ESTACIÓN EXPERIMENTAL DEL ZAIDÍN REPORT 2023

eez CSIC

Estación Experimental del Zaidín Consejo Superior de Investigaciones Científicas

Cover 2024: Scientific-Technical Services EEZ
(Top to bottom, left to right):

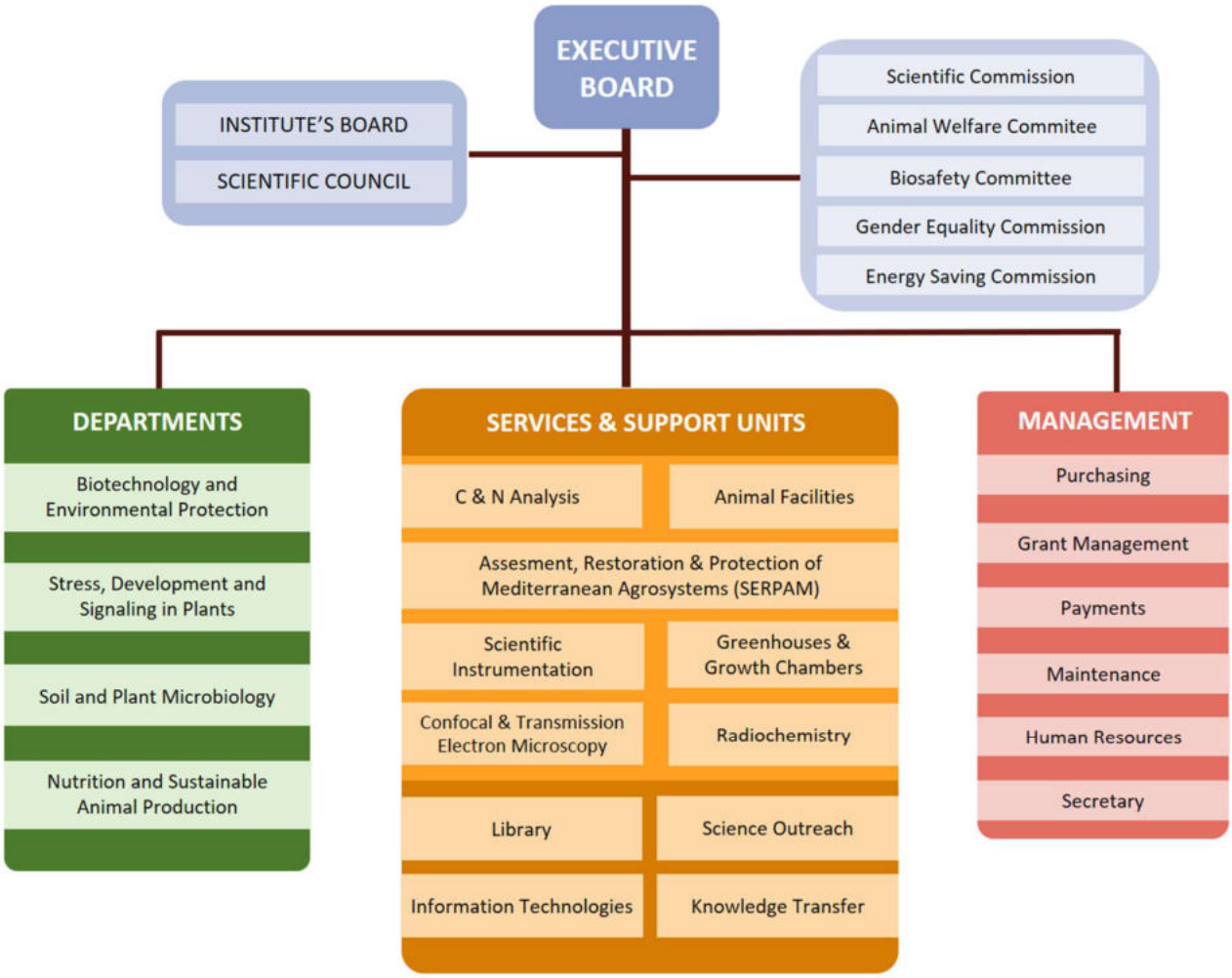
- Confocal and Transmission Electron Microscopy Service “Fire in the bush”, *photo by confocal microscope, submitted to FOTCIENCIA 2023 contest)*
- Assessment, Restoration and Protection of Mediterranean Agrosystems (*Sierra Filabres*)
- Carbon and Nitrogen Analysis Service (*N/C analyzer TruSpec CN)*
- Greenhouses and Plant Growth Chambers Service (Plants in one of the greenhouses)
- Animal Service (Animal facilities in Armilla headquarters)
- Scientific Instrumentation Service (high performance liquid chromatography equipment ACQUITY UPLC H-Class PLUS)
- Radiochemistry Laboratory (Radiochemistry image)

EEZ Annual Report Coordinators:
Inés Abril Martí
Nuria Ferrol González

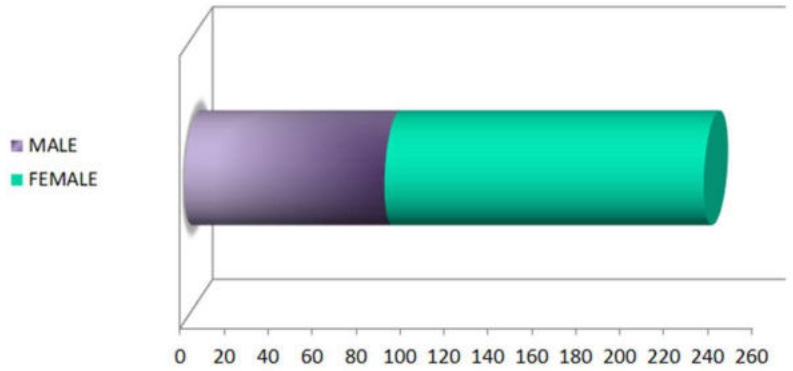
INDEX

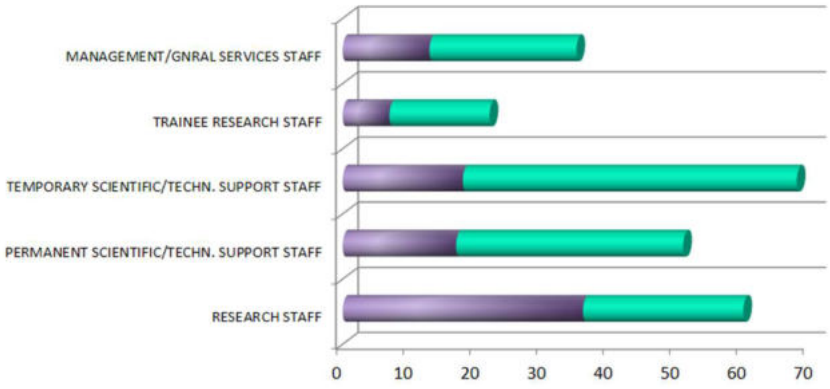
THE INSTITUTE

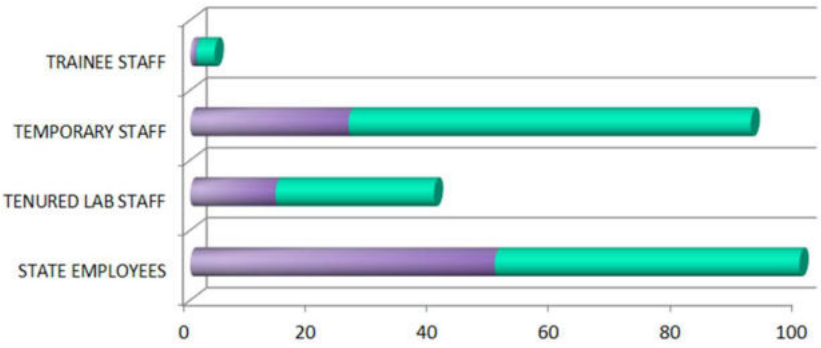
ORGANIZATION CHART

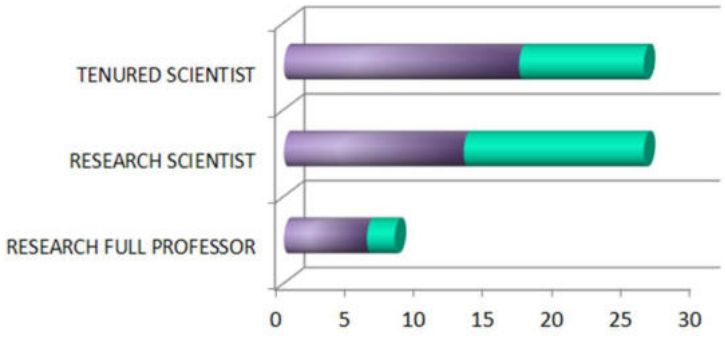


STAFF


MALE
FEMALE
0 20 40 60 80 100 120 140 160 180 200 220 240 260


MANAGEMENT/GNRAL SERVICES STAFF
TRAINEE RESEARCH STAFF
TEMPORARY SCIENTIFIC/TECHN. SUPPORT STAFF
PERMANENT SCIENTIFIC/TECHN. SUPPORT STAFF
RESEARCH STAFF
0 10 20 30 40 50 60 70


