil, Plant and Food Sciences, University of Bari Aldo Moro | Dep. of Soil, Plant and Food Sciences, University of Bari Aldo Moro | Dep. Environmental, Biological and Pharmaceutical Sciences and Technologies, University of Campania L. Vanvitelli | Dep. Environmental, Biological and Pharmaceutical Sciences and Technologies, University of Campania L. Vanvitelli | Dep. Of Engineering, University of Campania L. Vanvitelli | Dep. of Soil, Plant and Food Sciences, University of Bari Aldo Moro | Dep. Of Engineering, University of Campania L. Vanvitelli | Dep. Environmental, Biological and Pharmaceutical Sciences and Technologies, University of Campania L. Vanvitelli

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Topic: Soil
Presenter Name: Giovanna Marta Fusco
Contribution: Post

Producing high-quality durum wheat is challenging due to environmental conditions and crop management, which alter the kernels' metabolic profile, increasing asparagine and hexoses, thus leading to acrylamide formation during high-temperature cooking. Limited information exists on how alternative tillage and nitrogen management, affect the metabolic profile and acrylamide production. In a previous study on durum wheat (*Triticum turgidum* L. subsp. *durum* cv. Iride) cultivated in open field during 2021-2022, within a long-term open field experiment from 2009-2010 in rotation with faba bean, we evaluated the effects of tillage systems and N application on the metabolic profile of the kernels. Significant differences were found for the treatments Conventional Tillage (CT) 30 and 90, Reduced Tillage (RT) 30, and No Tillage (NT) 90. From the kernels of these treatments, we have now obtained three wheat fractions (bran, flour, and semolina) and assessed their acrylamide content after baking. NT 90 achieved the highest yield (+62%) and total protein content (+10%) as well as fewer vitreous kernels and broken kernels, while CT 90 showed the greatest soluble proteins content (+13%), compared to the avarage of other treatments. In contrast, 1000 kernel and hectolitre weight increased in RT and NT treatments but decreased under higher N levels. RT 30 had the highest levels of total and essential amino acids, including asparagine and glutamine (+54% and +150%, respectively) and of glucose and fructose (+25% and 9%, respectively), which are the metabolites involved in acrylamide formation. In particular, the highest value of acrylamide was present in bran from CT 30 (+185%), while in flour and semolina the highest contents were in RT30 (+20% and +15%, respectively) compared to the average of other treatments. Balancing eco-friendly practices and food safety is crucial for optimizing yield and quality while mitigating acrylamide risks. NT 90 offers higher yields, better nitrogen use efficiency, and lower asparagine and sugar content. CT 90 correlates with higher soluble proteins and sucrose, highlighting the metabolic impact of different tillage practices. Both RT 30 and CT 30 have high acrylamide levels, with CT 30 showing high content in bran and RT 30 in both flour and semolina. The

high acrylamide levels in these low N treatments pose significant food safety concerns due to its potential carcinogenic effects. Further research is needed to refine practices to optimize yield and minimize acrylamide formation, ensuring safe durum wheat production, especially in arid regions.

Chemical and biological solutions to improve manure nitrogen use efficiency

by Pietro Marino Gallina | Daniele Cavalli | Andrea Gasparini | Roberto Fuccella | Lorenza Michelon | Giovanni Cabassi | Department of Agricultural and Environmental Sciences - Production, Landscape, Agroenergy Università degli Studi di Milano | Council for Agricultural Research and Economics - Research Centre for Animal Production and Aquaculture | Council for Agricultural Research and Economics - Research Centre for Animal Production and Aquaculture | Department of Agricultural and Environmental Sciences - Production, Landscape, Agroenergy Università degli Studi di Milano | Condifesa Lombardia Nord-Est | Council for Agricultural Research and Economics - Research Centre for Animal Production and Aquaculture

Abstract ID: 98
Topic: Soil
Presenter Name: Pietro Marino
Contribution: Post

In intensive livestock systems, maize (*Zea mays* L.) is commonly fertilized with animal manures applied prior sowing, and mineral fertilizers at side-dressing. Mineral nitrogen (N) accumulates in soil during when maize plants do not take it up at fast rates (V1–V6), and thus it is susceptible to leaching. Nitrification inhibitors were adopted to reduce NO_3^- production from mineral fertilizers. Recently, application of N-fixing bacteria on the canopy was proposed as substitute of mineral fertilization. In winter 2023, two field experiments were established (Orzinuovi, 45°22’57”N and 9°53’19”E, and Basiglio, 45°20’30”N and 9°09’18”E), to study the effects of a nitrification inhibitor and N-fixing bacteria on the yield and N uptake of maize. The field experiments considered the factorial combination of two fertilization treatments (mineral fertilizer and cattle slurry), with the following management treatments: none (CK); application of a nitrification inhibitor (IN); application of a N-fixing bacteria (BF). Experiments were designed as split plot, with fertilization treatments in main plots (arranged in randomized compete block with four replicates), and management treatments in sub-plots (5.4 m × 10.0 m and 6.3 m × 10.0 m at Orzinuovi and Basiglio, respectively). Within each block, an unfertilized plot was included. Ammonium sulphate and slurries were applied at ≈ 100 kg NH_4-N ha^{-1} and, as the nitrification inhibitor Istinct® (1.7 l ha^{-1}), incorporated prior sowing. The BlueN®, containing N-fixing bacteria, was spread on maize plants at the V6 stage (330 g ha^{-1}). Maize was sown on 23 March and 29 March and harvested for silage on 28 July and 27 July at Orzinuovi and Basiglio, respectively. The dry matter (DM) and N content of aboveground biomass (AGB) was measured at V6, V9 and R5 stage. Concentration of mineral N (SMN = NH_4-N + NO_3-N) in topsoil (0–30 cm) was measured prior fertilizer application, at V6 and at V9. In both experiments, there was no significant effect of the tested factors on the yield and N uptake of maize, and on SMN at V6. However, in the two trials, ammonium sulphate treatments had higher SMN with IN, followed by BF and CK. This trend was not evident following addition of cattle slurry. Differences between the sites were marked, regarding both SMN and yield. Orzinuovi had low soil N supply early in the season (SMN = 28 kg N ha^{-1} in unfertilised plots at V6) and during crop growth, as demonstrated by low AGB (<10 t DM ha^{-1}) and N uptake (<83 kg N ha^{-1}). Low yields were also due to the growth of *Sorghum halepense* (L.) at this site. Opposite to Orzinuovi, Basiglio presented high SMN at V6 in unfertilized plots (111 kg N ha^{-1}) and provided high maize yield (on average, 21 t DM ha^{-1}) and N uptake (212 kg N ha^{-1}). The experiment in Basiglio is ongoing; results of the second cropping season (year 2024) will permit to understand more accurately the effects of the applied factors on the forage production.

Variable Rate Management of Livestock Effluents to Optimize Soil Organic Matter Storage

by Nicolò Pricca | Daniele Cavalli | Roberto Fuccella | Pietro Marino Gallina | Andrea Lazzari | Giovanni Cabassi | CREA ZA | CREA ZA | DISAA - Università degl Studi di Milano | DISAA - Università degl Studi di Milano | CREA ZA | CREA ZA

Abstract ID: 102
Topic: Soil
Presenter Name: Giovanni Cabassi
Contribution: Post

The PEI InfotecN Operational Group aims to develop a Decision Support System (DSS) for the spatial management of nitrogen in Lombardy maize cultivation. This integrates organic fertilization with livestock effluents and mineral fertilizers to protect and enhance soil organic matter content in arable lands. In cultivated soils, the capacity to stabilize organic matter on the fine mineral fraction (particles >50 µm) is often not fully saturated. This means that there is potential for additional organic carbon from organic fertilizers to be stabilized in the soil. The DSS optimizes the spatial distribution of livestock effluents to maximize soil organic matter storage by defining homogeneous zones based on soil carbon deficit mapping using expeditive techniques (a combination of resistivity mapping for estimating texture parameters and NIR spectrometry for estimating organic matter). The carbon deficit refers to the difference between the current stable organic carbon content and the soil's potential capacity to stabilize additional carbon on fine mineral fraction. In the presented case study, two contiguous fields (FIELD1 and FIELD2) with a total area of approximately 9 hectares, located in Basiglio (45°20'30"N, 9°09'18"E), underwent three years (2021, 2022, and 2023) of injected livestock effluent (cattle slurry) distribution according to a prescription map. This map specified a high dosage of 220 kg N/ha (HIMZ) in areas with higher carbon deficits and a lower input of 120 kg N/ha (LIMZ) in areas with lower carbon deficits. An average distribution of 170 kg N/ha was maintained in each field, in compliance with the Nitrates Directive for nitrate-vulnerable zones. Prior to the experiment in 2020, soils were sampled at a depth of 0-30 cm on a 50m regular grid and analyzed for texture, organic carbon, and total nitrogen. The soils were resampled at the same points at the end of the third year and reanalyzed. Analytical data allowed for the estimation of carbon deficit evolution due to the increase in soil carbon stock in different homogeneous zones. FIELD1 showed a decrease from 2.64 to 2.33 g/kg in LIMZ and from 3.39 to 2.70 g/kg in HIMZ, while FIELD2 showed a decrease from 1.55 to 1.35 g/kg in LIMZ and from 2.20 to 1.5 g/kg in HIMZ. The results suggest that variable rate management of effluent distribution combined with minimal tillage can contribute to soil carbon storage. Ongoing analytical determinations aim to directly evaluate changes in fine mineral fraction-bound carbon content in the collected samples. The study underscores the potential role of spatially targeted management in enhancing soil carbon sequestration. By matching effluent application rates to site-specific carbon deficits, the DSS ensures efficient use of organic inputs and maximizes their stabilization in the soil. This precision approach allows for

increased carbon sequestration in areas with higher capacity, directly addressing the carbon deficit and improving soil health.

Contrasting effects of two zeolites used as soil amendment on water retention characteristics of a sandy-loam soil

by Satriani Antonio | Comegna Alessandro | Castronuovo Donato | Belviso Claudia | Lovelli Stella | National Research Council-Institute of Methodologies for Environmental Analysis | School of Agricultural, Forest, Food and Environmental Sciences, University of Basilicata | Department of Pharmacy, University of Salerno | National Research Council-Institute of Methodologies for Environmental Analysis | School of Agricultural, Forest, Food and Environmental Sciences, University of Basilicata

Abstract ID: 109
Topic: Soil
Presenter Name: Lovelli Stella
Contribution: Post

Zeolites are aluminosilicate minerals that have been gaining interest in agriculture due to their environmentally friendly nature (Baricevic *et al*, 2023). They can serve as a reservoir of water and nutrients for plants, improve soil sorption capacity, reduce soil acidification, and increase nutrient use efficiency (Baričević *et al*, 2023, Castronuovo *et al*., 2023, Mondal *et al*, 2021; Jarosz *et al*, 2021). However, the use of natural zeolites or those synthesized from oversaturated commercial solutions is more explored commercially than those synthesized from residues (de Carvalho *et al*, 2024), and there is little information regarding the effect of commercial zeolites on the hydrological properties of soils with different textures. In this study, a sandy-loam soil (54% sand, 35% silt and clay 11%) was collected and mixed with varying amounts of synthetic zeolite, derived from coal fly ash (S; Belviso *et al,* 2022) and a commercial one (C; Zeolite ® Italia). Repacked soil samples were combined with two levels of zeolite (2% and 5%) by weight, and the obtained soil samples were characterized by measuring soil water retention curves (SWRCs) of soil-zeolite mixtures. The experimental soil water retention curves obtained from laboratory tests were modelled using the van Genuchten equation (van Genuchten, 1980). In the comparison of two zeolites specific attention was laid on the impact of zeolite in modifying soil's capacity to retain water, and hence on the energy required by plants to acquire a unit mass of soil water, referred to as Integral Energy (Ei; Minesny and Mc Bratney, 2003). Finally, the ANOVA test, analysis was performed. In our experiments, the ability of two zeolites added to sandy loam soil to retain water and then modify the range of available water was observed in a contrasting way. The Field capacity, Plant Wilting Point, Air Capacity and Integral Energy in the compared treatments on a sandy-loam soil varied among two zeolites studied (S and C) and among the soil percentage mixtures (i.e., 2% and 5%). We observed a shift of the water availability range towards higher soil humidity values in the case of synthetic zeolite (S), and a shift towards lower values of soil moisture in the case of commercial zeolite (C). Moreover, the Ei approach yielded valuable insights into soil water availability for plants. Our observations demonstrate that this parameter has an opposite variation according to the type of zeolite used in the sandy-loam soil studied. In sustainable agriculture and land management, exploring zeolites that can potentially reduce water usage in irrigation is crucial. However, the practice of amending soils with zeolites requires a rigorous approach

due to the complex effects on soil water retention curves that may be affected by the type of the zeolite, soil texture (Belviso *et al*, 2022; Comegna et al., 2023) and zeolite concentrations in soils.

A low-cost simple and rapid phenotyping pipeline to study early belowground interactions in intercropping

by Roberta Rossi | Daniele Cavalli | Tommaso Notario | Angelo Passerini | Giuseppe Morone | Luciano Pecetti | Council for Agricultural Research and Economics (CREA), Research Centre for Animal Production and Aquaculture | Council for Agricultural Research and Economics (CREA), Research Centre for Animal Production and Aquaculture | Council for Agricultural Research and Economics (CREA), Research Centre for Animal Production and Aquaculture | Council for Agricultural Research and Economics (CREA), Research Centre for Animal Production and Aquaculture | Council for Agricultural Research and Economics (CREA), Research Centre for Animal Production and Aquaculture | Council for Agricultural Research and Economics (CREA), Research Centre for Animal Production and Aquaculture

Abstract ID: 117
Topic: Soil
Presenter Name: Daniele Cavalli
Contribution: Post

Intercropping is a valid means to increase sustainability in agriculture. A large body of literature repeatedly indicated that different crops in mixtures can exceed their performance in monoculture, the overproduction being generally associated to a wide range of ecosystem services (Annicchiarico et al., 2019). A substantial part of plant interactions occurs underground where it remains largely unseen due to the methodological and practical difficulties in phenotyping roots in intercropping. Root interactions fall into three overarching categories, viz., competition, facilitation and resource partitioning mediated by root plasticity . Breeding for intercropping is still in its infancy, especially for what concerns the search of a root ideotype specifically suited for plant mixtures. Phenotyping root architecture and physiology in intercropping can help identifying species or genotype strategies to survive competition. We tested a simple phenotyping pipeline based on the use of low-cost, easily to assemble rhizoboxes, and rapid graphic indicators of root interactions. The pipeline was tested on white lupin (Lupinus albus L.) grown for three weeks as sole crop or intercropped with bread wheat (Triticum aestivum L.). We measured root system projected contour, visible root length, root system shape parameters and the area overlap between neighboring roots. We propose a novel rapid index of root interaction named 'root merge' (RM) based on the area overlap between neighboring roots relative to the total root area. This index, coupled with the other root metrics, such as root projected area, length and shape, is indicative of the plant tendency to avoid or intermingle with its neighbor. Our pipeline was useful to capture sizable differences between species and cropping systems. Lupin shoot mass did not differ between pure stand and intercropping. Intercropped lupin displayed similar values to the pure stand for visible root length but showed a tendency for a larger area with roots more spread horizontally (lower aspect ratio, $P<0.05$), and developed 67% more nodules ($P<0.05$), compared to the pure stand. Enhanced nodulation in legume-cereal intercropping is a well-known mechanism of resource partitioning, which often translates in pure facilitation for cereals. Lupin showed a relatively low root architectural plasticity but a large physiological plasticity. Wheat explored twice the area of pure lupin (831 vs 439 cm2) filling almost all the available soil volume. This is in line with research indicating that cereals display a great competitive ability in mixtures. RM differed significantly between cropping systems ($P<0.01$) with values between 17% in lupin sole crop and 69% in intercropping, indicating a large overlap between wheat and lupin roots, with no detrimental effects on lupin as proven by the other root and shoot metrics. Minimal root overlapping occurred in lupin pure stand, and this suggests an avoidance/scramble competition strategy. Our preliminary results prove that this simple low-cost phenotyping pipeline can provide several interesting and relatively high-throughput root metrics for intercropping that can be useful to highlight mechanisms behind species co-existence, as well as to screen genotype suitability for intercropping.