TRAINEE STAFF
TEMPORARY STAFF
TENURED LAB STAFF
STATE EMPLOYEES
0 20 40 60 80 100


TENURED SCIENTIST
RESEARCH SCIENTIST
RESEARCH FULL PROFESSOR
0 5 10 15 20 25 30

DIRECTION AND MANAGEMENT

Dr. Alfonso Clemente Gimeno
Director

Dr. Nuria Ferrol González
Deputy Director

Dr. Juan de Dios Alché Ramírez
Deputy Director

Mª del Rocío Santiago Rejón
General Manager

ADVISORY COMMITTEES

Institute's Board

PRESIDENCY:	Dr. Alfonso Clemente Gimeno	*Director*
	Dr. Nuria Ferrol González	*Deputy Director*
	Dr. Juan de Dios Alché Ramírez	*Deputy Director*
SECRETARY:	Mª del Rocío Santiago Rejón	*General Manager*
HEADS OF DEPARTMENTS:	Dr. Mª Antonia Llamas Lorente *Dept. of Biotechnology and Environmental Protection*	
	Dr. María C. Romero Puertas *Dept. of Stress, Development and Signaling in Plants*	
	Dr. Mª Trinidad Gallegos Fernández *Dept. of Soil and Plant Microbiology*	
	Dr. Ignacio Fernández-Fígares Ibáñez *Dept. of Nutrition and Sustainable Animal Production*	
STAFF REPRESENTATIVES:	Dr. Cristina Delgado Andrade Dr. José Luis Garrido Sánchez (until June 2023) Isabel Mª Jiménez Romero (since July 2023) Jaime C. Ramírez Melguizo Dr. Mª Eugenia Ramos Font	

Scientific Council

Juan de Dios Alché Ramírez
Ricardo Aroca Álvarez
Alberto Bago Pastor
Matilde Barón Ayala
Andrés Belver Cano
Emilio Benítez León
Antonio Jesús Castro López
Alfonso Clemente Gimeno
Francisco Javier Corpas Aguirre
Cristina Delgado Andrade
Mª Jesús Delgado Igeño
Estrella Duque Martín de Oliva
Manuel Espinosa Urgel
Manuel Fernández López
Ignacio Fernández-Fígares Ibañez
Nuria Ferrol González
Mª Trinidad Gallegos Fernández
José Manuel García Garrido
Inmaculada García Romera
José Luis Garrido Sánchez
José Carlos Jiménez López
José Ignacio Jiménez Zurdo
Tino Krell
Manuel Lachica López
Mª Antonia Llamas Lorente
Juan Antonio López Ráez
Eduardo López-Huertas León
Silvia Marqués Martín
Antonio Ignacio Martín García
Francisco Martínez-Abarca Pastor

Concepción Azcón González de Aguilar
Ad honorem Research Professor since July 2023

Miguel Ángel Matilla Vázquez
Jesús Mercado Blanco
Socorro Mesa Banqueri
Rosa Mª Nieto Liñán
Rogelio Nogales Vargas-Machuca
Raquel Olías Sánchez
José Manuel Palma Martínez
Daniel Pérez Mendoza
Mª José Pozo Jiménez
Mª Isabel Ramos González
Juan Luis Ramos Martín
Eva Ramos Morales
Mª Pilar Rodríguez Rosales
Carmen Romero Puertas
Mª Esperanza Romero Taboada
Miguel Ángel Rosales Villegas
Luis Rubio San Millán
Juan Manuel Ruiz Lozano
Mariam Sahrawy Barragán
Luisa Mª Sandalio González
Juan Sanjuán Pinilla
Ana Segura Carnicero
Isabel Seiquer Gómez-Pavón
Antonio Jesús Serrato Recio
Mª José Soto Misffut
Nicolás Toro García
Pieter Van Dillewijn
Cornelis Marinus Venema
David Yáñez Ruiz

Scientific Commission

Alfonso Clemente Gimeno
Juan de Dios Alché Ramírez
Manuel Espinosa Urgel
Nuria Ferrol González
Tino Krell
Mª José Pozo Jiménez
Luisa Mª Sandalio González
David R. Yáñez Ruiz

Animal Welfare Committee

Isaac Abdel Gálvez
Ignacio Fernández-Fígares Ibáñez
Mª Luisa Jiménez López (Abbott Laboratories, S.A.)
A. Ignacio Martín García
Luis A. Rubio San Millán
Isabel Seiquer Gómez-Pavón
David R. Yáñez Ruiz

Biosafety Committee

Alfonso Clemente Gimeno
Antonio Jesús Castro López
Mª Trinidad Gallegos Fernández
Rafael Hueso Ibáñez
Miguel A. Matilla Vázquez
Salvador Guerrero González (invited member, representing the Occupational Risk Prevention Service)
Francisco Sires Navarrete (associated member, as technician of the Greenhouses and Plant Growth Chambers Service)

Energy Saving Commission

Juan de Dios Alché Ramírez, president of the Commission
Andrés Belver Cano
Alfonso Clemente Gimeno
Ignacio Fernández-Fígares Ibáñez
Nuria Ferrol González
Mª Trinidad Gallegos Fernández
Luis M. García Rodríguez
Rafael Hueso Ibáñez
Mª Antonia Llamas Lorente
Samuel Martínez Marruecos
Pedro Palomares Martínez
María C. Romero Puertas
Rocío Santiago Rejón
Juan Vera Padial

Gender Equality Commission

Matilde Barón Ayala, who chairs the Commission
Alfonso Clemente Gimeno
Consuelo García Contreros
Carmen Lorente Navarro
Alejandro Rodríguez González
Alicia Rodríguez Sánchez
Carmelo Ruiz Torres
Luisa Sandalio González
Rocío Santiago Rejón
Manuel Zafra Sánchez

ADMINISTRATION AND GENERAL SERVICES

SECRETARY
Inés Abril Martí
Carmen Lorente Vázquez

ADMINISTRATIVE ASSISTANT
Ana Mª Esteban Muñoz (Armilla)

PAYMENTS
Isabel Abril Álvarez
Salomé García Jiménez
Inmaculada Pérez Masó
Mª del Mar Romero Pérez
Francisco J. Torres Alemán

HUMAN RESOURCES
Mª Paz Montesinos Parra
Juan María Pérez Torres
Rosa Mª Quero Molina

GRANT MANAGEMENT
Rosario Molina Quesada
Carmen Lorente Navarro
Mª José Pérez Jiménez
Ascensión Valderas Jiménez

OTHER PAYMENTS AND CONTRACTING
Eva Mª Sánchez Abolafia
Victoria Macías Moreno

PURCHASING
Manuel M. Zafra Sánchez
Luis M. García Rodríguez
Daniel González Pulido
María Jurado Torres
Jaime C. Ramírez Melguizo
Rafael M. Ruiz García

MAINTENANCE
Samuel Martínez Marruecos
Pedro Palomares Martínez
Juan Pablo Vera Padial (Armilla)

SCIENTIFIC-TECHNICAL SERVICES

The EEZ has several services available both to the Centre's groups and to the scientific community and companies that require them. All information and fees are available on the Centre's website. These services belong to the Scientific and Technical Services Network of CSIC.

ANIMAL SERVICE

Head
Isaac Abdel Gálvez

Technician
Francisco Funes Madrid

Facilities and equipment

This animal facility makes its installations available to researchers from the Department of Nutrition and Sustainable Animal Production, ensuring the necessary conditions and requirements necessary for carrying out research projects involving pigs, small ruminants, birds and rodents. The facilities consist of exercise yards, animal housing, testing rooms, a quarantine area, operating theatre, milking parlour, hayloft and feed warehouse. These facilities offer opportunities for collaboration with private companies. Regarding the wide range of available equipment that is used in the Animal Service, it could be highlighted:

- Milking machine
- Metabolic cages for pigs, small ruminants and rodents
- Heating system for pigs
- Scales
- Cart to transport animals
- High pressure cleaner
- Inhalation anesthesia machines
- Methane measurement chambers

Analyses / Services offered

- General services:

- Supply of EEZ-breed animals
- Reception of external animals, identification, weighing

- Maintenance of small ruminants, pigs, birds and rodents: housing, feeding, cleaning of enclosures and sanitary control
- Collaboration in experimental procedures

- Technical services:

- Waste management: SANDACH (carcasses/manure/slurry/milk)
- Management of animals´ transport
- Participation in the Animal Welfare Authority (OEBA)
- Organization of workshops and seminars for training in handling animals and experimental techniques
- Management of access to facilities
- Administration of the animals´census: records of discharges and casualties

- Laboratory services:

- Execution of necessary health checks to ensure the proper health status of the animals
- Assistance and prescription of medication
- Euthanasia following the legal criteria
- Necropsies
- Surgeries
- Technical assistance in experimental procedures

Activities in 2023

- Maintenance of small ruminants, pigs and birds (accommodation, food, cleaning and sanitary control)
- Small ruminant trough construction
- Adaptation to new enclosures. Promotion and maintenance of environmental enrichment (installation of shaded areas), measures to improve animal welfare
- Compliance with operating regulations of the Animal Service Facilities. Documentation management (treatment book, transport, procedures, SANDACH, etc.)
- Construction of a set of aromatic plants that partially delimit the facility, contributing to pest control

Animal Facility ES180210000016. Department of Nutrition and Sustainable Animal Production

CARBON AND NITROGEN ANALYSIS SERVICE

Head
Rafael Hueso Ibáñez

Technician
José Luis Luque Ojeda

Facilities and equipment

- Elemental analyzers (Leco TruSpec CN and Leco CN828)
- Analytical balance and drying oven