Potential role of “New Agricultural Carbon Credits” (ACC) in sustainable agronomic management

by Maria Giordano | Marco Schiavon | Paolo Gianpiero Miosi | Giorgia Raimondi | Marco Berton | Cristian Bolzonella | Samuele Trestini | Maurizio Borin | Carmelo Maucieri | Department of Agronomy, Food, Natural resources, Animals and Environment — DAFNAE, University of Padova | Department of Agronomy, Food, Natural resources, Animals and Environment — DAFNAE, University of Padova | Department of Agronomy, Food, Natural resources, Animals and Environment — DAFNAE, University of Padova | Department of Agronomy, Food, Natural resources, Animals and Environment — DAFNAE, University of Padova | Department of Agronomy, Food, Natural resources, Animals and Environment — DAFNAE, University of Padova | Department of Land, Environment, Agriculture and Forestry — TESAF, University of Padova | Department of Land, Environment, Agriculture and Forestry — TESAF, University of Padova | Department of Agronomy, Food, Natural resources, Animals and Environment — DAFNAE, University of Padova | Department of Agronomy, Food, Natural resources, Animals and Environment — DAFNAE, University of Padova

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Topic: Soil
Presenter Name: Maria Giordano
Contribution: Post

Soil organic matter, in addition to being the basis of physical, chemical, and biological fertility, provides several ecosystem services. Among these, it allows the formation of a stable carbon pool in the soil, mainly represented by substances with slow microbial degradation, contributing to the permanent capture of carbon dioxide from the atmosphere. Various agronomic strategies increase the soil organic matter, such as the burial of crop residues, the use of cover crops, and the organic fertilization. The latter, in recent decades, has been largely replaced by mineral fertilization, which has a more rapid impact on crop productivity. However, if profitability has long guided the choice of farmers, the growing sensitivity of the modern consumer towards a high-quality product with low environmental impact is placing organic fertilization among the useful actions to increase the soil organic matter content. A stimulus towards the use of organic fertilization, due to its potential to permanently accumulate carbon in the soil, is represented by the carbon credit market. The latter bases on voluntary monetized actions, not yet certified, aimed at reducing or eliminating greenhouse gases in the atmosphere, through the implementation or purchase of eco-sustainable practices. A carbon credit represents one ton of $CO_{2e(eq)}$ not emitted or sequestered. Agriculture through carbon sequestration in the soil, can play a leading role in the creation of “New Agricultural Carbon Credits” (ACC). The farmer himself becomes the creator and seller of carbon credits. From this perspective, carbon credits could offset the economic loss caused by a reduction in crop yield that is usually obtained with organic fertilization management. In this context, within the "Podere Fiorentina" Living Lab, ten different agronomic managements based on the combination of organic fertilization, the use of cover crops, and irrigation in a corn-soybean rotation were compared over four years. The objectives of the experimentation were to evaluate, for each of the ten possible managements tested, the soil organic carbon accumulation, corn and soybean grain yield,

and the impact of the carbon credit system application on the economic sustainability of each management. Results indicate that, for some of the managements, carbon credits can represent an interesting tool to stimulate the adoption of agronomic practices aimed at the soil organic carbon accumulation.

Use of grass species for phytoremediation of hydrocarbon contaminated soils

by Anna Verde | Donato Visconti | Nunzio Fiorentino | Massimo Fagnano | Dipartimento di Agraria - Università degli Studi di Napoli Federico II | Dipartimento di Agraria - Università degli Studi di Napoli Federico II | Dipartimento di Agraria - Università degli Studi di Napoli Federico II | Dipartimento di Agraria - Università degli Studi di Napoli Federico II

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Topic: Soil
Presenter Name: Anna Verde
Contribution: Post

Soil contamination is a major threat to human health and remediation can be aimed at removing the contaminants or at reducing the environmental and sanitary risks by limiting their movements. Removing contaminants can be very expensive and unattainable, so safety measures should be considered to reduce movement of these contaminants toward other environmental compartments (i.e. air and water) and from there to human beings. Among the different techniques, phytoremediation (e.g. phytoextraction or phytostabilization) is considered a more cheap and environmentally friendly method than the physico-chemical ones. This study analysed the potential (e.g. reducing resuspension of soil particles) of turfgrass mix (MA: *F. Arundinacea* Shreb., *P. pratensis* L., *L. perenne* L.; MB: 2 varieties of *F. Arundinacea* L.) assisted by biostimulants (*Bacillus megaterium* EL5 and *Kosakonia pseudosacchari* TL13) and compost fertilization as phytostabilization strategy for hydrocarbon contaminated soils. The MA showed higher biomass production as compared to MB six months after sowing (MAS). Compost application increased biomass production and plant height by 60% and 16%, respectively. A reverse pattern was found 12 MAS with MB showing the highest biomass yield (+28% increase compared to MA). These results were corroborated by image analysis. A higher soil coverage (80 %) was recorded 3 MAS after sowing with MA while the same result was achieved with MB only after 6 months, confirming the late growth of *F. Arundinacea* L.. It must be pointed out that this species is more persistent than those of MA (e.g. *P. pratensis* and *L. perenne*), resulting more appropriate under very limiting growth conditions (e.g. absence of water supply; low soil fertility) when compost fertilization is applied to soil. The content of hydrocarbons in leaves was the same in plants grown in contaminated and not contaminated soils, suggesting a biogenic nature of such hydrocarbons (e.g. epicuticular waxes) and as well as a possible effect of turfgrass in reducing resuspension of soil particles. Furthermore, the microbial biostimulant significantly accelerated biodegradation of hydrocarbons (64% reduction) as compared to non-inoculated pots (58% reduction). These results confirm the potential of using assisted phytoremediation with perennial meadows for reducing sanitary and environmental risks due to organic contaminants (i.e. securing or phytocapping).

Precision Soil Mapping: The Potential of an Autonomous Rover Combined with Multi-Geophysical Instruments

by Davide Gabrieli | Ilaria Piccoli | Franco Gasparini | Luigi Sartori | Antonio Berti | Francesco Morari | DAFNAE, Università degli Studi di Padova | DAFNAE, Università degli Studi di Padova | TESAF, Università degli Studi di Padova | TESAF, Università degli Studi di Padova | DAFNAE, Università degli Studi di Padova | DAFNAE, Università degli Studi di Padova

Abstract ID: 138
Topic: Soil
Presenter Name: Davide Gabrieli
Contribution: Post

Geophysical methods are techniques used to measure the physical - often electrical and mechanical - properties of a investigated media without altering its state. These methods can be applied qualitatively to identify soil anomalies and spatial heterogeneities, and quantitatively to relate primary soil properties to physical measurement. In precision farming, geophysical surveys play a crucial role in characterizing soil spatial variability, hydrological processes and nutrient patterns. Common techniques include electrical resistivity tomography (ERT), electromagnetic induction (EMI), and gamma ray (γ-ray) spectroscopy. There is also an increasing interest in the use of ground penetrating radar (GPR) and seismic methods. This study explores the potential for precision soil mapping by combining various geophysical sensors mounted on an autonomous robot, complemented by traditional ground-based soil analysis. The experiment was conducted at the Padova University experimental farm 'L. Toniolo' in Legnaro on a 2-ha field managed with different soil tillage operations. Three tillage intensities – no tillage (sod seeding), conventional tillage (30-cm ploughing + 15-cm rotary harrowing), and minimum tillage (15-cm rotary harrowing) – were compared according to a randomized block design with two replicates. An autonomous rover (Robotti 150D, Agrointelli- DK) was equipped with a γ-ray detector (Agri Detector MS-2000, Medusa - NL) and active optical sensor (OptRx, Ag Leader - USA) mounted at the front position, a GPR (Sream DP, IDS -IT) and cosmic ray neutron sensing probe (Finapp - IT) in the central part, and an electromagnetic conductivity meters (CMD-MiniExplorer, GF Instruments - CZ) on a wooden sled at the rear. Measurements were taken at a speed of 3.6 km h-1, with swaths repeated every two meters. All instruments worked simultaneously and were connected to a GPS with RTK positioning system, ensuring a precision of about 2 cm. A soil mapping survey was then carried out to characterise the soil profile for physical properties (i.e. soil moisture, resistance penetration, bulk density and texture) and chemical properties (e.g. soil organic carbon). Preliminary results demonstrated that the combination of an autonomous robot with several geophysical proximal sensors can act as a proxy for soil properties digital mapping, enhancing precision agriculture operations. While the EMI proved to be a reliable predictor of soil horizontal spatial variability, ERT, seismic and GPR showed promise in evaluating the soil properties stratification along the soil profile. Finally, the simultaneous collection of multi-layer datasets has paved the way for future research involving artificial intelligence application.

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Implementing Carbon Farming in the Euro-Mediterranean Basin: Collaborations, Strategies and Impact

by Nicola Dal Ferro | Ilaria Piccoli | Carlo Camarotto | Thomas Alexandridis | George Bilas | Francesco Morari | DAFNAE - University of Padova | DAFNAE - University of Padova | DAFNAE - University of Padova | School of Agriculture - Aristotle University of Thessaloniki | School of Agriculture - Aristotle University of Thessaloniki | DAFNAE - University of Padova

Abstract ID: 144
Topic: Soil
Presenter Name: Nicola Dal Ferro
Contribution: Post

European Union (EU) initiatives, such as the carbon farming strategy, advocate for managing carbon pools, flows and GHG fluxes at the farm level with the purpose of mitigating climate change. Despite the commendable nature of this initiative, there are currently no established EU-wide standards for monitoring, reporting, and verifying soil properties and carbon fluxes in agriculture over time and space. The Interreg Euro-MED project 'Carbon 4 Soil Quality' pioneers sustainable soil management practices aimed at carbon sequestration, mitigating the greenhouse effect, and enhancing soil health in the agroecosystems. Utilizing innovative tools and transnational collaboration, project partners from the Euro-Mediterranean region are tasked with establishing standards, monitoring protocols, and developing socio-economic models to evaluate carbon farming practices across diverse Mediterranean climates. Within this framework, the research team from the University of Padova at DAFNAE department will co-lead two key tasks of the project aim at: 1) identifying soil organic carbon (SOC) reference values for different soil types across EU Mediterranean countries, and 2) identifying reference values for soil quality, which will guide 3) the choice of best agricultural management practices to enhance SOC sequestration and preserve soil health in EU. The establishment of reference values for soil organic carbon (SOC) content and stock, as well as soil quality standards, is essential to provide reliable targets for farmers, policymakers, and stakeholders. The LUCAS database will be utilized to identify the pedo-climatic and management factors influencing SOC variability and to estimate the maximum achievable SOC content for farmers in any homogeneous area within the Euro-Mediterranean basin. To achieve this, machine learning algorithms, including artificial neural networks, regression trees, and random forests, will be employed. For establishing soil quality standards, a Bayesian Belief Network (BBN) model will be augmented into an innovative Influence Diagram. This approach will incorporate quantitative soil data and qualitative-quantitative perceptions from stakeholders through a value elicitation process, aiming to identify probabilistically defined relationships between soil properties, soil functions, and ultimately, soil quality indices. The expected results include the identification and mapping of SOC thresholds for each homogeneous area across the Euro-Mediterranean countries. These thresholds will be credible, verifiable, and potentially achievable by farmers through the implementation of best agricultural practices. Additionally, the project aims to quantify a soil quality probabilistic value that

overcomes the limitations of aggregating various soil functions or properties into a deterministic soil quality value.

Application of plant biostimulants to chickpea genotypes under field conditions

by Michele Andrea De Santis | Salvatore Colecchia | Luigia Giuzio | Damiana Tozzi | Zina Flagella | Dept. DAFNE - Unifg | CREA CI - Foggia | Dept. DAFNE - Unifg | Dept. DAFNE - Unifg | Dept. DAFNE - Unifg

Abstract ID: 161
Topic: Soil
Presenter Name: Michele Andrea De Santis
Contribution: Post

Sustainable cropping systems are more and more demanding for modern agricultural strategies. In rainfed Mediterranean areas, cereals and in particular durum wheat represent the main crop with limited options of rotations under drought conditions. Legumes would represent a good precession for cereals because of their ability to increase soil nitrogen by N2 fixation. Within pulses, chickpea is considered well adapted to drought conditions. Previous studies have shown that the yield gap between rainfed and irrigated chickpea is limited with respect to other crops, and this make this cultivation suitable in Mediterranean rainfed cereal systems. Hence, few information on chickpea nutrition is available, in particular with reference to plant biostimulant applications and their effects on yield and quality. To this aim a two-year field trial was set in South Italy, at Foggia, in order to observe the response of two chickpea genotypes, respectively large and small seed, to mineral and biostimulant treatments. The study was found by the MIUR Agritech National Research Center which received funding from the European Union Next-Generation EU (PNRR). Five biostimulants were inoculated, including a symbiotic *Rhizobium*, a not symbiotic N-fixing bacterium (*Azospirillum brazilense*), a PGPB (*Bacillus subtilis*) and a plant-based biostimulant (plant peptides and humic acids). Biostimulants were tested in a factorial combination with two N supply (0 vs 40 kg/ha of N) in order to verify their response as function of different N soil availability, and with two chickpea genotypes (Pascià, Sultano) in a split plot design with three replications. Spectral vegetation indexes measurements were carried out at flowering. Crop performance was assessed in terms of yield, water use efficiency and protein content. Field trials were conducted under two different crop seasons characterized by a marked variations in rainfall distribution. Preliminary results indicated that some combinations of fertilization and biostimulant could improve crop performance, that is markedly influenced also by weather conditions. Analyses on quality traits are in progress.

A case study of precision agriculture and biofertilization on durum wheat under drought conditions in South Italy

by Michele Andrea De Santis | Davide Misturini | Zina Flagella | Dept. DAFNE - University of Foggia | Agrinnovazione | Dept. DAFNE - University of Foggia

Abstract ID: 163
Topic: Soil
Presenter Name: Michele Andrea De Santis
Contribution: Post

Agricultural systems are nowadays demanded to face challenges to improve resource use efficiency on one hand, and productivity for an increasing population on the other hand. Precision farming, which is based on the use of the right input, in the right time and space, is considered one of the main solutions. In this study, a precision farming system was adopted on durum wheat in South Italy to combine the adoption of precision agriculture with biofertilization with the aim to improve resource use efficiency. The study was found by the MIUR Agritech National Research Center which received funding from the European Union Next-Generation EU (PNRR). An on-farm experiment was carried out in the province of Foggia, in a particularly dry crop season (2023/2024) in an area of about 6.5 hectares. Experimental design consisted of two durum wheat genotypes, two nitrogen fertilization strategies (business as usual vs DSS supported) and two biofertilization levels (inoculation with commercial *Bacillus subtilis* vs control), for a total of eight plots of about 0.8 hectares. Soil variability was assessed by electrical conductivity. Durum wheat was grown under conservative agriculture (no tillage). Soil water moisture was monitored at sowing, mid-season and harvest. Temporal NDVI measurements were carried out by satellite observations (Sentinel 2 / Landsat 8) and the area under the curve (AUC_NDVI) was calculated for the NDVI trend (Y axis) in the days from tillering to maturity (X axis). Business as usual fertilization consisted in an application of 90 kg/ha of N at the end of stem elongation (~ 1000 °C d). Optimized fertilization was carried out with the indications of a decision support system (DSS) that allowed to estimate the N demand on the basis of the agronomic inputs (variety, soil data, previous crop, yield target). On the basis of DSS indications 49 kg/ha of nitrogen were supplied. Urea ammonium sulfate was used as fertilizer (33% of N, iFert33). Supplementary fertilization was not carried out due to the severe drought occurred during the growing season. Variable rate (VR) of nitrogen fertilizer was applied on the basis of the prescription map made according to the NDVI values before fertilization. At booting (~ 1100 °C d) a commercial microbial biostimulant (*Bacillus subtilis*) was applied in the respective thesis. At maturity, subsamples of wheat plants were collected to assess yield components and to perform chemical analysis. Grains were finally harvested by a combine harvester equipped with GPS; yield map was then generated as an outcome. Yield data of the different experimental theses were compared to AUC_NDVI estimations and to the N fertilization supply. Preliminary results indicate a higher efficiency in the DSS thesis, and a higher crop vigor associated to biostimulant inoculation.

Health risk assessment in two agricultural soil contaminated by potential toxic elements

by Donato Visconti | Nunzio Fiorentino | Massimo Fagnano | Department of Agricultural Sciences - University of Naples Federico II | Department of Agricultural Sciences - University of Naples Federico II | Department of Agricultural Sciences - University of Naples Federico II

Abstract ID: 165
Topic: Soil
Presenter Name: Nunzio Fiorentino
Contribution: Post

Potential toxic elements (PTEs) can contaminate the soil and pose risks to human health through various pathways of exposure. PTE uptake has been extensively studied in various crops, which can absorb these elements from contaminated soils through their roots, while leaves can also absorb harmful elements from particles deposited on their surfaces. Since PTEs in crops can enter the human body through the food chain, food consumption represents a significant exposure pathway. In this study, we conducted a health risk assessment at two contaminated sites in Southern Italy in accordance with Ministerial Decree 46/2019. The first site (S1) was contaminated by Cd and located in an agricultural area affected by industrial sludge discharge. A phytoremediation protocol, involving a combination of poplar trees and a stable turfgrass, was implemented for four years (from 2017 to 2020). The second site (S2) was an agricultural area that has been used as a shooting range for several years and contaminated mainly by Pb, the main component of bullets. Soils were collected from both sites in 2020, and a pot experiment was conducted by cultivating four edible plant species commonly found in the study area and known for their ability to accumulate PTEs: lettuce, wild rocket, spinach, and chicory. Results showed that Pb concentrations in plant tissues were below the regulatory limits (0.3 mg kg^{-1} F.W. - EC Regulation 1881/2006) for all species and soils considered. Carcinogenic risks to consumers were observed, with only spinach showing a low carcinogenic risk. Cd concentrations in plant tissues grown on soil S2 exceeded the limits set by European regulations (0.2 mg kg^{-1} F.W - EC Regulation 1881/2006), but a reduction in Cd content in all species was observed in 2020 compared to 2017, suggesting a decrease in readily bioavailable Cd in the soil. The reduction of Cd concentrations in plants corresponded to a reduction in consumer risk. According to European regulations (EC Regulation 1881/2006), all species grown on soil S2 would not be marketable as they could pose a risk to human health, but indirect risk analysis indicated that only spinach and chicory could be hazardous, suggesting the need for a unified approach to assessing indirect risks associated with the ingestion of agricultural products. The results obtained in 2020 suggest that a low indirect carcinogenic risk associated with Pb exists at site S1, as well as a potential risk of dust inhalation, indicating the need for safety measures to reduce both direct and indirect risks. Regarding site S2, the results suggest that additional cycles of phytoextraction should further reduce the bioavailable Cd content in the soil and consequently in plants, thereby reducing health risks for consumers.

Assessing the impact of minimum tillage and legume species introduction on forage-cereals crop rotation under Mediterranean conditions

by Alice Palimodde | Davide Fois | Teresa Murgia | Antonio Pulina | Giovanna Seddaiu | Department of Agricultural Sciences, University of Sassari | Department of Agricultural Sciences, University of Sassari | Department of Agricultural Sciences, University of Sassari | Department of Agricultural Sciences, University of Sassari | Department of Agricultural Sciences, University of Sassari

Abstract ID: 167
Topic: Soil
Presenter Name: Alice Palimodde
Contribution: Post

Great attention is paid to low-input, high-efficiency farming systems to reduce costs, promoting environmental sustainability and farm self-sufficiency. Conservative agriculture practices and using legume species in cropping systems are crucial for agri-livestock farms' sustainability due to their nitrogen-fixing capacity, high nutritive value and ability to improve soil fertility**.** The objective of the study was to assess the effect of the interaction between tillage practices and forage cropping systems in rotation (triticale for silage production, hay crop mixture, and fava bean) with cereal crops (triticale and durum wheat) on crop yield and quality and some associated ecosystem services (e.g., N and C cycling) in a typical agri-livestock farm forage systems. The research activities are ongoing at the experimental farm of the University of Sassari in Ottava, Sassari. A two-year field experiment was established in the autumn 2023. The experimental design is a split-plot with four replicates in which the main factor is the tillage method with two levels: conventional tillage (CON), i.e. ripping at 40 cm and harrowing with a rotary harrow; minimum tillage (MIN), i.e. ripping at 10 cm and harrowing with a rotary harrow. The subfactor is the crop rotation with forage crops, with three levels: pure triticale (TRI) for silage production; pure fava beans (FAV) for fodder grain production; mixture of Italian ryegrass and alexandrine clover (MIX) for hay production. The total aboveground biomass, forage quality, phenological stages, and leaf area index (LAI) have been measured monthly during the growing season. At the same time, the fraction of Photosynthetic Active Radiation adsorbed by the canopy (fPAR), the Chlorophyll Content Index (CCI), and the surface reflectance in the green (560 nm), red (659 nm), Red Edge (730 nm), and Near Infrared (850 nm) have been measured with proximal sensors to assess the share of the variability of measured variables explained by derived multispectral indices and their ability to predict agronomical traits. The crop yield as hay production (MIX), silage (TRI), and grain (FAV) have been measured at the end of the growing season according to crop maturity stages. Soil physical and chemical characteristics were also determined at the beginning of the experiment. Soil C and N content, water availability, and bulk density will also be monitored at the end of each growing season. Soil water content has also been monitored continuously from early spring at 0-20 cm and 20-40 cm depth. The dataset will also be used to calibrate crop

models to assess the impact of such practices in the mid- and long-term, also under climate change scenarios. The expected results, for which data collection and analysis are currently in progress, could confirm the hypothesis that conservation agriculture techniques such as minimum tillage and crop rotations with legumes can positively affect crop productivity and quality and soil's biological and chemical properties. Furthermore, an improvement in ecosystem services such as food production, water storage, and carbon sequestration is expected to mitigate climate change and extreme weather events.

Session: WATER

Microbial consortia increase nutrient use efficiency on irrigated and rainfed corn over 5-year monocropping

by Francesco Ferrero | Ernesto Tabacco | Gabriele Rolando | Giorgio Borreani | University of Turin - Department of Agricultural, Forest and Food Sciences (DISAFA) | University of Turin - Department of Agricultural, Forest and Food Sciences (DISAFA) | University of Turin - Department of Agricultural, Forest and Food Sciences (DISAFA) | University of Turin - Department of Agricultural, Forest and Food Sciences (DISAFA)

Abstract ID: 23
Topic: Water
Presenter Name: Francesco Ferrero
Contribution: Oral

Inoculating crops with microbial consortia (MC) is increasingly gaining attention in agriculture as possible way for sustainable arable crop growth and efficiency. Some studies have stressed the positive effect of MC crop inoculation on growth, nutrient uptake under laboratory condition (Hett et al., 2023), however, field applications of MC over a long experiment period have been less investigated. Microbial consortia usually consist of two or more plant growth-promoting microorganisms, and, among these, the rhizobacteria and beneficial fungi are the most frequently used in cereal. The aim of the study was to assess the nutrient contents and uptakes of irrigated and rainfed mono-cropped corn inoculated with MC under field conditions over a long-term experiment. The study was conducted over a 5-year period at the University of Turin. A split-plot design with four replicates was used, with irrigation treatment assigned as the whole plot, inoculation with MC as split plots, and replicates as blocks. Corn was inoculated at sowing by row distribution with a MC containing mycorrhizae, beneficial bacteria of rhizosphere, and saprophytic fungi. Experimental field received 161, 48, and 61 kg ha^{-1} of N, P_2O_5, and K_2O, respectively. Irrigation treatment was managed following the crop needs and resulted in 2 to 4 irrigation per growing season. The dry matter (DM) yield, corn grain nutrient contents, nutrient balance, and nutrient use efficiency were assessed following Tabacco et al. (2018). On average the irrigation improved the yield of +7% (P<0.001) with a stronger effect showed in one year out of five (+18% and +21%, for control and MC, respectively). Inoculation with MC showed an increase in the yield of +3% (P=0.033) with higher value in irrigated than in rainfed plots. Inoculation with MC increased the nutrient use efficiency which compared with untreated corn increased from 0.88 to 0.92 (P=0.007), from 1.38 to 1.44 (P=0.011), and from 0.96 to 1.00 (P=0.042) for N, P_2O_5, and K_2O, respectively. This resulted in a reduction of surplus per hectare that was from 93 to 64 (P=0.001), from -90 to -105 (P=0.001) and from 12 to 1 (P<0.001) for N, P_2O_5, and K_2O, respectively. Due to high availability of soil P, the amount of P_2O_5 delivered to crop was lower than actual uptake and this resulted in very high nutrient efficiency. The N content of grain linearly decreased over the 5-year period (R^2 = 0.93), indicating the ability of plant to use a lower amount of nutrient without reducing the dry matter yield. Results of the present work indicates that MC can represent a way to improve corn nutrition efficiency and yield, however, evaluation

of difference in incomes or value-added between the two treatments are needed.
Acknowledgments**.** This study was carried out within the Agritech National Research Center and received funding from the European Union Next-GenerationEU (PNRR) – MISSIONE 4 COMPONENTE 2, INVESTIMENTO 1.4 – D.D. 1032 17/06/2022, CN00000022). This abstract reflects only the authors' views and opinions, neither the European Union nor the European Commission can be considered responsible for them.

Comprehensive Assessment of Wastewater Reuse in Agriculture: Risk and Benefit Evaluation in Tomato and Durum Wheat Cultivation

by Michele Denora | Vincenzo Candido | Francesco De Mastro | Giuseppe Gatta | Cristina De Ceglie | Sapia Murgolo | Costanza Fiorentino | Gennaro Brunetti | Michele Perniola | Department of European and Mediterranean Cultures, University of Basilicata | Department of European and Mediterranean Cultures, University of Basilicata | Department of Soil, Plant, and Food Science, University of Bari | Department of Agricultural Sciences, Food, Natural Resources and Engineering (DAFNE), University of Foggia | Water Research Institute (IRSA), National Research Council (CNR) | Water Research Institute (IRSA), National Research Council (CNR) | School of Agricultural, Forestry, Environmental and Food Sciences, University of Basilicata | Department of Soil, Plant, and Food Science, University of Bari | Department of European and Mediterranean Cultures, University of Basilicata

Abstract ID: 81
Topic: Water
Presenter Name: Michele Denora
Contribution: Oral

In regions facing increasing water scarcity, the reuse of treated wastewater emerges as a crucial strategy. However, concerns arise regarding the presence of emerging contaminants (ECs), such as pharmaceuticals and personal care products, necessitating a thorough investigation into their potential impacts on human health and the environment (Rout et al., 2021.). This study explores the complex dynamics of EC absorption, accumulation, and translocation in tomato and durum wheat crops irrigated with treated wastewater in Southern Italy, aiming to provide an understanding of the associated risks and benefits of this practice. Conducted at the experimental site of the Agrobiological Research Center ALSIA Metapontum (MT), the research employed lysimetric weighing tanks for tomato cultivation, specifically the 'Taylor F1' variety (*Solanum lycopersicum* L.; formerly *Lycopersicon esculentum* Mill.) transplanted in June 2021 and harvested in September 2021. Subsequently, durum wheat cultivation of the "Saragolla" variety (*Triticum durum* Desf.) was carried out in the same lysimeters, sown on January 13, 2022. Three irrigation strategies were implemented: conventional water (FW), treated wastewater with European average concentrations of contaminants (TWWx1), and treated wastewater with triple doses of emerging contaminants (TWWx3). The mix of added ECs included 12 contaminants: clarithromycin, sulfamethoxazole, trimethoprim, carbamazepine, diclofenac, fluconazole, climbazole, ketoprofen, metoprolol, naproxen, gemfibrozil, and triclosan (purity > 99%, supplied by Lab Instruments, Italy). Comprehensive analytical methods, including online solid-phase extraction (SPE) coupled with UPLC-QTOF/MS/MS, were used to quantify EC concentrations in water and soil samples, facilitating a detailed examination of their fate within the soil-plant-leachate system. Regarding the Tomato Study: Data analysis revealed complex interactions between ECs and the soil-plant system, particularly pronounced in the TWWx3 treatment. Carbamazepine and fluconazole exhibited significant accumulation in plant tissues, with degradation percentages of 53% and 11% respectively, soil accumulation percentages of 39% and 70%, and plant accumulation percentages of 5%. Although agronomic results indicated a substantial yield increase in plants irrigated with wastewater, attributed to the higher nutrient content of the water, the study emphasized the dual nature of wastewater irrigation, highlighting both its benefits and potential risks. Data from the durum wheat study showed variability in the fate of ECs, perfectly in line with the measured results on tomatoes, with some ECs showing rapid degradation, such as diclofenac, while others persist in the soil-water-plant system. In particular, carbamazepine and fluconazole exhibited persistence in plant tissues. Despite the agronomic benefits observed in plots treated with wastewater, the study emphasized the importance of carefully balancing these benefits with associated risks. Further research is needed to refine risk assessment protocols and inform the development of robust legislative frameworks aimed at promoting sustainable water resource management in agriculture. Acknowledgments. 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, CUP: C33C22000250001). This manuscript reflects only the authors' views and opinions, neither the European Union nor the European Commission can be considered responsible for them.