Analyses / Services offered

- Quantitative determination of total Nitrogen (by Dumas method) and Carbon (by infrared detector) in a wide range of matrices (water, biological fluids like milk or urine, animal feed, forage, animal or plant tissues, faeces, soils, etc.)
- Quantification is performed with certified standards from Leco

Activities in 2023

- Quantification of organic carbon by low temperature combustion
- Monitoring of organic content in wastewater from our animal treatment plan

N/C Analyzer (TruSpec CN)

GREENHOUSES AND PLANT GROWTH CHAMBERS SERVICE

Head
Andrés Belver Cano

Technician
Francisco Sires Navarrete (until November 2023)

Facilities and equipment

- 15 walk-in growth chambers provided with temperature control, LED illumination and ventilation, with a total cultivation area of approximately 140 m^2. One chamber is dedicated to the cultivation of plants under short-day conditions, other to *in vitro* cultivation, 2 are conditioned for studies at high ambient CO_2 concentrations and 2 are exclusively devoted to the cultivation of plants infected with pathogenic bacteria and fungi
- 10 greenhouses, providing a total area for plant cultivation of 154 m^2, temperature control with additional lamps to provide artificial light, 3 of them also equipped to set up hydroponic cultures
- Phenotyping platform, with the possibility of incorporating different sensors (CCD, thermal or multispectral cameras)
- Latest generation imaging fluorimeter
- Infrared Gas Analyzer-IRGA (LICOR 6800), equipped with a Multiphase Flash Fluorometer, for the determination of photosynthetic parameters, such as photosynthesis, transpiration and conductance

Activities in 2023

- New physical server exclusively for the Greenhouses and Plant Gwowth Chambers Service, containing the remote management systems for the maintenance technician, the reservation website and the Culture Chambers and Greenhouses databases. The booking website and the databases of the Cultivation Chambers and Greenhouses. Redesign of the booking website (ITS Service, Javier Mengual)
- Chamber 10, new long day *Arabidopsis* Growing Chamber
- Chamber 4, converted into a general-purpose Chamber
- Infrared Gas Analyzer-IRGA (LICOR 6800), equipped with Multiphase Flash Fluorometer, funded by FAS2022_017 funds and co-financed by the Service and interested research projects (Scientific Manager, Mariam Sahrawy)
- Imaging PAM (Scientific Manager, Mónica Pineda)
- Installation of a washing and disinfection area of culture material for users of the Service (in the Casa Roja annex building), financed by own funds
- Automated greenhouse cover awnings (controlled by wind, lighting and temperature), financed by own funds
- Root washing system in large and medium pots, financed by own funds

New automated greenhouse cover awnings

CONFOCAL AND TRANSMISSION ELECTRON MICROSCOPY SERVICE

Head
José Carlos Jiménez López

Technicians
Alicia Rodríguez Sánchez
Andreína C. Peralta Leal

Facilities and equipment

- Confocal Laser Scanning Microscope (Nikon C-1)
- Transmission Electron Microscope (JEOL JEM-1011)
- Inverted Epifluorescence Microscope (Leica DMI600B)
- Epifluorescence Stereomicroscope (Leica M165FC)
- Different tissue processors for electron and laser microscopy: automatic tissue processor for electron microscopy samples (Leica EM TP), processor for paraffin inclusion (Leica TP1020) (Leica EG1150), vibratome (Leica VT1200s), microtome (Leica RM 2165), ultramicrotome (Reichert-Jung

ULTRACUT E), cryostat microtome (Leica Jung Frigocut 2800) and multidimensional analysis of images equipment

Photos obtained using Laser Scanning Confocal Microscopy and Stereomicroscopy. They were submitted to FOTCIENCIA20 (https://www.fotciencia.es/publico/index.aspx)

RADIOCHEMISTRY LABORATORY

Head
Francisco Martínez-Abarca

Technician / IR Supervisor
Mª Dolores Molina Sánchez

The EEZ has authorization to operate the 2nd category radioactive facility IR/GR-06/73 (IRA 159, according to the CSN nomenclature). The authorized activities are the use of non-encapsulated radioactive material.

Authorized isotopes:
- ^{3}H (50mCi); ^{14}C (30mCi); ^{33}P (20mCi); ^{35}S (10mCi); ^{125}I (5mCi); ^{32}P (10mCi)
- Encapsulated radioactive source of ^{137}Cs of 32.25 µCi (1.19 MBq) of maximum activity used in the scintillation counter

Facilities and equipment

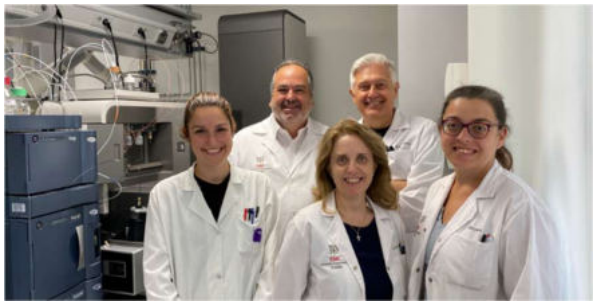
- Two units, one located on the ground floor of the Microbiology Building that consists of two areas (monitored area and controlled area), and a second laboratory located at the Armilla headquarters
- Geiger-Müller contamination detectors
- Liquid scintillation counter (Beckman Coulter, model LS 6500)
- Phosphorimager Autoradiography, Digital detection System of radioactivity (Personal Molecular Imager TM (PMITM System, BioRad)
- Fume hood, thermal cycler, hybridization oven, freezer, refrigerator and microcentrifuges
- Adequate radioprotection and decontamination equipment

Performed techniques

- Microbiology Building: DNA and RNA labelling and probes-hybridization, autoradiography, incorporation of radioisotopes into cells, protein phosphorylation, *in vitro* transcription, etc.
- Armilla headquarters: Radioimmunoassay for determination/quantification of animal hormones

Operating the phosphorimager facilities of Radiochemistry laboratory

SCIENTIFIC INSTRUMENTATION SERVICE



Head

Eduardo López-Huertas León

Technicians

Rafael Núñez Gómez
Lourdes Sánchez Moreno
Miryam Rojas Gómez
Beatriz Sánchez Romera

Facilities and equipment

- Equipment for Liquid Chromatography and Mass Spectrometry:

· HPLC Waters Allience 2695
· UPLC Waters Acquity H-Class
· UV, fluorescence and refractive index detectors
· Electrospray ionization mass spectrometer with triple cuadrupole detector (Quattro micro)
· Electrospray ionization mass spectrometer with qTOF detector (Vion IMS-QTof)

- Equipment for Gas Chromatography (GC):

· Gas Chromatograph coupled to Mass Spectrometer Varian 450-GC-240MS
· Gas Chromatograph 490 Micro GC

- Equipment for elemental analysis:

· Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) Varian ICP 720-ES

- Isothermal Titration Calorimeter (ITC)

· Nano Isothermal Titration Calorimeter (T.A. Instruments)

- Electron Paramagnetic Resonance (EPR) Spectrometry:

· EPR spectrometer EMXnano (Bruker)

Analyses / Services offered

- Detection and quantification of a wide range of low molecular weight compounds by liquid chromatography or gas chromatography separation followed by infusion into mass spectrometers
- Quantification of permanent gases by GC (methane, CO, CO_2, N_2O, etc.)
- Determination of elemental composition of liquid and solid samples using ICP-OES
- Analysis of molecular interactions by microcalorimetry
- Custom-tailored development of extraction protocols of analyte compounds from different biological samples

Activities in 2023

- Training Course on Chromatographic Techniques, Estación Experimental del Zaidín-CSIC, Granada, 16-20 October 2023, organized and administered by our staff members

Main laboratory of the Scientific Instrumentation Service

ASSESSMENT, RESTORATION AND PROTECTION OF MEDITERRANEAN AGROSYSTEMS (SERPAM)

Head
Ana Belén Robles Cruz

Technicians
A. Ignacio Martín García (since March 2024)
Antonio Jesús Pérez Luque
Mª Eugenia Ramos Font
Cristina Soler Moreno
Mauro Tognetti Barbieri

SERPAM is an environmental research and advisory service (natural and agricultural environments), whose pillars are:
- Knowledge of Mediterranean pasture systems and resources: flora, wild forage crops, vegetation, pastures, plant covers, and agrosilvopastoral systems
- Management of the natural environment: evaluation and management of natural pastures, livestock carrying capacity, restoration of degraded lands, enhancement of mountain areas and preventive silviculture alternatives with livestock

Analyses / Services offered

1. Design and monitoring of vegetation cover restoration measures in silvopastoral systems
    a) Design of vegetation restoration systems
    b) Location of seed sources and collection of seeds of wild species
    c) Planning grazing for fire prevention
2. Vegetation inventories
    a) Vegetation composition (diversity and richness) and vegetation inventories
    b) Assessment of the impact of disturbances (herbivory, fire, prescribed burning, etc.) on herbivory
    c) Assessment of the response of vegetation after prescribed burning or after a forest fire
3. Drone service
    a) Flight with MicaSense MX/ MX BLUE sensor (10 bands)
    b) Flight with Zenmuse P1 RGB sensor
    c) Zenmuse L1 LIDAR sensor flight
    d) Mavic 3E RTK flight
    e) Workswell WIRIS Enterprise SC Thermographic Sensor Flight
    f) Image processing
4. Precision GPS surveying