Biodegradable mulching improves processing tomato yield, water productivity, and fruit quality under regulated deficit irrigation

by Andrea Burato | Giovanna Marta Fusco | Alfonso Pentangelo | Paola Iovieno | Rosalinda Nicastro | Petronia Carillo | Pasquale Campi | Domenico Ronga | Mario Parisi | CREA-OF | University of Campania | CREA-OF | CREA-OF | University of Campania | University of Campania | CREA-AA | University of Salerno | CREA-OF

Abstract ID: 82
Topic: Water
Presenter Name: Andrea Burato
Contribution: Oral

Freshwater scarcity is becoming a limiting factor for widely grown vegetable crops such as processing tomato (Solanum lycopersicum L.) in several Mediterranean districts, making it necessary the use of water-saving techniques. The present study aimed to assess the effect of a regulated deficit irrigation (RDI) strategy and a biodegradable mulching film (BMF) on processing tomato yield and sustainability, and fruit technological and functional quality. The open-field trial was carried out at two sites (L: Marigliano, Naples; Lesina, Foggia) over two years (Y: 2021-22) on ‘Heinz 1534’ tomato hybrid. Three drip irrigation strategies (T) were compared in a randomized block design with three replicates: i) IRR (restoring 100% ETc), ii) RDI (supplying 100% up to 750 cumulated growing degree-days from transplant, then 50% ETc), and iii) RDI-BMF (as RDI, combined with BMF). Considering both years and locations, the total amount of seasonal rainfall varied from 67 to 120 mm. Single harvestings were conducted when ripe fruits approximately accounted for 85% of the total. On each replicate, the total (TY), marketable (MY), and brix (BrY) yield, the number of red-ripe fruits per plant (NFR), the irrigation (WPI) and economic (EWP) water productivity, the taste index (TI), the percentage of sunscald fruits, the technological (soluble solids content – SSC; fruit dry matter – DM; pH; titratable acidity – TtA) and functional quality of fruits, and the metabolic profiling (carbohydrates, soluble proteins, free amino acids, polyphenols, and lycopene) were assessed as described in Burato et al., 2024. ANOVA was applied on all data and a Tukey HSD test was adopted to separate means. Overall, RDI strategies ensured a considerable water saving (161 mm/year/field) corresponding to 32% of the average seasonal irrigation volume supplied in IRR (506 mm). Considering the main significant variations observed in the trial ($p \leq 0.001$), the irrigation management only had effects on yield variables, WPI, EWP, and TtA, with RDI-BMF boosting TtA, TY, NFR, MY, BrY, WPI, and EWP by 4, 21, 22, 24, 29, 78 and 89%, respectively, when compared to IRR. Y influenced proteins, polyphenols, lycopene, MEA, and Met, while L affected proteins and MEA. Y×L interaction affected most of the evaluated variables, particularly yield, WPI, EWP, TtA, SSC, DM, TI, soluble sugars (fructose/glucose, sucrose, and starch), and metabolic profiling (Ala, GABA, Gln, Gly, His, Ile, Lys, Orn, Ser, Thr, Trp, Val, TAA, BCAA, and EAA). Y×T had effects on Ala, GABA, Gln, Gly, Ile, Lys, Ser, Trp, Val, TAA, BCAA, and EAA, while

L×T affected SSC, DM, Ala, and Ser, with RDI-BMF showing enhancements when compared to RDI. No effect was recorded on sunscald fruits and Asp. Different environmental conditions and sites reshaped plant metabolism, modulating the content of soluble sugars, secondary metabolites, proteins, and amino acids. Particularly, 2022 favored carbohydrate accumulation and polyphenol synthesis, while 2021 promoted biochemical pathways adjustments (higher levels of proteins and amino acids) to optimize plant growth and stress resistance. Therefore, since Y×L interaction had major effects on most of the evaluated variables, further research should be carried out to validate the present findings.

Enhancing Barley Biomass and Water Use Efficiency with Biochar and Functionalized Biochar Under Varied Irrigation Regimes

by Federica Caradonia | Fabrizio Petti | MUHAMMAD FAZAIL NASAR | Giovanni Caccialupi | Giulia Santunione | Enrico Francia | Department of Life Sciences and Centre BIOGEST-SITEIA, University of Modena and Reggio Emilia | Department of Life Sciences and Centre BIOGEST-SITEIA, University of Modena and Reggio Emilia | Department of Life Sciences and Centre BIOGEST-SITEIA, University of Modena and Reggio Emilia | Department of Life Sciences and Centre BIOGEST-SITEIA, University of Modena and Reggio Emilia | Department of Life Sciences and Centre BIOGEST-SITEIA, University of Modena and Reggio Emilia | Department of Life Sciences and Centre BIOGEST-SITEIA, University of Modena and Reggio Emilia

Abstract ID: 34
Topic: Water
Presenter Name: Federica Caradonia
Contribution: Pitch

One of the main challenges for future agricolture is to increase crop yield while reducing the use of inorganic fertilizers. Biochar has proven to be an innovative fertilizer capable of retaining nutrients and water, and enhancing soil microbial activity. The efficacy of biochar can be further improved by integrating microorganisms and agrifood by-products. Climate change is reducing winter rainfall, and since most European barley is grown under rainfed conditions, there is a pressing need to increase the water use efficiency of the crop. In this contest, the objective of this study was to investigate the effect of pure and functionalized biochar on the growth of a barley genotype (cv. ‘Nure’) grown in pots under two irrigation regimes. The biochar used in this experiment was derived from solid municipal organic waste, while a Plant Growth-Promoting Rhizobacterium - PGPR (*Pseudomonas chlororaphis* subsp. *aureofaciens* isolated from the rhizosphere of tomato plants) was use for functionalization. At sowing, peat was mixed with different treatments: 1) control, 2) PGPR, 3) biochar, 4) apple peel powder 5) biochar + PGPR 6) biochar + PGPR + apple peel powder. A completely randomized design was applied with fifteen biological replicates. The pots (12 cm x 10 cm) were maintained under control conditions (16 h/8 h day/ night; 24 °C/19 °C day/night) in the greenhouse at the Department of Life Science, UNIMORE. Two irrigation regimes (soil moisture at 20 % and 40 %, representing stress and control conditions, respectively) were applied 14 days after sowing. Seedling growth was monitored weekly by recording morphological and physiological traits, and two weeks later, the plants were harvested for biomass evaluation. The data were analysed by two-way ANOVA using GenStat 17th (VSN Int., UK). Means were compared using Tukey’s test ($p < 0.05$). Results showed that all treatments increased the number of leaves. Peat inoculated with PGPR and peat with pure biochar significantly increased the height of barley seedlings before the application of different irrigation regimes. There was interaction between irrigation regime and amendment treatment, showing higher efficacy under control conditions. All treatments, with exception of biochar functionalized with PGPR and apple peel powder,

increased the dry biomass of seedlings. Additionally, biochar, PGPR and biochar functionalized with PGPR improved water use efficiency. These findings demonstrated the effectiveness of innovative fertilizers in increasing resilience during the early developmental stages of barley cultivation.

An indicator-based framework for the assessment of sustainability in paddy rice farms

by Laura Zavattaro | Davide Biagini | Ivan Di Furia | Silvia Fogliatto | Barbara Moretti | Francesco Vidotto | DSV - University of Turin | DISAFA - University of Turin | DISAFA - University of Turin | DISAFA - University of Turin | DISAFA - University of Turin | DISAFA - University of Turin

Abstract ID: 42
Topic: Water
Presenter Name: Laura Zavattaro
Contribution: Pitch

A sustainability assessment is an evaluation of farm management in relation to defined objectives within the multi-faceted sustainability concept. The assessment requires i) a defined framework of themes (e.g. economic issues, environmental impact, resource consumption/maintenance…); ii) a list of specific indicators within each theme (e.g. yield, nutrient use efficiency, GHG emissions…); iii) defined methodologies to calculate indicators (e.g. IPCC guidelines, scientifically-proven estimators, e.g for NUE, N leaching, soil erosion…); iv) a calculation method that combines information into an overall judgement. Pooling all information into a single score inevitably causes a loss of detail and an inner compensation among contrasting trends. Nevertheless, a single concise final score can be used to compare various farms, and serve as a showcase for food chains where performance assessment is an added value. The variability of farm approaches to sustainability poses problems in setting the assessment framework. For instance, large intensive farms have different strategies from small extensive farms in marginal areas, but a comprehensive system should acknowledge efforts of both. Therefore, the choice of indicators, methodologies and weights are crucial aspects. In the context of a regional Operational Group that involved 10 farms, a sustainability assessment framework was developed for the evaluation of paddy rice farms. Three sustainability themes were included: environmental, territorial, and social. The first theme included indicators on agri-ecological value, biodiversity, pesticide use, gas emissions, and nutrients. The territorial theme included indicators on landscape elements, infrastructures, territorial protection, erosion and flood protection. Finally, the social theme included indicators evaluating local food chains, social function, tourism, culture and economic function. The above indicators were valued in a 0-1 scale. Some of these were numerical, and their values were scored according to specific criteria; e.g. N surplus was scored 1 if its value was within ±20 kg ha^{-1} yr^{-1}, and 0 in all other cases, N_2O emission was 1 if <2.5 kg ha^{-1} yr^{-1} and 0 if above. Other indicators were categorical, as adopting (1) or non-adopting (0) a good practice, e.g. maintenance of wetlands, invasive species control, hedges, historical buildings. The sum of (weighed) single indicator values was then standardized and expressed in a 1-4 scale, and summed up (weighed) to an overall farm score, expressed on four classes (A-D) and three sub-classes (+, 0, -) coupled to a colour, similar to the EU energy label. Specific weights can be assigned to indicators within groups and to groups within the final score, thus allowing also a different importance of themes in contributing to the final score. The assignment of

weights includes political issues and will be defined at a later stage. In practice, the framework is a web platform where farmers can insert productive and management data, and obtain the final score. The framework can be used as a basis for a production specification document and a certification system. The system also allows a traceability of farm operations and practices, as well as tracing and monitoring the change of indicator values or score with and without the adoption of each practice.

Intercropping of legumes and cereals: a strategy to support food production and improve the resources use of agricultural systems

by Leonardo Verdi | Marco Mancini | Shamina Imran Pathan | Giacomo Pietramellara | Simone Orlandini | Anna Dalla Marta | DAGRI - University of Florence | DAGRI - University of Florence | DAGRI - University of Florence | DAGRI - University of Florence | DAGRI - University of Florence | DAGRI - University of Florence

Abstract ID: 52
Topic: Water
Presenter Name: Leonardo Verdi
Contribution: Pitch

As traditional cropping systems experience soil degradation, biodiversity loss, and a decrease in ecosystem benefits, it becomes imperative the transition toward practices that are sustainable and productive. Intercropping offers a solution by supporting biodiversity, increasing land productivity, and optimizing biogeochemical cycles within agroecosystems. One of the main limiting factors for wheat production is nitrogen (N) availability, and the combined cultivation with forage legumes can reduce the risk of yield losses. We evaluated the effect of relay intercropping between soft wheat and red clover on crops productivity potentials and N use. In addition, we assessed the wheat grain quality and straw production, clover forage yields, and the uptake of nutrients by both crops. The experiment was carried out at the experimental farm of Terre Regionali Toscane institution, Cesa (Arezzo). Experimental shceme was a complete randomized block design with three replicates. Plots were 60 m× 20 m (20 m of border on each side and 5 m of space between blocks). Two fertilization doses were tested in both sole wheat and wheat-clover intercropping using ammonium nitrate (27%): 75 kg N/ha (70N) and 110 kg N/ha (100N), referred to 70% and 100% of the N dose normally applied in the area. Sole clover was cultivated as an additional control and managed conventionally with a winter sowing (November). The analysis of the results showed that the highest grain yields were obtained in the intercropping (regardless of N levels) and in sole wheat 100N. Although the lowest yields were observed in sole wheat 70N, there were no significant differences among the treatments (average 4.4 t/ha). The calculation of the harvest index indicated higher values in the intercropping (average 43%) compared to sole wheat (average 32%), regardless of the N dose. The analysis of protein content showed similar values across all treatments, with an average of about 11.5%. Both the hectoliter weight and the weight of 1000-seeds were consistent with previous observations, showing no significant differences among treatments. Regarding hectoliter weight, the results were slightly above the national average (around 74.7 kg/hl), whereas the weight of 1000 seeds was below the national average, (around 35.3 g). The introduction of clover, besides contributing to biodiversity improvement, increases the potential for the photosynthetic efficiency of the system. An accumulation of approximately 0.5 t/ha of carbon was calculated within the clover biomass in the intercropping, thus contributing to climate

change mitigation when used as green manure at the end of the wheat crop cycle. The presence of clover after wheat harvest provides a certain degree of soil cover, protecting it during the critical summer period. However, clover yields in intercropping were significantly lower than in the sole clover cultivation. Intercropped clover in wheat contributes to diversifying the cropping system by elevating biodiversity and soil microbial biomass (data not shown) while maintaining wheat yield quantity and quality. This research demonstrated that intercropping can be a viable option to increase soil productivity, improve grain yield and biomass accumulation in cereals, and enhance resources use compared to monoculture.

Beta vulgaris L. and Salicornia spp. as potential strategic crops in King's Lagoon coastal wetlands

by Anna Rita Bernadette Cammerino | Michela Ingaramo | Vincenzo Rizzi | Massimo Monteleone | Dipartimento di Scienze Agrarie, Alimenti, Risorse Naturali e Ingegneria (DAFNE) - Università di Foggia | Dipartimento di Scienze Agrarie, Alimenti, Risorse Naturali e Ingegneria (DAFNE) - Università di Foggia | Centro Studi Naturalistici | Dipartimento di Scienze Agrarie, Alimenti, Risorse Naturali e Ingegneria (DAFNE) - Università di Foggia

Abstract ID: 27
Topic: Water
Presenter Name: Anna Rita Bernadette Cammerino
Contribution: Post

The "King's Lagoon" has been selected as a reference study area in a national PNRR project called AGRITECH and as a showcase for several nature-based solutions. This coastal wetland of about 40 hectares, located in the Gargano National Park, has recently been restored through the reconstruction of canals and flooded areas. In addition to the strategic importance of restoring the wetland through renaturation and protection measures, the agricultural activity is also subject to specific evaluation so that it can be carried out in symbiosis with the conservation of biodiversity, establishing a mutually beneficial relationship with the latter. In this difficult environment, *Salicornia* and *Beta* were identified as the most interesting of the wild species found in the study area and, among others, the most common halophytes in the Atlantic and Mediterranean regions, often growing in salt marshes and abandoned salt pans. In particular, *Salicornia* has long been of interest to local farmers, although not in this area of the Gargano promontory facing south, but in the area facing north. *Salicornia* is probably one of the most successful examples of halophyte cultivation to date. In fact, there are some companies in the area that cultivate and market *Salicornia*, both raw and, above all, in oil. With this in mind, a first crop trial was carried out last year and a second has just started, focusing on *Salicornia* and *Beta*, comparing their productivity both as single crops and in combination, i.e. intercropping. In summer 2023, the experimental field was lightly surface tilled (with prior mowing and shredding of the cover vegetation) in preparation for the planting of *Beta* and *Salicornia*. After planting, the field was treated with manual application of compost, drip irrigation with brackish water, hoeing and pyrethrum application. *Beta* was harvested three times in succession, while *Salicornia* was harvested once as a final harvest at the end of August 2023. Preliminary results from the first year of the trial showed the general benefit of intercropping, as indicated by a LER (Land Equivalent Ratio) slightly above 1 (i.e. 1.14). In particular, the effect of intercropping on *Beta* was significantly positive (51% increase in productivity), whereas the effect on *Salicornia* was negative (23% decrease in productivity). It remains to be seen whether the results of the second year trials will confirm those of the first one, but in general it can be said that the cultivation of the two species offers interesting opportunities for the creation of a very typical production chain in the study area.

Agronomic tolerance of durum wheat to transient waterlogging events at tillering

by Silvia Pampana | Daniele Antichi | Nicola Grossi | Leonardo Ercolini | Lorenzo Gabriele Tramacere | Nicola Silvestri | Lorenzo Cotrozzi | University of Pisa | University of Pisa | University of Pisa | University of Pisa | University of Pisa | University of Pisa | University of Pisa

Abstract ID: 29
Topic: Water
Presenter Name: Silvia Pampana
Contribution: Post

The Mediterranean region has been identified as one of the most vulnerable to climate change. Besides severe drought, the frequency and intensity of flooding events are expected to increase, thus causing waterlogging (i.e., the accumulation of excess water in the root zone), or partial/full submergence (when also the aerial plant parts are partly or completely flooded). Under waterlogging or submergence, the rootzone is deprived of oxygen, thus reducing plant respiration rate and adenosine triphosphate (ATP) production. The disrupted plant metabolism leads to reduced growth rates, and finally to lower plant yield (Colmer et al., 2014). Durum wheat [*Triticum turgidum* L. subsp. durum (Desf.) Husn], one of the major cereals of the Mediterranean basin, shows yield depletion in excessive water conditions, especially when occurring at tillering (Pampana et al.,2016; Cotrozzi et al., 2021). To date, few scientific studies have been carried out under rainfed Mediterranean conditions for waterlogging evaluation of cereals throughout the entire crop cycle. To fill this gap, a 2-year pot experiment was carried out at the Research Centre of the Department of Agriculture, Food and Environment of the University of Pisa, Italy (43° 40′ N, 10° 19′ E). Each year, the experimental design compared two durum wheat cultivars (i.e., Svevo, and Emilio Lepido) exposed to three waterlogging durations (15, 30, and 45 days), together with well-drained controls. Plants were grown in a *Xerofluvents* soil, with sandy-loam texture. Phosphorus and potassium were applied pre-planting (150 kg ha^{-1} of P_2O_5 and K_2O), and 150 kg N ha^{-1} were split in three applications (i.e., 30, 60, and 60 kg N ha^{-1}, respectively, at sowing, pseudo-stem erection, and first node detectable). Pots were placed outdoors and kept under drained conditions until waterlogging imposition at tillering stage (BBCH20) by putting them into containers filled with water. At the end of each period of waterlogging, pots were removed from containers and kept in drained conditions until plants reached maturity. At harvest, plants from each pot were manually cut at ground level and partitioned into straw and grain. Roots were separated from the soil by gently washing with a low flow from sprinklers to minimize loss or damage. For dry weight determination, samples were oven-dried at 65 °C to constant weight. Our results highlighted that genotypic differences exist, and Emilio Lepido showed better agronomic tolerance because grain yield loss under the longest duration of waterlogging was lower (63%) than in Svevo (68%). Emilio Lepido also suffered a minor reduction of shoot and root growth which in turn allowed the production of culms and spikes similar to the control. However, the length of the treatment progressively reduced the yield of durum wheat in both cultivars, because either the plants had less time to recover and because higher temperatures aggravated the effects of waterlogging since the supply of oxygen to both plant roots and soil microorganisms increased. Our results showed that varietal choice could be pivotal when predicting waterlogging events, and root growth during waterlogging or recovery can be useful for identifying waterlogging tolerance.

Water Stress Response of Different Quinoa Genotypes Grown with and without Woody Biochar

by Muhammad Zubair Akram | Angela Libutti | Anna Rita Rivelli | School of Agricultural, Forest, Food and Environmental Sciences, University of Basilicata | Department of Agricultural Sciences, Food, Natural Resources and Engineering, University of Foggia | School of Agricultural, Forest, Food and Environmental Sciences, University of Basilicata

Abstract ID: 30
Topic: Water
Presenter Name: Anna Rita Rivelli
Contribution: Post

Drought stress due to current climate change scenarios poses a significant threat to crop production, necessitating the adoption of efficient strategies to meet global food demand. Soil application of organic amendments, such as biochar, could be a viable agronomic option to face the adverse effects of drought on plant growth and yield, particularly in arid and semi-arid agricultural areas. Biochar is extensively reported to improve soil's characteristics including structure, porosity, water-holding capacity and hydraulic conductivity, cation and anion exchange capacity, nutrient retention, and its availability. Quinoa (*Chenopodium quinoa* Willd.) is a grain crop that has gained worldwide attention over the past decades, due to its nutritional and functional properties and its ability to adapt to adverse growing conditions (marginal soils, drought, salinity and cold). However, quinoa genome displays a wide degree of variability in abiotic stresses tolerance, including drought. Therefore, the present study aimed at investigating the response of different quinoa genotypes to water stress conditions during the vegetative growth phase, through biochar application. In a greenhouse pot experiment, quinoa genotypes of different origins, including the Danish Titicaca, the Italians Quipu and Regalona, and the Pakistani UAFQ7 and Q126, were grown without and with woodchip biochar at 0% (B0) and 2% (B2) rates (dry weight basis), under well-watered conditions (WW; restitution of 100% ET losses whenever soil was at 70% of the AWC) and water-stressed conditions (WS; by withheld watering until soil reached the permanent wilting point in two consecutive stress cycles). Each treatment was replicated thrice, and plant response was assessed by monitoring a set of growth attributes, i.e. plant height, number of leaves and branches, fresh and dry biomass production. A statistical factorial CRD (three way) analysis was applied to experimental data by using RStudio software. Overall, the results showed a significant reduction in plant growth under water stress conditions in all quinoa genotypes grown on both B0 and B2. However, under WS conditions, biochar application significantly increased the number of leaves (NL) and leaf area (LA) of UAFQ7 plants, with increase of 36% and 15%, respectively, compared to UAFQ7 ones grown on B0, which in turn were not statistically different from those grown without biochar and in WW conditions. Still under WS conditions, the Italian Quipu showed 16% and 7% increases of NL and LA, respectively, in B2 compared to B0. The Danish variety Titicaca appears to be more sensitive to drought due to significant growth reduction compared to other genotypes. These first findings suggest that the amendment of soil with

woodchip biochar could be a successful strategy to promote the quinoa's vegetative growth, although its efficiency depends upon the chosen genotype. Moreover, the tested genotypes could represent valuable resources for further investigations on quinoa plant tolerance to water stress in open field and during all growing cycle.

Quantifying water stress in maize using smartphone-based estimates of stomatal conductance

by Chiara Rusconi | Livia Paleari | Ermes Movedi | Roberto Confalonieri | Università degli Studi di Milano, ESP, Cassandra lab | Università degli Studi di Milano, ESP, Cassandra lab | Università degli Studi di Milano, ESP, Cassandra lab | Università degli Studi di Milano, ESP, Cassandra lab

Abstract ID: 35
Topic: Water
Presenter Name: Chiara Rusconi
Contribution: Post

Optimizing water management is of primary importance for the productivity and the environmental sustainability of a variety of cropping systems, especially considering that global water demand is expected to increase in the coming decades. For this reason, different technologies – mostly based on remote sensing, simulation models and proximal sensors – have been developed to estimate variables related to crop water status. Among these variables, stomatal conductance (g_s, mmol m^{-2} s^{-1}) is considered as particularly suitable for quantifying water stress, and instruments (e.g., gas exchange analyzers) are available for its determination. However, their cost and low applicability under operational farming conditions (e.g., time-consuming data collection) have limited their use to research contexts. To overcome these limitations, a new mobile application has been developed to estimate g_s using a common smartphone. The app allows users to perform 3D scans of leaf surfaces and automatically derives synthetic indices characterizing canopy architecture (e.g., the parameter χ of the Campbell's ellipsoidal distribution, the light extinction coefficient, the mean leaf tilt angle, the leaf bending index). These indices are then used to estimate g_s, thanks to the relationships between g_s and the changes in leaf orientation triggered by physiological mechanisms (e.g., decrease in leaf turgor) involved in crop response to water stress. Experimental data were collected on three maize hybrids (P0937, P1096, and P2088) grown in pots at two different irrigation regimes (well-watered and water stressed). The measurements of g_s and canopy architecture scans were carried out at two stages during the crop cycle (V5-V6 and VT). Step-wise regression techniques were then applied to derive the relationships between g_s and canopy architecture indices. Regardless of the genotype, the best model for estimating g_s was a multiple linear regression function of the mean bending index of upper leaves, the light extinction coefficient, and the mean leaf insertion angle. This relationship highlighted a notable predictive capability, with an average R^2 equal to 0.71 and an average absolute error equal to 20 mmol m^{-2} s^{-1}. The wide range of plant water status explored (measured g_s ranged from 4 mmol m^{-2} s^{-1} to 202 mmol m^{-2} s^{-1}) allowed the use of this relationship to identify threshold values of g_s estimated with the app, corresponding to mild, moderate, and severe water stress, according to well-known thresholds available in the literature. The reliability and the inexpensiveness of the proposed approach (just a standard smartphone is needed) open to new opportunities for g_s-based management of water stress in operational farming contexts.

Effects of Salt and Water stresses on Morphological and Physiological traits of Hemp grown under LED light

by Valeria Cafaro | Salvatore L. Cosentno | Giorgio Testa | Vivienne Panebianco | Silvio Calcagno | Cristina Patanè | CNR, IBE | Di3A, University of Catania | Di3A, University of Catania | Di3A, University of Catania | CNR, IBE | CNR, IBE

Abstract ID: 44
Topic: Water
Presenter Name: Valeria Cafaro
Contribution: Post

Industrial hemp (*Cannabis sativa* L.) is a plant belonging to the Cannabaceae family, originating from Central Asia. It well adapts to temperate areas of Europe and America, and nowadays it is spread across the globe. In the past, hemp was primarily used in the textile industry. Today, hemp production has grown exponentially, thanks to its wide range of applications, as raw material for industries, but also for oil and secondary metabolites production, such as cannabinoids and terpenes. In a context of climate changes, an important role is played by the agronomic research on alternative crops that could face the great challenges of the millennium. In this view, hemp represents a good candidate for marginal lands, to be used and exploited. A study was conducted in laboratory on a cultivar of hemp (Tygra) in 2024, to evaluate the effects of salt (in NaCl) and water stress, on plant morphological and physiological traits under LED light. Plants were grown under a photon flux density (PPFD) of 300 mmol $m^{-2}s^{-1}$, a 12/12 h photoperiod, and 25±1°C temperature. Three levels of NaCl, generating the following water potentials (y), were considered: 0, -0.2, -0.4 MPa. Three levels of irrigation water were considered: I100, I60 and I30, corresponding to 100 (no stress), 60 (moderate stress), and 30% (severe stress) of crop evapotranspiration–ETc restoration, respectively. Plant weight was significantly affected to a greater extent by salt stress (33.2 and 80.4% plant height reduction, at -0.2 and -0.4 MPa, respectively), than water stress (28.8 and 66.2% plant height reduction, in I60 and I30, respectively). Similarly, stem height was more affected by salt stress (23 and 72% reduction, at -0.2 and 0.4 MPa, respectively), than water stress (13 and 30% reduction over the control, in I60 and I30, respectively). Differently, leaf number was more influenced by water than salt stress. Chlorophyll content fluctuated during the growth period according to irrigation, Plants tended to concentrate more chlorophyll when salt stressed, whilst no clear differences were observed among water treatments. Fluorescence, which indicates the functioning of the photosynthetic system, progressively decreased during plant growth, to a greater extent in the last period, according to plant senescence. Unexpectedly, fluorescence kept higher under severe water stress conditions (I30) and in both salt stressed treatments. Flavonoids progressively increased during the plant growth, in all treatments, but to a greater extent in unstressed plants. Salt stressed plants tended to accumulate lower levels of flavonoids than those water stressed. Both stresses induced a secondary oxidative stress in the hemp plants, as highlighted by a significant increase in the malondialdehyde (MDA) content. Salt stress-induced damage (54 and 105% higher MDA than control, in -0.2 and -0.4

MPa, respectively) was more relevant that water stress-induced damage (31 and 36% higher MDA than control, in I60 and I30, respectively). These findings confirm the greater sensitivity of hemp to salt stress rather than water stress. Its tolerance to low water availability validates its adaptability to marginal lands, making hemp a valid candidate to those areas.