Equipment

- Drone Matrice 300 RTK
- Drone Mavic 3 E RTK
- Sensors: Zenmuse P1, Zenmuse L1, MicaSense RedEdge MX Dual
- GNSS Mobile Station D-RTK2
- Precision GPS Base+Rover Kolida K5 UFO/Kolida K20S
- Software for images processing, statistics and GIS
- GPSs for livestock tracking (in the field)
- Two weather stations (in the field)
- Forced air oven for drying vegetal material
- Refrigerator and cold room
- Germination chamber
- Balances and precision balance
- Herbarium material: press, two binocular magnifying glasses (one including video camera), determination keys, dissection material
- Field GPS
- Field material for vegetation monitoring
- Field material for sowing and seed cleaning

Activities in 2023

(More details reported in the corresponding sections)

- Participation as IP in 4 research projects funded by international and national agencies (LIFE-WATCH-ERIC, CSIC-intramural, MICINN, MITECO)

- Participation in a Scientific and Technology Contract with Aix-Marseille University (20225183)

- Publication of 2 peer-review articles

- Participation in various dissemination activities and training courses

Vegetation sampling. Alcóntar, Sierra de los Filabres

Drone Matrice 300 RTK (left) and Drone Mavic 3 E RTK (right)

TECHNICAL RESEARCH SUPPORT UNITS

INFORMATION TECHNOLOGIES SERVICE (ITS)

Head
Francisco Javier Mengual Maldonado

Other members
César Azorín Márquez
Víctor Baena Vílchez (Integra S.L.)
Lourdes Salmerón García (Armilla headquarters)
Jesús Sierra Duarte

The ITS maintains and supports the entire communications infrastructure (voice and data) at the two headquarters of the EEZ. It also manages different services, such as the Centre's website and intranet, and offers support to the users' incidences. The Service objectives are to develop and implement computer systems to facilitate research and administrative management, focusing mainly on service availability, energy efficiency and continuous improvement, thereby promoting innovation.

Activities in 2023

- Incorporation of the Strategic Plan for Sustainable Management of Electronic Waste and Prevention of Planned Obsolescence, with the aim of raising awareness, incentivizing, and promoting the repair and reuse of computer equipment. This commitment to sustainability and energy efficiency is supported by the update of the Calipso software, which automates the shutdown of equipment at the end of the workday, and in turn represents significant advances in security. In this latter case, several shutdown intervals have been incorporated, selectable by the user to better fit their workday.

- Update of components of the servers comprising the EEZ private cloud to ensure effective service, addressing new requirements.

- Report of a 0-day security vulnerability to the Cybersecurity Operations Center.

- Update of the Greenhouses and Plant Growth Chambers Service website, and implementation of remote software for the control of a new growth chamber.

- Implementation and modification of several services, collaborating with the EEZ Management, such as a new shared storage system “Egeo”, modification of the "SIPO" purchasing website, and order management tools.

- User support and microinformatics tasks: it takes over 50% of the daily workload (210 requests in 2023), not including telephone or in-person attention, where most of the requests are received and solved.

KNOWLEDGE TRANSFER UNIT

Head
Juan de Dios Alché

In collaboration with:
Victoria Macías Moreno

This Unit provides support to the Centre's research groups, managing the transfer of the knowledge generated through its technological offer and promoting collaboration with companies and institutions. Its activities include consultancy and management of research contracts, support in the application for public aid in collaboration with companies, the development of an updated portfolio of technology-based companies, as well as the protection, promotion and commercialization of research results.

The transference unit delivers a framework for collaboration with third parties in order to make research results returning to society

Services offered

- Advice to research groups for the management of contracts, patents and collaborations with companies and institutions
- Management of contracts for Technological Support, R&D (Research and Development), Confidentiality Agreements (NDA), Material Transfer Agreements (MTA), Patents and Services

Activities in 2023

- Advice on the signing of contracts with 34 companies (22 Spanish and 12 from abroad), including 23 Technological Support/R&D contracts, 6 NDA, 3 MTA and 23 contracts to provide services

- European publication of the international patent on "Bacterial nanocellulose production" invented by Silvia Marqués Martín, Sophie Marie Martirani von Abercron, Patricia Marín Quero, Daniel Pacheco Sánchez (European Patent application number: 2021817696.4, publication date: 05/04/2023)

- The EEZ has been a member of Granada Salud since January 2020, an association of different public and private organizations with the aim of communicating and promoting Granada's potential in the field of innovation in the health sector

Meetings and attendance at trade fairs and congresses:

- Foro Transfiere, Málaga, 15-17 February 2023
- 11th Edition of Murcia Food Brokerage Event, 11-16 May 2023
- Interview with Juan de Dios Alché for the Innovation and Knowledge Management Blog of Junta de Andalucía

Transfiere
12º European Meeting on Science, Technology and Innovation
Málaga
15 - 16 - 17 Feb
2023

LIBRARY

Head
Felícitas Ramírez Malo

Librarian
Francisca González Iglesias

The EEZ has a public library for specialized researchers working on plant and environmental biotechnology, soil microorganisms and their interaction with plants, as well as animal nutrition and sustainable production. It belongs to the area of Life Sciences and is part of the CSIC Library and Archives Network (Red de Archivos y Bibliotecas del CSIC), whose technical coordination corresponds to the Scientific Information Resources Unit (Unidad de Recursos de Información Científica para la Investigación, URICI). The EEZ Library has around 7.000 volumes and specialized scientific magazines with over 300 journal titles. Since 2000 the bibliographic collections offer access on line to digital books and journals practically 100 %. Since 2015 the Library acts as curator of historical archives (1940-1980) to preserve the institute's historical documents.

Services offered

- Reading room with internet access
- Book loan
- Interlibrary loan
- Scientific bibliographic information and assistance
- Documents supply service for staff
- Reproduction of documents
- Access to digital journals and books

- Access to scientific bibliographic databases
- Delegated archive in the institutional repository

Activities in 2023

- The library extension activities are related to the public visits to the EEZ facilities, its website and the Science Outreach Unit.

- Commemoration of *World Book and Copyright Day w*ith the exhibit *MNEMOSYNE: CIENCIA 0 ARTE* in Granada University's ETS Architecture Library.

Visitors at the exhibit MNEMOSYNE: CIENCIA 0 ARTE, ETS Architecture Library, University of Granada

SCIENCE OUTREACH UNIT

Head
Manuel Espinosa Urgel

Public outreach and Science education

- *Science Area in Granada's Book Fair 2023.* Coordinated by EEZ-CSIC, IAA-CSIC and Parque de las Ciencias, with support from the Vice-Presidency for Scientific Culture (*Vicepresidencia Adjunta de Cultura Científica*, VACC) and CSIC Delegation in Andalusia and Extremadura. A dedicated space for more than 20 science talks for the general public, interviews, and workshops for kids and families, during the 10 days of the Book Fair.

Science Area, Book Fair 2023. Interviews with three CSIC scientists.

- *European Researchers' Night.* Funded by the EU, EEZ scientists took part with talks, workshops and demonstrations for the general public, and specific activities for school groups.
- *Mushrooms all year round.* Exhibit at the "Casa de las Ciencias" museum in Logroño. From September 8, 2023 to January 7, 2024. Over 200 lyophilized specimens and other items, with their corresponding information, are shown in this exhibit, prepared by the EEZ. 17.459 visitors.

Mushrooms all year round*, exhibit at the "Casa de las Ciencias" museum in Logroño*

- *CAOS 3.* Research projects carried out by high school students, supervised by EEZ scientists. Results were presented in a meeting and published in *High School Students for Agricultural Science Research*, Vol. 12, ISSN 2340-9746.
- Oral presentations of EEZ activities at the 1st Inclusive Science Meeting (CSIC, Madrid) and Science in the South (CSIC, Sevilla).

Press releases and social media

- During 2023, the Unit has issued 28 web news and press releases. The highest media coverage regarding scientific issues was received by projects and results related to food technologies.
- The data of our social media in 2023 were:
    - Twitter (X): 2.904 followers (+5% with respect to 2022)
    - Facebook: 2.269 followers (+1%)
    - Instagram: 689 followers (+20%)
    - Youtube: 397 suscriptors (+9%)

Women in Science, in colaboration with the Gender Equality Commission

- *International Day of Women and Girls in Science (11th February)*: several talks by female EEZ scientists with high school students.
- *Women's Day (8th March)*: 1st Meeting of female scientists and enterpreneurs of Granada.