A Living Lab approach for a multi-scale experimentation in Northern Italy on drought resistant maize hybrids

by Gabriela Alandia | Giorgio Borreani | Francesco Ferrero | Vittoria Giannini | Elisa Marraccini | Carmelo Maucieri | Gabriele Rolando | Ernesto Tabacco | Maurizio Borin | University of Udine | University of Turin | University of Turin | University of Padua | University of Udine | University of Padua | University of Turin | University of Turin | University of Padua

Abstract ID: 51
Topic: Water
Presenter Name: Gaetano Roberto Pesce
Contribution: Post

Maize is high-water requirements crop and plays an important role in Northern Italy, however, periods of drought in recent years have compromised crop yield. In this context, drought-tolerant (DT) maize hybrids could help addressing water scarcity, without compromising grain health, with a result that can be influenced by both the agronomic management and pedoclimatic conditions. For this reason, in 2023 at the Universities of Padua (UNIPD) and Turin (UNITO) started an experimentation to compare DT maize hybrids to conventional ones. The activities were carried out both in plot experimentations (PEs) and in On Farm Experimentations (OFEs) mobilizing a Living Lab approach. In a PE at its experimental farm, UNIPD compared six hybrids (DT and conventional hybrids, FAO classes 300, 400 and 500) both in irrigated and in rainfed conditions. There was a significant effect of irrigation, that resulted in a yield of 13.4 t DM ha^{-1} and 9.0 t DM ha^{-1} in irrigated and rainfed plots, respectively. Conventional hybrids yielded slightly more than DT ones (on average 11.5 *vs*. 10.9 t DM ha^{-1}). In an OFE, UNIPD compared two DT hybrids with a conventional one in rainfed conditions. Conventional hybrid produced more than the DT ones (10.4 *vs*. 9.4 t DM ha^{-1}). Conversely, in another OFE, UNIPD recorded a slightly higher productivity of the DT hybrid compared to the conventional one (6.4 *vs*. 5.8 t DM ha^{-1}). In one PE and 4 OFE, UNITO evaluated four hybrids (DT and conventional hybrids, FAO classes 300 and 500). In the UNITO PE, the FAO 300 DT was more productive than the conventional one (on average 10.3 *vs*. 9.4 t DM ha^{-1}), both in irrigated and rainfed conditions. Similarly, FAO 500 DT was more productive than the conventional one (on average 13.6 *vs*. 11.9 t DM ha^{-1}). In 2024, UNIPD and UNITO are involved in a second year of PEs and OFEs, whereas the University of Udine (UNIUD) joined the activities of both PEs – at the experimental farms – and OFEs. In the UNIUD OFEs, two farms will compare two FAO 500 hybrids, the one DT and the other conventional. Furthermore, in one farm, a DT FAO 400 hybrid will also be tested. In one farm, cultivation will be rainfed and the hybrids' performances will be compared in soils with different depth and gravel content, whereas in the other farm, the genotypes will be tested in both irrigated and rainfed conditions. These PEs and OFEs in a multi-temporal experiment will support our understanding of the best conditions for DT maize hybrids in Northern Italy. Acknowledgments. 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) within the Task 4.2.1. This abstract reflects only the authors' views and opinions, neither the European Union nor the European Commission can be considered responsible for them.

Allelopathic Effect of Water Plant Extracts on Seed Germination and Seedling Growth

by Thomas Conte | Antonia Carlucci | Angela Libutti | Department of Agricultural Sciences, Food, Natural Resources and Engineering, University of Foggia | Department of Agricultural Sciences, Food, Natural Resources and Engineering, University of Foggia | Department of Agricultural Sciences, Food, Natural Resources and Engineering, University of Foggia

Abstract ID: 56
Topic: Water
Presenter Name: Angela Libutti
Contribution: Post

Weeds are one of the major biotic constrain in agricultural production, resulting in crop yield and quality reduction. Their management many rely on the use of synthetically-derived herbicides, whose intensive application in the last fifty years has considerably increased agricultural productivity, but with several adverse effects, such as the high persistence in the environment and food chain, the toxicity for non-target organisms, the development of highly herbicide-resistant weed biotypes. Recently, the use of natural bioactive compounds (mainly phenolic compounds, terpenoids and compounds containing a N atom) produced by plants through secondary metabolism pathways has been reported as a sustainable and effective method for weed control. Thanks to their allelopathic effects on germination and growth of weeds, these natural compounds have a potential as bioherbicides with safer toxicological and environmental profiles. A lab-based study was carried out to investigate the effectiveness of water extracts from different plants, including *Schinus molle* L., *Laurus nobilis* L., *Carya illinoinensis* (*Wangenh*.) K. Koch, *Punica granatum* L. and *Eucalyptus globulus* Labill., for possible effects on seed germination and seedling growth of durum wheat (*Triticum durum* Desf.) as cultivated species; cress (*Lepidium sativum* L.) as indicator plant species; slender meadow foxtail or black grass (*Alopecurus myosuroides* Huds.) as a troublesome weed in the cereal cultivation areas. Twenty-five seeds of each species were placed in a Petri dish lined with two paper filters and moistened with 5 mL of each water extract. Distilled water was used as untreated control. Petri dishes were maintained at room temperature and exposed to natural light, in a completely randomized experimental design with four replicates. Water extracts inhibited the final germination percentage (FGP) of both cress and slender meadow foxtail seeds compared to 100% and 44% FGP values, respectively, in control, suggesting a potential allelopathic effect. As to the wheat, lower FGP values were observed in water extract treatments (between 88% and 55%) than the control (93%) and, similarly, the germination index (GI) showed always lower values in wheat seeds treated with water extracts (between 0.94 and 0.24) than the control (1.5). The mean germination time (MGT) was lower for cress and wheat seeds in control (4 days) and wheat seeds treated with *Schinus Molle* and *Laurus nobilis* extracts (4.3) than the other treatments, indicating an earlier germination. Ultimately, the wheat seed vigor (SV) was lower in plant extract treatments compared to the control, by reaching a zero value when seeds were treated with *Eucalyptus globulus* extract. This also reflected in the lengths and

dry weights of radicle and shoot of wheat seedlings, which were reduced by water extract application. These preliminary results showed the potential allelopathic effect of the tested water extracts on *Alopecurus myosuroides* seeds. They also provide interesting suggestions about the phytotoxic activity that bioactive compounds could have on seed germination and wheat seedling growth. Further experiments are needed to deeply explore the potential of the tested extracts (also in terms of concentrations and doses) in inhibiting weed germination without compromising the growth of the cultivated species.

Camelina response to salinity from early root growth to rosette stage: preliminary implication for mediterranean regions

by Rossella Mastroberardino | Federica Zanetti | Andrea Monti | Dept. of Agriculture and Food Sciences (DISTAL), Università di Bologna | Dept. of Agriculture and Food Sciences (DISTAL), Università di Bologna | Dept. of Agriculture and Food Sciences (DISTAL), Università di Bologna

Abstract ID: 69
Topic: Water
Presenter Name: Rossella Mastroberardino
Contribution: Post

The expansion of salt-affected soils presents substantial challenges for agriculture, especially in Mediterranean regions where soils, despite being classified as slightly or moderately saline, often exhibit poor texture and sodicity, creating severe agricultural constraints. Typically, only cereals, especially barley and sorghum, are grown in these lands, underlining the importance of diversifying agriculture in such areas through alternative crops, among which camelina, being an stress-proof crop. This study aimed to investigate camelina diversity in response to salt stress, both in vitro during early root growth, and in vivo at rosette stage. Twelve camelina accessions from different sources (i.e., gene banks and commercial materials) were incubated with a 200 mM NaCl solution on blue blotter germination paper substrate to observe early-stage root development. Measurements of root area after 6, 8, 10, and 13 days after sowing reported a significant effect of the interaction lines x treatment. Thereafter, 3 lines (UNT58, UNT21 and Lenka) characterized respectively by the highest, the lowest, and an average final root area under saline conditions were selected to investigate their morphological, physiological and biochemical parameters at the rosette stage in a growth chamber experiment, simulating a spring sowing of camelina. The plants were grown in pots filled with a sandy sodic and slightly saline soil, taken from the northeast coast of Italy, in comparison with a control clay soil, which was neither saline nor sodic, taken from the northeast inland of Italy traditionally vocated to agriculture. Plant height, number of leaves, and average leaf growth rate were recorded weekly starting from seedlings emergence, while Chl fluorescence, net photosynthesis, stomatal conductance, and intercellular CO_2 were measured 45 days after sowing at rosette stage. Additionally, proline content, antioxidant activity and polyphenols content were analyzed in leaves and roots of tested lines at rosette stage. Plant height, leaf growth rate, net photosynthesis and stomatal conductance were reduced under salinity in all camelina lines, confirming the occurrence of osmotic stress, while UNT58 showed an increase in intercellular CO_2 under saline treatment, suggesting morphological changes affecting mesophyll conductance or the activation of different biochemical path in its response to salinity. Lenka was the sole variety where total polyphenols and total antioxidant activity in leaves of salt-treated plants decreased, oppositely to the other two lines, which, under saline conditions, reported an increase of total polyphenols in roots.

UNT21 showed distinct behavior in proline content under saline conditions, reporting a higher increase of proline both in leaves and in roots compared to the other lines. This study highlights significant variability among camelina lines in response to salt stress at early stage, emphasizing the need for additional trials to identify and confirm the most significant parameters for screening salt tolerance in camelina, considering also seed production.

AquaCrop Model Assessment for Simulating Rice Response Under Alternative Irrigation Management to Flooding Practice

by Itzel Inti Maria Donati | Pasquale Garofalo | Andrea Martelli | Davide Rapinesi | Stefano Monaco | Leonardo Verdi | Anna Dalla Marta | Filiberto Altobelli | CREA (Research Centre for Agricultural Policies and Bioeconomy, Rome) | CREA (Research Centre for Agriculture and Environment, Bari) | CREA (Research Centre for Agricultural Policies and Bioeconomy, Rome) | CREA (Research Centre for Agricultural Policies and Bioeconomy, Rome) | CREA (Research Centre for for Engineering and Agro-Food Processing, Turin) | DAGRI (Department of Agriculture, Food, Environment and Forestry) University of Florence) | DAGRI (Department of Agriculture, Food, Environment and Forestry) University of Florence | CREA (Research Centre for Agricultural Policies and Bioeconomy, Rome)

Abstract ID: 70
Topic: Water
Presenter Name: Itzel Inti Maria Donati
Contribution: Post

Besides a notable demand for water, flooded rice systems are a significant source of methane (CH4) emissions. Problems with water scarcity and CH4 emissions have increased research and development of water-saving techniques for rice cultivation around the world in recent decades, such as alternate wetting and drying (AWD) and even drip irrigation, which, however, are expected to reduce yield level compared with permanent flooded rice. The main objective of this study was to calibrate and validate the AquaCrop model for different irrigation schedules, diversified from the typical flooding of rice in the Grosseto plain, in the rice-growing area of Castiglione della Pescaia (Italy, Tuscany). In this area, rice has been cultivated since the 1960s, but nowadays this area faces the prospective evolution of traditional agricultural practices (conventional rice paddies controlled by flooding) that no longer have access to the same quantity of water as in the past. We aim to improve the management of water resources by replacing the common practice of flooding with non-submerged cultivation methods based on the crop's actual water consumption. The overall hypothesis of the study is that improved irrigation scheduling is crucial for saving farmers' expenses, enhancing yields, and preserving water resources. This work also seeks to estimate to what extent yield losses can be assumed by farmers' deficit irrigation strategies, using the AquaCrop crop growth simulation model. The experimental trial on rice was carried out for three growing seasons (2021, 2022, 2023) with sowing between late May and early June and harvesting in late September in Tuscany (Maremma plain) on loamy soil. The experimental scheme is a 'split-plot' design, on which four rice cultivars were cultivated, with nitrogen fertilization in pre-sowing in the form of cattle manure 200 q ha^{-1}. Based on the observed data over the three experimental years, the AquaCrop crop simulation model was calibrated and validated to parameterize rice cultivation concerning different irrigation strategies that did not involve rice flooding but rather the total or partial return of the water consumed by the crop. The parameterization of the rice crop involved both conservative and non-conservative parameters. Directly observable field data, such as dates for the different

phenological phases, canopy development, and harvest index, were used to calibrate and validate AquaCrop. Parameters not measured and/or not measurable in the field (water and thermal stress coefficients, water depletion thresholds at which water stress begins) were adjusted to minimize the distance between measured and simulated data, using specific indices such as the Pearson correlation coefficient, the Normalized Root Mean Square Error, and the index of agreement. After the initial calibration phase, the validation phase confirmed the reliability and robustness of AquaCrop in simulating rice under the pedo-climatic conditions of the experimental field and under the several irrigation managements. In this initial step, the modelling activity focused on adapting AquaCrop to formalize rice's response to alternative irrigation management to flooding. The simulation model will then be used to evaluate a wide variety of irrigation strategies in the context of climate change scenarios.

Supplemental irrigation on broad bean (Vicia faba L., var. minor): irrigation strategies compared with ML-DSS approach.

by Andrea Martelli | Davide Rapinesi | Itzel Inti Donati | Leonardo Verdi | Anna Dalla Marta | Filiberto Altobelli | CREA (Research Centre of for Agricutural Policies and Bioeconomy, Rome) | CREA (Research Centre of for Agricutural Policies and Bioeconomy, Rome) | CREA (Research Centre of for Agricutural Policies and Bioeconomy, Rome) | DAGRI (Department of Agriculture, Food, Environment and Forestry) University of Florence | DAGRI (Department of Agriculture, Food, Environment and Forestry) University of Florence | CREA (Research Centre of for Agricutural Policies and Bioeconomy, Rome)

Abstract ID: 76
Topic: Water
Presenter Name: Filiberto Altobelli
Contribution: Post

Broad bean (*Vicia faba* L., var. *minor*) is one of the major winter-sown legume crops grown in the Mediterranean region for animal feeding and as green manure. In some areas, the cultivation of broad bean has been replaced by soybean (*Glycine max* L.). However, due to its lower production costs and resources requirements (especially water), broad bean remains an interesting leguminous crop that should be considered to promote sustainable and competitive agricultural systems. For these purposes, it’s necessary to improve the yields of the broad bean and to optimizing the resources use such as water. In fact, the period of high evaporative demand for the crops coincides with increasingly frequent droughts. As a result, broad bean undergo considerable soil moisture stress during the reproductive growth stage, often leading to poor yields. On the other hand, irrigation has never been a practice used for broad bean by farmers. In this regard, the advent of IoT in agriculture, propelled by innovative technologies such as machine learning (ML), is revolutionizing precision irrigation and can be a valid support to the cultivation of this crop. The objective of this study, carried out in central Italy, was to elucidate the effects of irrigation and seeding density on the yield and water productivity of broad bean (*cv*. Chiaro di Torrelama). Additionally the study explored a ML-based decision support systems (DSS) for optimizing supplemental irrigation (SI) on the crop. In particular, over two years (2020-2021 and 2021-2022), two irrigation strategies—ML-DSS and a traditional method (based on ETc computed)- were compared, alongside varying seeding densities (40, 50, and 60 plants per square meter). Similar rainfall amounts (408 mm and 476 mm in 2020-2021 and 2021-2022 respectively) and highly different ET0 (533 mm and 734 mm in 2020-2021 and 2021-2022 respectively) were recorded during the growing seasons. Irrigation positively impacted growth and yield. In particular, an average increase in total yields of + 41% (4.54 t/ha vs 2.70 t/ha) was observed in the irrigated systems compared to rain-fed treatment. Compared ETC with ML-DSS treatment, no significance difference were recorded in terms of Total Yield (4.42 t/ha *vs* 4.66 t/ha) and yield per plant (8.90 g *vs* 9.42 g). The seeding density increased the total yield, especially in the second experimental year (2.88 to 3.97 t/ha, from 40 to 60 respectively plant per meter square).ML-DSS exhibited the

highest average yield in terms of WP (8.41 Kg mm-1), statistically similar to the ETC method (7.97 kg mm-1). ETC and ML-DSS with 60 plants/m^2 showed the best results, while in non-irrigated conditions the best results were observed with 50 plants/m^2. Support irrigation fostered higher and more consistent yields over time. Finally, while ML-based systems showed similar results with ETC-based approach, both methods encountered water productivity challenges during periods with higher temperatures.

Assessing crop water use of industrial crops under different irrigation input using a Sub Water Retention System

by Sebastiano Andrea Corinzia | Alessandra Piccitto | Elena Crapio | Antonella Iurato | Cristina Patanè | Giorgio Testa | Salvatore Luciano Cosentino | Università di Catania | Università di Catania | Università di Catania | Università di Catania | Consiglio Nazionale delle Ricerche | Università di Catania | Università di Catania

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Presenter Name: Sebastiano Andrea Corinzia
Contribution: Post

The activity aims to evaluate the effect of a Sub Water Retention System (SWRS) on hemp (*Cannabis sativa* L.), sorghum (*Sorghum bicolor* (L.) Moench), castor bean (*Ricinus communis* L.) in a sandy soil affected by poor water retention capacity and to develop and optimize a crop model to predict the crop water use (CWU) and consequently the available soil water content using leaf area index (LAI) and soil moisture data. The field trial is carried out in an experimental field located in Ispica (4 m a.s.l., 36°42'43"N 14°57'31"E) in a Xeropsamment soil (USDA, 1999). The bulk density is 1.5 g cm^{-3}. The soil moisture contents at field capacity (at −0.03 MPa) and nominal wilting point (at −1.5 MPa) were 0.13 and 0.05 g H_2O g^{-1} of soil dry weight respectively. Three warm-season crops (hemp, sorghum, castor bean) are evaluated under two levels of irrigation input, rainfed and 100% of maximum crop evapotranspiration (ETm) restoration during the summer months (June-August). The SWRS consists of impermeable plastic strips, 1.2 m wide and 9 m apart, placed 1 m below ground level. Soil moisture is assessed at two depth (30 and 60 cm) and three distances from the SWRS strips (0, 1.5 m and 4.5 m) using soil moisture sensors that measure apparent dielectric permittivity (Teros10 moisture sensors, Delta-T). LAI has been measured monthly during the growing season (May – October), at three distances from the SWRS strips (0, 1.5 m and 4.5 m) using an AccuPAR model LP-80 PAR/LAI Ceptometer, which calculates by measuring the amount of radiation transmitted through the canopy and of radiation scattered by leaves within the canopy and comparing with the above canopy photosynthetically active radiation (Decagon Devices, Inc.). Crop water balance is calculated both on the basis of the measured soil moisture trends and according to a crop water model. The available soil water content at field capacity, (mm), has been calculated according to: where FC and WP are respectively the field capacity (0.27) and the wilting point (0.11) for the experimental site, ϕ is the bulk density of the soil and D is the main root depth (1m). The daily CWU was calculated considering the reference evapotranspiration (ET0, mm), calculated according to Allan et al. (1998), the cultural coefficient (Kc) and the stress index (SI). Kc was a function of LAI and , which is a crop specific parameter. The SI has been calculated as a function of the available soil water content and a crop specific parameter. The parameters and have been optimized by minimizing the mean square error between the predicted and the linearly interpolated observed ASWC (from the soil moisture sensors) using the Nelder-Mead simplex method.

Preliminary assessment of genotype diversity in Faba Bean from Low and High Rainfall Regions: Field Phenotyping of Root and Shoot Traits for Drought Tolerance

by Roberta Rossi | Paolo Di Renzo | Redouane Elargoubi | Michele Falivene | Biagio Catarinella | Giovanni Bitella | Gaetano Laghetti | Council for Agricultural Research and Economics, Research Centre for Animal Production and Aquaculture (CREA-ZA) | National Research Council of Italy Institute of Biosciences and BioResources (CNR-IBBR) | ConProBio – Consorzio Produttori Biologici e Biodinamici | ConProBio – Consorzio Produttori Biologici e Biodinamici | ConProBio – Consorzio Produttori Biologici e Biodinamici | School of Agriculture, Forestry, Food and Environmental Sciences, University of Basilicata | National Research Council of Italy Institute of Biosciences and BioResources (CNR-IBBR)

Abstract ID: 108
Topic: Water
Presenter Name: Roberta Rossi
Contribution: Post

Faba bean is a critical protein source in Mediterranean countries, drought sensitivity is a major factor contributing to yield instability. Several mechanisms contribute to stress tolerance, with early phenology being a well-known drought escape strategy. Root architecture is crucial for water acquisition efficiency. Drought-tolerant genotypes tend to develop a parsimonious root system to avoid excessive water use during vegetative growth and develop a narrow root gravitropic angle when utilizing stored water. Gene banks provide valuable resources to expand the genetic base for breeding activities aimed at improving drought stress tolerance. In this study, we evaluated four accessions of Vicia faba minor supplied by the Mediterranean Genebank of CNR-IBBR (Bari, Italy). Accessions were chosen based on their provenance and passport data. A genotype from a high rainfall region (Germany) was compared to four genotypes from drought-prone environments of Afghanistan, Syria, Ethiopia, and the commercial cultivar "Prothabat" (Spain) as a benchmark. In 2023 plants were cultivated in a farm located in south of Italy(Azienda Falivene, ZONA 167, 85024, Lavello, PZ, Italy). Genotypes were arranged in a completely randomized block design with three replications. Plants were compared for phenology (flowering date) and root architecture. Roots were sampled in two out of three blocks, measuring two to four sub-replicates per block. Data were analysed using generalized least square modelling to account for heteroskedastic variance, with spatial correlation between sub-replicates modelled by a first-order correlation function (AR1) . Lateral root number, density, and root gravitropic angle and tap root diameter were evaluated at the beginning of flowering using a field phenotyping technique called "shovelomics" , digging out a monolith of approximately 25x25x25 cm (height, width, length). Accessions from the drought-prone environments of Ethiopia and Iran flowered first, showing a significant difference in phenology compared to the German accession and the commercial variety ($P<0.05$). The accession from Afghanistan showed intermediate phenology. All genotypes developed a relatively shallow root systems, lateral roots were mostly concentrated in the first 5 cm. Average gravitropic angle was around 120° . The widest gravitropic angle was found in the

German accession (mean = 132°, sd = 13.0), while the narrowest was found in the Syrian genotype (mean = 115°, sd = 10). Accessions from Syria and Afghanistan (mean = 127°, sd = 8.16) were significantly different from each other ($P<0.05$). Genotypes from Afghanistan and Ethiopia developed a significantly lower number of laterals in the topsoil and a similar number of laterals between 5 and 10 cm and between 10 and 15 cm. Despite significant variability in the data, the genotypes showed trends consistent with their provenance. Early phenology characterized materials from drought-prone and warm environments, while the accession from Afghanistan (a drought-prone environment with cooler winters) flowered later. Middle Eastern genotypes exhibited root features associated with more efficient water use (parsimonious root system) and water acquisition capacity (narrower gravitropic angle). This preliminary survey suggests that further investigation of these materials is warranted to identify potential donors of traits correlated with drought tolerance.

Optimizing quinoa cultivation in Southern Italy: irrigation and agronomic practices

by Michele Rinaldi | Francesco Ciavarella | Carmen Manganiello | Giuditta De Santis | Council for Agricultural Research and Economics - Research Centre for Cereal and Industrial Crops | Council for Agricultural Research and Economics - Research Centre for Cereal and Industrial Crops | Council for Agricultural Research and Economics - Research Centre for Cereal and Industrial Crops | Council for Agricultural Research and Economics - Research Centre for Cereal and Industrial Crops

Abstract ID: 119
Topic: Water
Presenter Name: Michele Rinaldi
Contribution: Post

In the framework of increasing crop diversification and sustainability, quinoa (*Chenopodium quinoa* Willd.) emerges as a promising candidate. It is a member of the Amaranthaceae family originating from the Andean regions; an increasing scientific and commercial attention for this crop, is mainly due to its attributes, including a high seed protein content (14-20%), antioxidant properties and it is considered a functional food as gluten-free product. For the agronomic aspects, quinoa is known for its resilience to various environmental stresses. It is considered resistant to factors such as salinity, extreme temperatures, and variations in soil reaction. This versatility makes it an attractive crop for cultivation in different geographical locations worldwide. To explore quinoa's potential, two years of field experiments (2021 and 2022) were carried out at the CREA – Research Centre for Cereal and Industrial Crops in Foggia, Italy. In this area the soil is alluvial silty-clay and the climate is "thermo-accentuated Mediterranean" (below 0 °C in winter and above 40 °C in summer) and with average annual rainfall of 550 mm. In a first experiment the effects of two different irrigation regimes on quinoa cultivation in Southern Italy were evaluated: three (IRR3) vs five (IRR5) irrigation applications were compared. The seasonal average amount of water used was 1423 m3/ha in IRR3 and 2132 m3/ha in IRR5. In a second experiment, two plant densities per square meter (25 vs 50 plants/m2) and two row spacings (25 vs 50 cm) were compared. Seed characteristics at harvest and irrigation water use efficiency (IWUE) were evaluated. The irrigation strategies influenced statistically quinoa seed yield: the application of five irrigation applications showed a higher seed yield (+42%), as well as a higher harvest yield, thousand seeds weight, and biomass yield, respect to IRR3. It was observed that IRR3 exhibited, on the contrary, a comparatively higher IWUE (+6%), suggesting a more efficient utilization of water resource than IRR5. The assessment of this parameter is significant, especially considering the climatic conditions and water availability in Southern Italy. The effect of plant density and the rows distance did not result statistically significant, showing a great compensation effect and plasticity of this plant, with a good adaptation to the space availability by means of production of lateral panicles. The results suggest that quinoa could potentially be cultivated in Southern Italy, offering a new agricultural opportunity as crop in rotation with cereals and legumes. As quinoa continues to gain popularity for its nutritional benefit, its successful integration into

Southern Italy's agricultural landscape could contribute to crop diversification and offer new opportunity for farmers’ profit. Future research should continue to explore quinoa's potential, focusing on sowing date, weed control, and mechanical harvest setting, to further enhance its productivity and adaptability. Therefore, further research and investment in quinoa production and utilization can have far-reaching benefits for both agricultural sustainability and human health.

Co-designing agronomic options for the sustainability of endangered pastoral systems: the case of small-scale family farms in drylands of the West-Bank, Palestine

by Alberto Tanda | Qusay Abu Dawas | Sameh Jarrar | Pier Paolo Roggero | Department of Agricultural Sciences, University of Sassari | GVC-WeWorld, Cooperation Agency, Ramallah, Palestine | National Agricultural Research Centre (NARC), Ramallah, Palestine | Department of Agricultural Sciences, University of Sassari

Abstract ID: 128
Topic: Water
Presenter Name: Alberto Tanda
Contribution: Post

The West Bank Palestinian territories, situated in the fertile crescent where key crops like barley and wheat were first domesticated, are characterized by a range of bioclimatic zones and rich biodiversity, despite their small size. However, the region's agriculture and pastoral systems face significant challenges due to decades of conflict, climate change, and import restrictions, necessitating locally sourced agronomic solutions and a participatory approach to overcome sociotechnical barriers and foster sustainable development. The sheep and goat farming systems in the West Bank represent a vital socio-cultural heritage and source of livelihood for the region's poorest rural communities, facing unprecedented challenges. In this study, framed within a cooperation programme funded by AICS-Italy, we hypothesised that the characterization of the feeding systems is an essential step to understand their basic needs and identify sustainable development pathways through a co-design participatory approach with local stakeholders. We identified the strengths, weaknesses, opportunities, and threats of these systems and field-tested a range of agronomic options to increase the self-sufficiency of local herders: i) forage shrubs; ii) local accessions of barley and forage legumes; iii) agroforestry in the olive groves. The results showed that local sociotechnical barriers in the West Bank can be partially overcome by improving the capacity of the rural communities to improve their self-sufficiency based on local resources with the support of the governmental agencies. Future steps will address the adoption of grazing management technologies, improvement of permanent dryland grasslands, and expand the cooperation among stakeholders.

Decision Support System for large scale and early irrigation requirements estimation

by Michele Rinaldi | Sergio Ruggieri | Francesco Ciavarella | Giuseppe Satalino | Davide Palmisano | Anna Balenzano | Cinzia Albertini | francesco Lovergine | Francesco Mattia | Vito Iacobellis | Andrea Gioia | Donato Impevodo | Luigi Nardella | Michele Di Cataldo | Nicoletta Noviello | Rocchina Guarini | Patrizia Sacco | Maria Virelli | Deodato Tapete | Pasquale Garofalo | Consiglio per la Ricerca in agricoltura e l'analisi dell'Economia Agraria, Cerealicoltura e Colture Industriali | Consiglio per la Ricerca in agricoltura e l'analisi dell'Economia Agraria (CREA), Agricoltura e Ambiente | Consiglio per la Ricerca in agricoltura e l'analisi dell'Economia Agraria (CREA), Cerealicoltura e Colture Industriali | Consiglio Nazionale delle Ricerche, Istituto per il Rilevamento Elettromagnetico dell'Ambiente | Consiglio Nazionale delle Ricerche, Istituto per il Rilevamento Elettromagnetico dell'Ambiente | Consiglio Nazionale delle Ricerche, Istituto per il Rilevamento Elettromagnetico dell'Ambiente | Consiglio Nazionale delle Ricerche, Istituto per il Rilevamento Elettromagnetico dell'Ambiente | Consiglio Nazionale delle Ricerche, Istituto per il Rilevamento Elettromagnetico dell'Ambiente | Consiglio Nazionale delle Ricerche, Istituto per il Rilevamento Elettromagnetico dell'Ambiente | Politecnico di Bari, Dipartimento di Ingegneria Civile, Ambientale, del Territorio, Edile e di Chimica | Politecnico di Bari, Dipartimento di Ingegneria Civile, Ambientale, del Territorio, Edile e di Chimica | Università degli Studi di Bari Aldo Moro, Dipartimento di Informatica | Consorzio per la Bonifica della Capitanata | Consorzio per la Bonifica della Capitanata | Consorzio per la Bonifica della Capitanata | Consorzio per la Bonifica della Capitanata | Agenzia Spaziale Italiana | Agenzia Spaziale Italiana | Agenzia Spaziale Italiana | Agenzia Spaziale Italiana | Consiglio per la Ricerca in agricoltura e l'analisi dell'Economia Agraria (CREA), Agricoltura e Ambiente

Abstract ID: 132
Topic: Water
Presenter Name: Michele Rinaldi
Contribution: Post

In Mediterranean region an effective water resource management is crucial for sustainable agriculture. Scientists and decision-makers are working to address issues of resource conservation and agricultural productivity, with a growing interest in coupling hydrological and crop models. The current trend of interest seems to be limited to the improvement of crop system performance and environmental impact assessment, but attention also needs to be paid to sustainable crop production and water management concerns. For these reasons, the Italian Space Agency (ASI) is supporting an ambitious collaborative project, called THETIS (Earth Observation for the Early forecasT of Irrigation needS). The project focuses on the early assessment and forecasting of irrigation needs in the irrigation district "Sud Fortore - 6/B" in the Apulian Tavoliere. The final Spatial Decision Support System (SDSS) will integrate hydrologic and crop growth models with advanced Earth Observation (EO) products, Artificial Intelligence (AI) and a WEBGIS interface to provide basin-scale information for the efficient planning of irrigation resources for three different use cases (i.e. early forecasting, irrigation start and mid-season estimation) for different target crops. The Crop Module, rooted in AquaCrop crop model architecture, emerges as a pivotal component in simulating and predicting crop growth, development, and water dynamics. It operates across leaf development, crop growth and productivity, and water balance levels, ensuring adaptability to daily temperature variations for real-time simulations. A primary

focus of the proposed architecture lies in generating time-series estimates of root zone soil moisture, essential for defining the initial conditions in the crop growth model AquaCrop which plays a pivotal role in managing the water balance at the field scale in the areas relevant to irrigation needs assessment. To achieve this goal, the project aims to integrate, for the first time, a revised version of the well-known daily basin-scale hydrological model DREAM with the physically based Soil Moisture Accounting and Routing (SMAR) model. The hydrologic and crop growth models will be undergone to calibration and validation using previous data-set. Specifically, the calibration of the hydrological and crop models spans from summer 2021 to autumn 2022. The subsequent phase will include a validation phase (year 2023) and an operational phase to estimate water use for the upcoming irrigation season (2024). The validation of the model outputs includes the comparison of the estimated water demand with the actual irrigation volumes applied by the consortium. The expected outcomes encompass increased precision in irrigation scheduling, early anticipation of water demand, and improved seasonal forecasting. This comprehensive approach positions stakeholders for informed decision-making, fostering sustainability and efficiency in agricultural practices. The project architecture relies significantly on the use of EO derived products. These products are acquired through the integrated use of Synthetic Aperture Radar (SAR), multispectral and hyperspectral data. They serve the purpose of monitoring the land surface and extracting crucial parameters for hydrological and crop growth model constraints. The proposed approach shows promise for providing insights into soil dynamics for operational implementation, supporting advances in sustainable agricultural techniques and rational water resource management in semi-arid environments.