DEPARTMENTS AND RESEARCH GROUPS

Department of Biotechnology and Environmental Protection

- Genetics of Phytobacterial Infections
- Environmental Microbiology and Biodegradation
- Sustainability of Soil-Plant Systems and Environmental Decontamination

Department of Stress, Development and Signaling in Plants

- Antioxidants, Free Radicals and Nitric Oxide in Biotechnology, Food and Agriculture (ARNOBA)
- Plant Reproductive Biology and Advanced Microscopy Laboratory (PReBAIL)
- Molecular Physiology of Ion Transport in Plants under Adverse Environmental Conditions
- Redox Regulation, Sugar Signaling and Phenotyping using Imaging Techniques to detect Plant Stress
- ROS and Nitric Oxide-Signaling and Peroxisomal Dynamics in Plants

Department of of Soil and Plant Microbiology

- Biofertilization and Biodegradation by Rhizospheric Fungi
- Structure, Dynamics and Function of Rhizobacterial Genomes
- Plant-Bacteria Interactions
- Nitrogen Metabolism in Rhizospheric Bacteria
- Mycorrhiza

Department of Nutrition and Sustainable Animal Production

- Animal Nutrition
- Gastrointestinal Health and Food Safety
- Sustainable Production of Ruminants

DEPARTMENT OF BIOTECHNOLOGY AND ENVIRONMENTAL PROTECTION

GENETICS OF PHYTOBACTERIAL INFECTIONS

MEMBERS

Senior Researchers
Mª José Soto Misffut, *Group Leader*

Hired Researchers
Lidia Mª Bernabéu Roda

Staff Technicians
Virginia Cuéllar Maldonado

OVERVIEW

The general objective of the Group is to decipher the molecular mechanisms that explain how bacteria are capable of colonizing and infecting plants using the *Rhizobium*-legume symbiosis as a model. We are especially interested in identifying chemical signals and bacterial components involved in the early stages of the interaction and that can affect the colonization of plant tissues, an essential step required for the establishment of both pathogenic and mutualistic plant-bacteria associations. To achieve our goal, we focus our studies on the regulatory mechanisms that control rhizobial life on surfaces and on the role played by bacterial airborne metabolites. The knowledge acquired during these investigations can provide the basis for the development of agrobiotechnological solutions aimed at the control of phytopathogens and/or the production of biofertilizers/biostimulants in the context of sustainable agriculture.

LINES OF RESEARCH

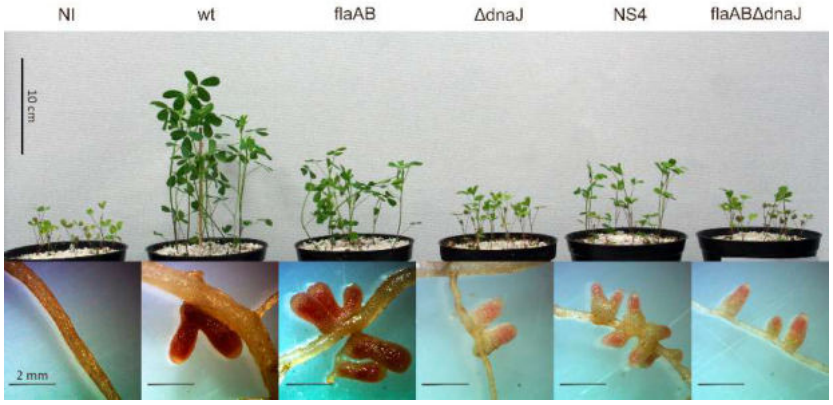
1. Studies of the volatilome of *Rhizobium* and its role in interkingdom communication with plants.

2. Identification of the molecular bases responsible for the different types of surface motility exhibited by *Sinorhizobium meliloti*.

MOST RELEVANT PUBLICATIONS IN 2023

Brito-Santana, P.; Duque-Pedraza, J.J.; Bernabéu-Roda, L.M.; Carvia-Hermoso, C.; Cuéllar, V.; Fuentes-Romero, F.; Acosta-Jurado, S.; Vinardell, J.M.; Soto, M.J. 2023. *Sinorhizobium meliloti* DnaJ is required for surface motility, stress tolerance, and for efficient nodulation and symbiotic nitrogen fixation. *International Journal of Molecular Sciences,* 24: 5848.

Soto, M.J.; Pérez, J.; Muñoz-Dorado, J.; Contreras-Moreno, F.J.; Moraleda-Muñoz, A. 2023. Transcriptomic response of *Sinorhizobium meliloti* to the predatory attack of *Myxococcus xanthus*. *Frontiers in Microbiology,* 14: 1213659.



Plant growth and nodules formed by alfalfa inoculated with Sinorhizobium meliloti dnaJ *mutants, which are impaired in surface motility and insensitive to volatile 2-tridecanone (Brito-Santana* et al. *2023. International Journal of Molecular Sciences, 24: 5848)*

ENVIRONMENTAL MICROBIOLOGY AND BIODEGRADATION

MEMBERS

Senior Researchers
Manuel Espinosa Urgel, *Group Leader*
Estrella Duque Martín de Oliva
Tino Krell
Marian Llamas Lorente
Silvia Marqués Martín
Miguel Ángel Matilla Vázquez
Mª Isabel Ramos González
Juan Luis Ramos Martín
Ana Segura Carnicero
Pieter van Dillewijn

Postdoctoral Researchers
Jean Paul Cerna-Vargas

Predoctoral Researchers
Ana Ángeles García Franco
Roberta Genova

Verónica Pérez Padilla
Mª Isabel Recio Muñoz

Hired Researchers
Inés Castillo Rodríguez
Mª del Rocío Fernández González
Patricia Godoy Alba
Tamara Mª Gómez Gallego
Cristina Lomas Martínez
Francisco Javier Marcos Torres
Sophie Marie Martirani von Abercron
Elizabet Monteagudo Cascales
Rafael Nisa Martínez
Mª del Rocío Palacios Ferrer
Miriam Rico Jiménez
Iván Sánchez Castro
Ana Sánchez Jiménez
Zulema Udaondo Domínguez
Félix Velando Soriano

Staff Technicians
Jesús de la Torre Zúñiga
Alicia Inmaculada García Puente
Patricia Marín Quero
Lázaro Molina Delgado
Mª Antonia Molina Henares
Daniel Pacheco Sánchez
Mª Luisa Travieso Huertas

Hired Technicians
Marina Fernández López
Irene Hurtado Fernández
Sabina Moles Santiago
Raquel Vázquez Santiago

OVERVIEW

Our research focuses on bacteria of environmental, agricultural, industrial and biomedical interest, with the final goal of developing new biotechnological applications. Our work comprises two broad research areas: 1) Understanding crucial processes for bacterial survival, persistence and interaction with their environment and hosts; 2) Exploring and expanding bacterial activities of relevance in environmental and plant protection, circular bioeconomy and global health.

We analyse fundamental mechanisms in plant-microbe interactions (beneficial and pathogenic) and the adaptation of bacteria to the rhizosphere: biofilm development, chemotaxis, signal molecules and pathways, antimicrobial production, and the regulatory elements involved. We also study how opportunistic pathogens interact with their hosts, focusing on signal transduction pathways, cell-surface signaling, stress responses, etc. The aim is to discover new targets and antimicrobials against infection.

Our work on biodegradation and bioremediation strategies, and the synthesis of added-value bio-products, targets a variety of aromatic compounds, waste products and organic pollutants. We uncover novel aerobic and anaerobic pathways, their genetic determinants, and the molecular mechanisms controlling their expression. We construct improved strains through metabolic engineering or synthetic biology approaches, and use metagenomics to explore metabolic diversity, responses of microbial communities towards environmental changes, and to identify sources for new activities of biotechnological interest.

LINES OF RESEARCH

1. Biofilm and plant-bacteria interactions.

2. Bacterial sensing and signal transduction, in particular chemotaxis.

3. Signal transduction by cell-surface signaling systems and virulence.

4. Anaerobic biodegradation, pathways and regulation.

5. Aromatics and pesticide biodegradation, metabolic engineering.

6. Biodegradation and biodiversity.

7. Rhizoremediation and synthesis of biofuels.

8. Biosynthesis of added value compounds and polymers, and circular economy.

9. Bacterial signaling and antibiotic production in phytobacteria.

MOST RELEVANT PUBLICATIONS IN 2023

Cerna-Vargas, J.P.; Gumerov, V.M.; Krell, T.; Zhulin, I.B. 2023. Amine-recognizing domain in diverse receptors from bacteria and archaea evolved from the universal amino acid sensor. *Proceedings of the National Academy of Sciences of the United States of America,* 120: e2305837120.

Matilla, M.A.; Evans, T.J.; Martín, J.; Udaondo, Z.; Lomas-Martínez, C.; Rico-Jiménez, M.; Reyes, F.; Salmond, G.P.C. 2023. Herbicolin A production and its modulation by quorum sensing in a *Pantoea agglomerans* rhizobacterium bioactive against a broad spectrum of plant-pathogenic fungi. *Microbial Biotechnology,* 16: 1690-1700.

Espinosa-Urgel, M.; Ramos-González, M.I. 2023. Becoming settlers: elements and mechanisms for surface colonization by *Pseudomonas putida*. *Environmental Microbiology,* 25: 1575-1593.

Daddaoua, A.; Álvarez, C.; Oggerin, M.; Rodríguez, N.; Duque, E.; Amils, R.; Armengaud, J.; Segura, A.; Ramos, J.L. 2023. Río Tinto as a niche for acidophilus enzymes of industrial relevance. *Microbial Biotechnology,* 16: 1069-1086.

Sánchez-Jiménez, A.; Marcos-Torres, F.J.; Llamas, M.A. 2023. Mechanisms of iron homeostasis in *Pseudomonas aeruginosa* and emerging therapeutics directed to disrupt this vital process. *Microbial Biotechnology,* 16: 1475-1491.

Antifungal activities of a biocontrol rhizobacterium

SUSTAINABILITY OF SOIL-PLANT SYSTEMS AND ENVIRONMENTAL DECONTAMINATION

MEMBERS

Senior Researchers
Rogelio Nogales Vargas-Machuca, *Group Leader*
Emilio Benítez León
Esperanza Romero Taboada

Hired Researchers
Martín Aguerrebengoa Barreña
Nuria Guirado Romero
Adriana Isabel Moral Rodríguez

Staff Technicians
Celia Cifuentes Urién
Mª Luisa Fernández Sierra
Beatriz Moreno Sánchez

OVERVIEW

The main research goals of this research Group is to generate basic and applied knowledge, within the framework of a circular and a green economy, contributing to the protection of soil, water and crops through the use of low-cost agro-environmental technologies and the promotion of agrosystems by sustainable alternatives. This is approached from a triple perspective: 1) the development of biotechnological processes for recycling and reusing of organic and inorganic wastes, 2) the development of low-cost biotechnologies for the prevention and protection of soils and waters against diffuse and punctual pollution induced by organic pollutants (pesticides, emerging pollutants), and 3) the development of methods for the sustainable management of agrosystems and their implication in the maintenance of multiple ecosystem services. For these approaches, innovative fields, chemical, enzymatic and molecular biology tools are used at different spatial scales.

LINES OF RESEARCH

1. Recycling or organic wastes using low-cost biotechnologies to promote a circular bioeconomy.

2. Development of hydrothermal carbonization processes to convert residual biomass into value-added adsorbents for emerging contaminants from waters and soils.

3. Sustainable management of agroecosystems and maintenance of multiple ecosystem services.

MOST RELEVANT PUBLICATIONS IN 2023

Alcalá-Herrera, R.; Moreno, B.; Aguirrebengoa, M.; Winter, S.; Robles-Cruz, A.B.; Ramos-Font, M.E.; Benítez, E. 2023. Role of agricultural management in the provision of ecosystem services in warm climate vineyards: functional prediction of genes involved in nutrient cycling and carbon sequestration. *Plants,* 12: 527.

Beaumelle, L.; Giffard, B.; Tolle, P.; Winter, S.; Entling, M.H.; Benítez, E.; Zaller, J.G.; Auriol, A.; Bonnard, O.; Charbonnier, Y.; Fabreguettes, O.; Joubard, B.; Kolb, S.; Ostandie, N.; Reiff, J.M.; Richart-Cervera, S.; Rusch, A. 2023. Biodiversity conservation, ecosystem services and organic viticulture: a glass half-full. *Agriculture, Ecosystems and Environment,* 351: 108474.

Field plot experiment with soil, either unamended or amended with vermicomposts, and/or treated with pesticides

DEPARTMENT OF STRESS, DEVELOPMENT AND SIGNALING IN PLANTS

ANTIOXIDANTS, FREE RADICALS AND NITRIC OXIDE IN BIOTECHNOLOGY, FOOD AND AGRICULTURE (ARNOBA)

MEMBERS

Senior Researchers
José Manuel Palma Martínez, *Group Leader*
Francisco Javier Corpas Aguirre
Eduardo López-Huertas León

Predoctoral Researchers
Mª de los Ángeles Muñoz Vargas

Hired Researchers
Salvador González Gordo
Marta Rodríguez Ruiz

Staff Technicians
Mª Jesús Campos Ramos
Carmelo Ruiz Torres

Hired Technicians
José Manuel Rubí Villegas

OVERVIEW

The Group investigates the role of antioxidants, free radicals and nitric oxide (NO) in the physiology of horticultural species (pepper, tomato, olive, etc.), for the development of biotechnological tools/strategies addressed to a better exploitation of the nutritional and nutraceutical features of these crops. *Arabidopsis* and pea are used as model plants, aimed to generate knowledge for future scientific purposes. The Group also investigates food quality and food safety with impact in the areas of human nutrition and health. We collaborate with research organizations and leading companies in the biotechnology and food sectors, such as Syngenta Seeds Ltd., Sakata, United Caro Research and Development, S.L.U., Lactalis-Puleva, S.L.U., Deoleo, Agrosol, Istituto Nutrizionale Carapelli, IFAPA and Fundación MEDINA.

The Group was launched in 1983 and, from the beginning, its objectives are the study of antioxidants and cell signaling by Reactive Oxygen, Nitrogen and Sulfur Species (ROS, RNS and RSS, respectively) in species of agronomic interest. Without refusing to basic research, the Group's activity is also aimed at applied research to ease the knowledge transfer to the productive sector. After greatly contributing to the advance of the knowledge, the Group has gained the expertise to be potentially exploited in the Biotechnology and Agro-food fields.

LINES OF RESEARCH

1. Study of the fruit physiology from crop species. Ripening and post-harvest are investigated in pepper, tomato and olive, by transcriptomics, proteomics and metabolomics.

2. Role of and reactive oxygen, nitrogen and sulfur species (ROS, RNS and RSS) in germination, development, abiotic stress and cell signaling processes in higher plants.

3. Functionality of natural bioactive compounds (antioxidants, capsaicin, flavonoids, proteins, antihypertensive peptides, etc.) and oils coming from plant species with nutritional, nutraceutical, health, biotechnological and pharmacological applications.

4. Research on nutrition and health, food quality and safety of meat products for human consumption.

MOST RELEVANT PUBLICATIONS IN 2023

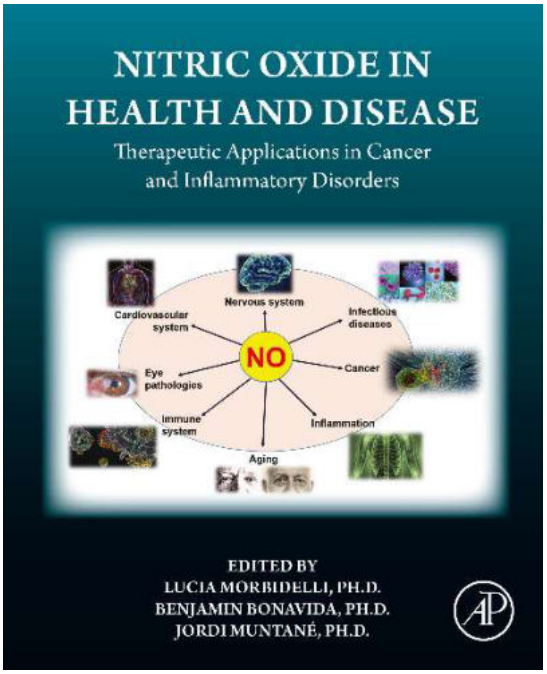
Corpas, F.J. 2023. H_2S: a simple molecule with multifaceted biochemistry and functions. *Antioxidants & Redox Signaling,* 39: 980-982.

González-Gordo, S.; Muñoz-Vargas, M.A.; Palma, J.M.; Corpas, F.J. 2023. Class III peroxidases (POD) in pepper (*Capsicum annuum* L.): genome-wide identification and regulation during nitric oxide (NO)-influenced fruit ripening. *Antioxidants,* 12: 1013.

Muñoz-Vargas, M.A.; López-Jaramillo, J.; González-Gordo, S.; Paradela, A.; Palma, J.M.; Corpas, F.J. 2023. H_2S-generating cytosolic L-cysteine desulfhydrase and mitochondrial D-cysteine desulfhydrase from sweet pepper (*Capsicum annuum* L.) are regulated during fruit ripening and by nitric oxide. *Antioxidants & Redox Signaling,* 39: 2-18.

Palma, J.M.; Rodríguez-Ruiz, M.; Foyer, C.H.; Corpas, F.J. 2023. Editorial: subcellular compartmentalization of plant antioxidants and ROS generating systems, volume II. *Frontiers in Plant Science,* 14: 1224289.

Rodríguez-Ruiz, M.; Ramos, M.C.; Campos, M.J.; Díaz-Sánchez, I.; Cautain, B.; Mackenzie, T.A.; Vicente, F.; Corpas, F.J.; Palma, J.M. 2023. Pepper fruit extracts show anti-proliferative activity against tumor cells altering their NADPH-generating dehydrogenase and catalase profiles. *Antioxidants,* 12: 1461.



Cover of the book "Nitric Oxide in Health and Disease. Therapeutic Applications in Cancer and Inflammatory Disorders". The image was taken from the chapter by Palma et al. *included in this volumen (page 19)*

PLANT REPRODUCTIVE BIOLOGY AND ADVANCED MICROSCOPY LABORATORY (BReMAP)

MEMBERS

Senior Researchers
Juan de Dios Alché Ramírez, *Group Leader*
Antonio Jesús Castro López
José Carlos Jiménez López

Predoctoral Researchers
Salvador Priego Poyato
Andrea Román Mateo

Hired Researchers
José Mª Berral Hens
Mª Elena Lima Cabello
Mª Ángeles Moliné García

Staff Technicians
Diana Fuensanta Nicolás Llorach

Hired Technicians
Julia Escudero Feliú
Esther Rodríguez de Haro

OVERVIEW

The main goal of the research group is to advance into the knowledge of the reproductive developmental biology of plants, including model plants (e.g. *Arabidopsis*, *Lilium*…) and particularly in species of agronomic interest like the olive tree, lupine and argan, in order to further manipulate the plant reproductive cycle improving crop productivity and quality. In addition, we aim to understand the impact of different components from reproductive tissues (pollen, fruit, seed) and other industrial derived products (e.g. oils, flours, isolates, etc.) in allergy, their nutritional and nutraceutical properties, and in the development of molecular tools of agro-food interest. To achieve these objectives, we use multidisciplinary approaches, encompassing integrative omics, and biochemical, molecular and cellular methods, with special emphasis in advanced microscopy techniques. Current research lines include the study of the functional role of reactive oxygen and nitrogen species, lipid droplets and their associated proteins in the pollen grain and their impact in plant fertilization, and the characterization of the potential health benefits of seed constituents as anti-inflammatory and anti-diabetic molecules. These research lines have also broad practical applications, which are explored through the development of patentable and transferable industrial collaborations.