Biomass development, essential oil yield and bioactive compounds composition of sage (Salvia officinalis L.) under the influence of water availability and harvest time during the balsamic period.

by Sebastiano Delfine | Carmen Formisano | Daniela Rigano | Università degli Studi del Molise, Dip. Agricoltura, Ambiante ed Alimenti | Università di Napoli Federico II, Dipartimento Farmacia | Università di Napoli Federico II, Dipartimento Farmacia

Abstract ID: 134
Topic: Water
Presenter Name: Sebastiano Delfine
Contribution: Post

Sage (*Salvia officinalis* L.) is cultivated in many countries due to its medicinal and industrial importance. Environment variability and crop management always affect the uniformity of the crop yield to be included in the chain of officinal plants. This study aims to the evaluation of sage cultivation as a sustainable crop for the diversification of Mediterranean cropping systems, by exploring the possibility of affecting the uniformity of the essential oil yield and composition. So, we investigated the influence of the water availability and the harvest time, during balsamic period, on this interesting crop: the main agronomic and ecophysiological traits in term of plant biomass production and photosynthetic performance, as well as essential oil yield and composition have been evaluated. The well-watered crops harvested 42 days after beginning of flowering, exhibited higher dry biomass yield than rainfed plants as well as higher values of relative water content, photosynthesis and leaf CO_2 conductance. Instead, at same time (after 42 days) the oil content was higher in rainfed plants then in well-watered ones, where it remains constant throughout all the harvesting period. All the extracted essential oils were rich in bioactive compounds as α-thujone, β-thujone, camphor and borneol, but only in well-watered plants the content was constant throughout all the harvesting period. In fact, essential oil of rainfed plants analyzed over the harvest time is mainly rich at the beginning in Camphor and Borneol, whereas in the middle in α-Thujone. Our study demonstrates that the crop performance was greatly influenced by the water availability during the balsamic period. The results of this study provide new knowledge to produce adequate quality of the oil of sage for different uses.

Effect of paper mulch on weed control and irrigation water management on baby leaf lettuce produced in organic farming system

by Domenico Ronga | Giampaolo Oliviero | Pharmacy Department, University of Salerno | Paper Be

Abstract ID: 152
Topic: Water
Presenter Name: Domenico Ronga
Contribution: Post

As an important technology to improve the quality and yield of farmland crops, mulching film has been used in many field crops. Hence, mulching has become an important practice in modern field production. However, with people's attention to environmental problems gradually in recent years, the environmental pollution of traditional plastic mulch makes it unable to be the first choice of field crop cultivation. In response to this problem, this work focuses on paper mulch for the production of baby leaf lettuce and discusses the opportunity that it offers for solving the problems of weed management in the organic farming system and as well as the immense use of plastics in agriculture and the associated environmental threat. The work was carried out in Northern Italy, on sandy soil during summer 2023. An innovative solution was assessed, in fact, mechanized sowing was done directly between two paper mulch films. During the crop cycle agronomic and physiological traits were recorded. In general, our result reported a reduction of 99% of annual weed emergence, as well as a reduction of the irrigation water (about 38% of the total per crop cycle) and an increase of the yield of baby leaf lettuce (about 15%). Paper mulch breached down naturally within two weeks after usage and incorporate into the soil. In addition, paper mulch is one of the valid solutions for mechanized harvest like baby leaf lettuce. These results are interesting but other experimental works are needed to validate these results on other crops and other geographical areas.

Drought Stress Affects Morphometric, Agronomic, and Qualitative Traits of Rosemary Grown in Different Locations in Sicily

by Valentina Formica | Federico Leoni | Celia Duce | José González-Rivera | Massimo Onor | Paolo Guarnaccia | Stefano Carlesi | Paolo Bàrberi | Department of Agriculture, Food, and Environment, University of Catania | Group of Agroecology, Centre of Plant Sciences, Scuola Superiore Sant'Anna | Department of Chemistry and Industrial Chemistry, University of Pisa | National Institute of Optics, (INO-CNR) | Institute of Chemistry of Organometallic Compounds (ICCOM-CNR) | Department of Agriculture, Food, and Environment, University of Catania | Group of Agroecology, Centre of Plant Sciences, Scuola Superiore Sant'Anna | Group of Agroecology, Centre of Plant Sciences, Scuola Superiore Sant'Anna

Abstract ID: 157
Topic: Water
Presenter Name: Valentina Formica
Contribution: Post

Medicinal and Aromatic Plants (MAPs) represent a crucial component of endemic flora in Sicily, known for producing active ingredients with cosmetic and pharmaceutical properties under specific environmental conditions. Within Sicilian MAPs, rosemary (*Salvia rosmarinus* Spenn.), from the Lamiaceae family, is one of the most drought-stress-resistant species due to its deep root system and needle-shaped leaves. Under drought stress conditions, characterized by water scarcity and high temperatures, rosemary usually exhibits a decrease in the development of its fresh biomass and an increase in the production of essential oils with higher concentrations in the leaves and flowers, influencing the metabolic synthesis of some compounds, such as α-pinene and bornyl-acetate. We conducted an on-farm experiment in three different localities with two rosemary cultivars during autumn and spring to explore drought's influence on rosemary morphometric, agronomic, and qualitative traits. Two local rosemary cultivars were used: CV 'Barbecue' (BBQ) and 'Tuscan Blue' (TB). The plants were transplanted in rows with a density of 2 plants m^{-2} in autumn 2021. Field experiments were carried out during the cropping seasons 2021-2022 and 2022-2023 in a marginal area of three farms in Ragusa province: Scicli (36°44'03.4 "N, 14°42'48.6 "E), Sampieri (36°44'00.6"N, 14°42'22.9"E), and Donnalucata (36°46'12.0 "N, 14°39'07.4 "E). Two irrigation levels were implemented: fully irrigated, which maintained 80-100% of Field Capacity (FC), and drought stress, where FC was limited to 40-50%. Plants were exposed to a three-week drought during autumn and spring flowering. Data on some morphometric traits, such as maximum canopy height and width (cm) and maximum stem diameter (mm), were collected before biomass harvest. After the harvest in May 2023, essential oils were extracted using a Clevenger apparatus in a steam distillation system, and the essential oil yield was determined as grams of oil per gram of fresh biomass distilled. The number and categories of chemical compounds were examined using Gas Chromatography-Mass Spectrometry (GC-MS). A one-way ANOVA was implemented for each factor and parameter with a Šidák post hoc test to separate means using StataSE 18 software. The two rosemary cultivars exhibited different biomass allocations after drought,

with woody biomass being more affected than leaf biomass. The growing locations and cultivars significantly influenced woody and leaf-dry biomass (g plant^{-1}) and the plant's morphological parameters, such as canopy height and width; for example, BBQ *cv* cultivated in Sampieri was higher than BBQ *cv* from Donnalucata (89 *vs* 73.2 cm plant^{-1}). Essential oil yield varied significantly with different environments and genotypes ($p=0.001$) and drought stress ($p=0.0487$). Specifically, TB *cv* grown in Scicli produced 50% less essential oil (2.21 ml m^{-2}) compared to TB cv grown in Sampieri (4.14 ml m^{-2}) under drought conditions. At the Donnalucata farm, the level of α-pinene decreased, while bornyl-acetate and E-caryophyllene increased in *cv*. BBQ in response to drought. Specific growing location factors and cultivars influenced the stress response. Despite reductions in biomass, analysis of rosemary essential oil showed interesting changes in aromatic profile and yield, mitigating drought effects and making rosemary cultivation suitable for marginal lands.

Assessing the Environmental Impact of Wheat Production in Southern Italy: A Life Cycle Analysis Approach

by Antonio Minoliti | Donato Visconti | Gabriella Fiorentino | Amalia Zucaro | Nunzio Fiorentino | University of Naples Federico II, Department of Agricultural Sciences | University of Naples Federico II, Department of Agricultural Sciences | ENEA, Division Resource Efficiency, Department for Sustainability, Research Centre of Portici | ENEA, Division Resource Efficiency, Department for Sustainability, Research Centre of Portici | University of Naples Federico II, Department of Agricultural Sciences

Abstract ID: 170
Topic: Water
Presenter Name: Donato Visconti
Contribution: Post

According to the FAO, agriculture accounts for 70% of global water consumption, for 40% of the world's land use, and contributes to 25% of global greenhouse gas emissions. The loss of organic matter in the soil further degrades its health, increasing at the same time agriculture environmental footprint. Promoting sustainable agricultural practices is critical to decrease this impact, by optimising the use of resources and reducing the use of nutrients, fertilisers, and energy per unit of land. Life Cycle Assessment (LCA) is a standardized methodology for assessing the environmental impact of products, thus allowing to monitor and improve the sustainability of farming practices in cereal-based cropping systems. The aim of this study was to identify and address critical issues in the agricultural supply chain of both soft and durum wheat to implement the Common Agricultural Policy and the sustainable management of cereal crops, thereby encouraging low environmental impact productions. This study involves 27 farms chosen from the primary wheat-producing regions of central and southern Italy. The selection criteria included the geographical expanse covered, the distinctiveness among production zones, the diversity in soil composition and climatic conditions and the varied agronomic methodologies practiced by farmers. All primary data for Life Cycle Inventory analysis were collected through an *ad hoc* questionnaire provided to all involved companies. The questionnaire was divided into 10 sections covering general information about the farm under study. In addition, soil samples were gathered from farms for soil characterization, whereas meteorological features were obtained through the Campania Regional Portal and the Copernicus database. The LCA was carried out in accordance with ISO standards and the professional software SimaPro 9.05, coupled with the Environmental Footprint (EF) 3.1 (adapted) V1.00 impact assessment method, was used to analyse the various stages of the wheat production process and assess their environmental impact. Ultimately, a multivariate analysis was conducted to evaluate the relations between the environmental impacts of crops cultivation, the productive inputs and pedo-climatic features of the selected farms to obtain a complete and in-depth view of the sustainability of wheat production in central and southern Italy. Results showed that farms characterised by sandy soils and often dedicated to the production of high-yielding soft wheat have a significant tendency to lose nutrients to groundwater, thus contributing to eutrophication. Conversely, farms that produce durum

wheat on clayey soils in internal areas show greater variability in impacts, with some farms not differing significantly from those cultivating soft wheat, and others being particularly demanding in terms of energy and nutrient load. These discrepancies are associated with high energy demanding tillage of clayey soils and the need to maintain fertility in durum wheat areas with soils that are generally nutrient-poor. These preliminary results provide important insights into the complex relationships between soil composition, agronomic practices and environmental impacts associated with cereal production and underline the importance of adopting sustainable management strategies.

Proximal and remote sensing data integration to evaluate the crop water requirements of processing tomatoes

by Angelo Luigi Aprile | Oscar Rosario Belfiore | Albino Maggio | Guido D'Urso | Mario Palladino | Giovanni Battista Chirico | University of Naples "Federico II" | University of Naples "Federico II" | University of Naples "Federico II" | University of Naples "Federico II" | University of Naples "Federico II" | University of Naples "Federico II"

Abstract ID: 172
Topic: Water
Presenter Name: Angelo Luigi Aprile
Contribution: Post

Among the challenges related to climate change, water scarcity is one of the most relevant, with a strong impact on expanding agriculture. Although water resources are running out, it is undeniable that a relevant part of the problem is represented by inefficient management of water supplies; maximizing the efficiency of water utilization is mandatory for a more sustainable agriculture. Here, we evaluated the efficiency of an advanced irrigation scheduling method for open-field crops that integrates traditional crop growth models with remote sensing technology with sequential assimilation of satellite crop imagery. In this study, performed on tomato cultures in Campania Region (Southern Italy), we integrated data from the Sentinel-2 satellite network (canopy cover) and information gathered by proximal sensors (weather, soil water content, matric potential) with the powerful agro-hydrological crop growth simulation program AquaCrop. Processing tomato (Solanum lycopersicum L.) was cultivated in year 2024 (41°00′00.49″ N 14°16′46.65″ E) in parcels of about 2 ha. Tomato seedlings were transplanted on 26th of April 2024 in continuous double rows with 32 cm space between plants, 50 cm between rows, 1.60 cm between double rows, with a final plant density of 33,500 plants/ha. Plants were watered by light driplines, with 20 cm dripper spacing and 2.6 l/h flow rate at 1 bar, with irrigation volume monitored by a water volume meter. Meteorological daily data of maximum and minimum air temperature, wind speed, air relative humidity and precipitation were collected at a complete weather station situated in the study area. The area of two hectares was divided into two plots: one was managed according to data integration from the before mentioned sources, while a control area was defined, whose management was based on the farmer's own criteria. During the experiment, crop development and irrigation advice were then monitored in real-time using parameterization of the AquaCrop model. AquaCrop prediction performances were evaluated using tomato yield and field irrigation data as a reference both in the case of AquaCrop implemented with parameter settings based on the best a priori knowledge of the processing tomato cultivar and of sequential correction by AquaCrop through forcing the simulated canopy cover with the canopy cover observed by satellite images.

Intermediate results are very encouraging, showing a reduction of water consumption of more than three times in comparison with traditional management, resulting in a very slight variation in the number and size of the fruit; moreover, we found a 20% reduction in leaf biomass. Crop harvesting will allow us to take definitive data and conclusions from this experiment.