LINES OF RESEARCH

1. Study of gene products in plant reproductive tissue development, focusing on pollen tube signaling and growth.

2. Characterization of proteins in olive seeds and by-products, identifying biomolecules in olive oils for food and pharmaceutical applications.

3. Research on pollen and food allergies, including allergen characterization, genetic variability, and molecular diagnosis and therapy.

4. Evaluation of new plant-based foods, assessing nutritional value and potential health benefits or toxicity in animal models and human studies.

MOST RELEVANT PUBLICATIONS IN 2023

Bullones, A.; Castro, A.J.; Lima-Cabello, E.; Alché, J.D.; Luque, F.; Claros, M.G.; Fernández-Pozo, N. 2023. OliveAtlas: a gene expression atlas tool for *Olea europaea*. *Plants,* 12: 1274.

Bullones, A.; Castro, A.J.; Lima-Cabello, E.; Fernández-Pozo, N.; Bautista, R.; Alché, J.D.; Claros, M.G. 2023. Transcriptomic insight into the pollen tube growth of *Olea europaea* L. subsp. *europaea* reveals reprogramming and pollen-specific genes including new transcription factors. *Plants,* 12: 2894.

Escudero-Feliu, J.; García-Costela, M.; Moreno-SanJuan, S.; Puentes-Pardo, J.D.; Arrabal, S.R.; González-Novoa, P.; Núñez, M.I.; Carazo, A.; Jiménez-López, J.C.; León, J. 2023. Narrow leafed Lupin (*Lupinus angustifolius* L.) beta-conglutin seed proteins as a new natural cytotoxic agents against breast cancer cells. *Nutrients,* 15: 523.

López-Pedrouso, M.; Lorenzo, J.M.; Alché, J.D.; Moreira, R.; Franco, D. 2023. Advanced proteomic and bioinformatic tools for predictive analysis of allergens in novel foods. *Biology,* 12: 714.

Micol-Ponce, R.; García-Alcázar, M.; Lebrón, R.; Capel, C.; Pineda, B.; García-Sogo, B.; Alché, J.D.; Ortiz-Atienza, A.; Bretones, S.; Yuste-Lisbona, F.J.; Moreno, V.; Capel, J.; Lozano, R. 2023. Tomato POLLEN DEFICIENT 2 encodes a G-Type lectin receptor kinase required for viable pollen grain formation. *Journal of Experimental Botany,* 74: 178-193.

The olive (Olea europaea *L.) pollen grain is one of the group's essential research materials. This image shows a pollen grain (PG) germinating* in vitro *with a clearly visible callose plug (CP) in the pollen tube. Differential interference contrast (DIC) microscopy*

MOLECULAR PHYSIOLOGY OF ION TRANSPORT IN PLANTS UNDER ADVERSE ENVIRONMENTAL CONDITIONS

MEMBERS

Senior Researchers
Andrés Belver Cano, *Group Leader*
Mª Pilar Rodríguez Rosales
Cornelis Venema

Hired Researchers
Mª de las Nieves Aranda Sicilia
Jaime Mañas Galindo

Staff Technicians
Francisca López Molina
Mª Elena Sánchez Romero

Hired Technicians
Miriam Lucas Fernández

OVERVIEW

We use an integrated approach to study molecular and physiological mechanisms of ion homeostasis in plants to develop biotechnological applications in crops to improve nutrient and water use efficiency, yield and quality, as well as the resistance to environmental stresses like salinity, drought and nutrient imbalance. We make special emphasis on the functional characterization of ion transporters in economically important crops and model organisms with two research lines: 1. Genetic and molecular approach focusing on quantitative traits (QTL) of halotolerance, functionally supported by Na^+ and Cl^- transporters, combining QTL mapping, candidate gene analysis transcriptomic and reverse genetics, in order to obtain tolerant plants to abiotic stress or their use as rootstocks of commercial varieties in tomato an citrus. 2. Biochemical and molecular characterization of ion transporters involved in regulating H^+, K^+ and Cl^- gradients that play primordial roles in photosynthesis, specifically, the role of chloroplast KEA K^+/H^+ antiporters in photosynthesis efficiency in *Arabidopsis* and tomato plants in which these genes are disrupted by CRISPR/Cas. We also address physiological and molecular processes that affect development, metabolism and water relations in plants in response to their environment, with the aim of reducing the effects of climate change and nitrate pollution in agriculture.

LINES OF RESEARCH

1. Analysis of genetic factors related to ion homeostasis by identifying genes that encode Na^+ and Cl^- transporters involved in salt tolerance QTLs in terms of fruit yield in tomato and citrus.

2. Study of the molecular basis of ion transport (Na^+, K^+, Cl^-, Ca^{2+}) across chloroplast membranes of glycophytic and halophytic species and their relevance for chloroplast function and photosynthesis under normal and stress condition.

3. Study of novel functions of Cl^- nutrition and its interaction with NO_3^- in plants.

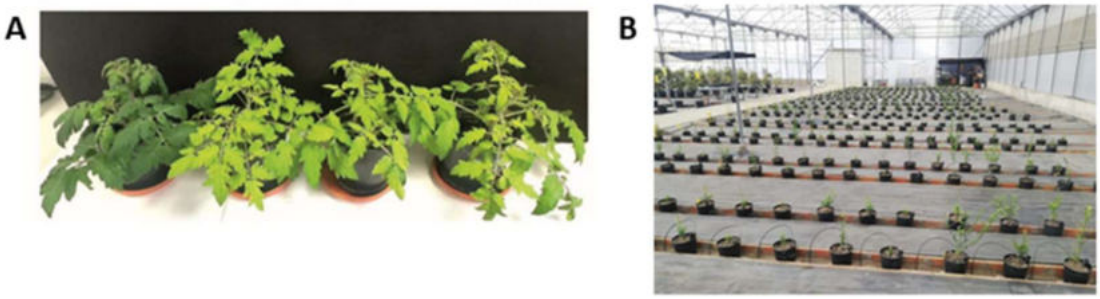
4. Use of organic amendments from agricultural waste to promote circular economy and physiological performance of crops.

MOST RELEVANT PUBLICATIONS IN 2023

Asins, M.J.; Bullones, A.; Raga, V.; Romero-Aranda, M.R.; Espinosa, J.; Triviño, J.C.; Bernet, G.P.; Traverso, J.A.; Carbonell, E.A.; Claros, M.G.; Belver, A. 2023. Combining genetic and transcriptomic approaches to identify transporter-coding genes as likely responsible for a repeatable salt tolerance QTL in citrus. *International Journal of Molecular Sciences,* 24: 15759.

Baghour, M.; Akodad, M.; Dariouche, A.; Maach, M.; Haddaji, H.E.; Moumen, A.; Skalli, A.; Venema, K.; Rodríguez-Rosales, M.P. 2023. Gibberellic acid and indole acetic acid improves salt tolerance in transgenic tomato plants overexpressing LeNHX4 antiporter. *Gesunde Pflanzen,* 75: 687-693.

Peinado-Torrubia, P.; Álvarez, R.; Lucas, M.; Franco-Navarro, J.D.; Durán-Gutiérrez, F.J.; Colmenero-Flores, J.M.; Rosales, M.A. 2023 Nitrogen assimilation and photorespiration become more efficient under chloride nutrition as a beneficial macronutrient. *Frontiers in Plant Science*, 13: 1058774.



A. Phenotypes of WT (left) and 3 different CRISPR tomato lines with disruptions in SlKEA1. B. General view of the experiment with 42 apomictic Citrus rhesni *(R) X* Poncirus trifoliate *(P) mapping population for identifying QTLs that regulate leaf Cl- exclusion (Asins* et al*. 2023. International Journal of Molecular Sciences, 24: 15759)*

REDOX REGULATION, SUGAR SIGNALING AND PHENOTYPING USING IMAGING TECHNIQUES TO DETECT PLANT STRESS

MEMBERS

Senior Researchers
Antonio Jesús Serrato Recio, *Group Leader*
Matilde Barón Ayala
Mariam Sahrawy Barragán

Hired Researchers
Paola Andrea Vargas Gallego

Staff Technicians
Mónica Pineda Dorado
Tamara Molina Márquez

Hired Technicians
Andrea García Alcaide
Mª Trinidad Moreno Martín

OVERVIEW

Understanding redox regulatory mechanisms, by which plants adapt to environmental changes and regulate their metabolism, together with the development of big-data based tools, to monitor crops productivity with non-invasive techniques, are crucial to know how plants would respond and adapt to climate change. These complementary approaches are well represented in the two sub-lines of our research: 1) Redox Regulation and 2) Plant Phenotyping.

LINES OF RESEARCH

1. We study the members of the thioredoxin family in the context of the redox regulation of photosynthesis and carbon metabolism. Our research focusses on uncovering plant mechanisms aimed at integrating the redox and sugar signalling networks in chloroplasts.

2. Plant phenotyping uses computer vision to study how plants are affected by pathogens, parasites, and environmental stressors. This includes thermography, chlorophyll fluorescence, multicolour fluorescence, and hyperspectral imaging. In addition, artificial intelligence tools for data handling and analysis are used.

MOST RELEVANT PUBLICATIONS IN 2023

Demicheli, J.; Sabljic, I.; Beguy, G.; Ploschuk, E.; Sahrawy, M.; Serrato, A.J.; Pagano, E.A. 2023. Improving drought tolerance in soybean by classical breeding leads to physiological adjustments of photosynthesis and stomata functioning. *Plant Stress,* 10: 100275.

Pineda, M.; Barón, M. 2023. Assessment of black rot in oilseed rape grown under climate change conditions using biochemical methods and computer vision. *Plants,* 12: 1322.

***A**) Determination of photosynthesis parameters in cucumber (*Cucumis sativus*) plants using an Infrared Gas Analyser (IRGA). **B**) Time course of* Botrytis cinerea *(grey mould) infection in melon (*Cucumis melo*) leaves. Stomata in affected tissues progressively closed, producing areas with higher temperatures than unaffected tissues*

ROS AND NITRIC OXIDE-SIGNALING AND PEROXISOMAL DYNAMICS IN PLANTS

MEMBERS

Senior Researchers
Luisa Mª Sandalio González, *Group Leader*
María C. Romero Puertas

Predoctoral Researchers
Jesús Espinosa Rodríguez
Eliana Molina Moya
Alejandro Rodríguez González

Hired Researchers
Aurelio Manuel Collado Arenal

Staff Technicians
Felipe Luis Pérez Gordillo

Hired Technicians
Diego Becerra Mora

OVERVIEW

In our Group we are interested in understanding the mechanisms involved in plant responses to different types of abiotic (heavy metal, salinity and xenobiotics) and biotic (*Pseudomonas* and *Fusarium*) stress with the aim of applying the knowledge obtained to early stress monitoring and design of improved plant breeding strategies. For that purpose, multidisciplinary approaches will be used: biochemistry, cellular and molecular. The Group focuses on two main lines of research: 1) The study of the function of reactive oxygen and nitrogen species as signaling molecules in the regulation of gene expression and plant metabolism, throughout protein post-translational modifications and autophagy processes in response to stress, and 2) The study of the role of peroxisomal dynamics (peroxules formation and proliferation) and peroxisomal dependent signaling in both the perception and regulation of cell response to their environment.

LINES OF RESEARCH

1. Function of ROS and NO in signaling and plant response to biotic and abiotic stress.

2. Dynamics of peroxisomes and signaling dependent of these organelles.

3. Role of autophagy processes in response to heavy metals.

MOST RELEVANT PUBLICATIONS IN 2023

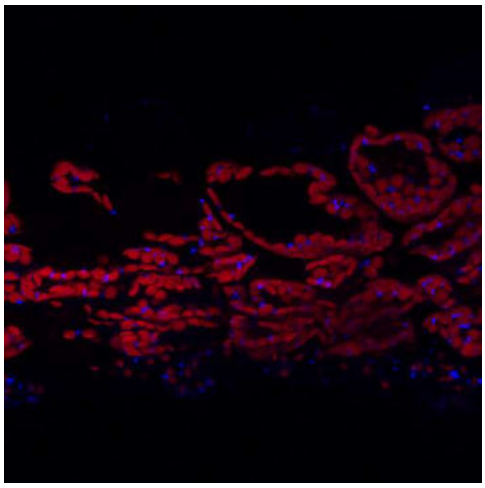
Arnaiz, A.; Romero-Puertas, M.C.; Santamaría, M.E.; Rosa-Díaz, I.; Arbona, V.; Muñoz, A.; Grbic, V.; González-Melendi, P.; Mar Castellano, M.; Sandalio, L.M.; Martínez, M.; Díaz, I. 2023. The *Arabidopsis* thioredoxin TRXh5 regulates the S-nitrosylation pattern of the TIRK receptor being both proteins essential in the modulation of defences to *Tetranychus urticae*. *Redox Biology,* 67: 102902.

Romero-Puertas, M.C.; Lüthje, S.; Zabalza, A.; de Gara, L.; Foyer, C.H. 2023. Editorial: women in plant science - redox biology of plant abiotic stress 2022. *Frontiers in Plant Science,* 14: 1236150

Sandalio, L.M.; Collado-Arenal, A.M.; Romero-Puertas, M.C. 2023. Deciphering peroxisomal reactive species interactome and redox signalling networks. *Free Radical Biology and Medicine,* 197: 58-70.

Sandalio, L.M.; Espinosa, J.; Shabala, S.; León, J.; Romero-Puertas, M.C. 2023. Reactive oxygen species- and nitric oxide-dependent regulation of ion and metal homeostasis in plants. *Journal of Experimental Botany,* 74: 5970-5988.

Terrón-Camero, L.C.; Molina-Moya, E.; Peláez-Vico, M.A.; Sandalio, L.M.; Romero-Puertas, M.C. 2023. Nitric oxide and globin Glb1 regulate *Fusarium oxysporum* infection of *Arabidopsis thaliana*. *Antioxidants,* 12: 1321.



Peroxisomal population in different cell types in Arabidopsis *leaves and their interaction with chloroplasts. Image obtained by confocal microscopy. Blue: peroxisomes; red: chloroplasts (PID2021-122280NB-I00)*

DEPARTMENT OF SOIL AND PLANT MICROBIOLOGY

BIOFERTILIZATION AND BIODEGRADATION BY RHIZOSPHERIC FUNGI

MEMBERS

Senior Researchers
José Manuel García Garrido, *Group Leader*
Alberto Bago Pastor
Inmaculada García Romera

Postdoctoral Researchers
Tania Ho Plágaro

Predoctoral Researchers
Jonathan David Avilés Cárdenas
Martín Ramos-Alvelo Cancellieri

Staff Technicians
Custodia Cano Romero
Nuria Molinero Rosales
Mª Isabel Tamayo Navarrete

Hired Technicians
Silvia Moreno Morillas
Jacob R. Pérez Tienda

OVERVIEW

Research in this Group is particularly focused on the improvement of the arbuscular mycorrhiza (AM) symbiotic association in order to optimize plant nutrition. We use a broad range of approaches, technologies and experimental systems to investigate the phenomenon of compatibility between plants roots and AM fungi that implies the elucidation of the recognition mechanisms and molecular signaling and regulatory events involved in AM formation, especially in the development and turnover of arbuscules.

AM fungi establish relationships with other soil microorganisms, particularly saprobic fungi, and research in the Group addresses questions related to how this relationship can alleviate abiotic stresses such as heavy metals, and examines a range of biological activities of saprobic fungi related to degradation of phytotoxic compounds in order to valorize agricultural waste from the olive oil industry, as bio-stimulatory fertilizer and contaminant adsorbent.

Other research in the Group focus on the design, formulation and production of mycorrhizal ultra-pure inoculants and biostimulants, such as the unique, patented gel-type products, nowadays

commercialized in over 70 countries. A particular attention is given to alleviation of heavy metal and other recalcitrant contaminant stresses in plants and soils via autochthonous arbuscular mycorrhizal fungi through tailor-made inoculants.

LINES OF RESEARCH

1. Regulation of the formation and function of arbuscules in Arbuscular Mycorrhiza (AM).

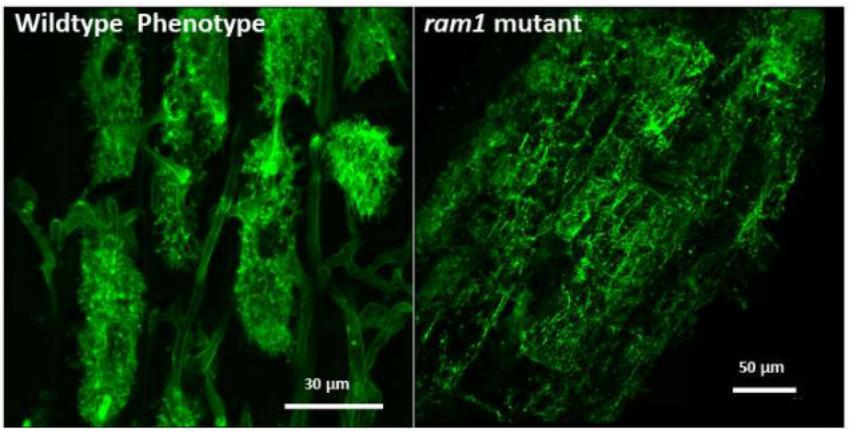
2. Role of the GRAS transcription factors in AM regulation.

3. Use of AM and saprobic fungi in the bioremediation of soils contaminated with heavy metals and aromatic hydrocarbons and in the conservation of soil biodiversity.

4. Optimization of the valorisation of agricultural waste from the olive oil industry by saprobic fungi to use as bio-stimulatory fertilizer and adsorbent for soil decontamination.

5. Formulation and production of mycorrhizal ultra-pure inoculants.

6. Alleviation of heavy metals and other recalcitrant contaminant stresses in plants and soils combining saprobic fungi and autochthonous arbuscular mycorrhizal fungi through tailor-made inoculants.



Arbuscular Mycorrhizal phenotype of ram1 tomato mutant. Roots were subjected to WGA–Alexa Fluor 488 staining and visualized by confocal laser scanning microscopy. Fully developed fungal arbuscules were observed in wild roots, while a defective arbuscule branching appeared in the ram1 mutant

STRUCTURE, DYNAMICS AND FUNCTION OF RHIZOBACTERIAL GENOMES

MEMBERS

Senior Researchers

Nicolás Toro García, *Group Leader*
Manuel Fernández López
José Ignacio Jiménez Zurdo
Francisco Martínez-Abarca Pastor
Jesús Mercado Blanco

Predoctoral Researchers

Sabina Kiara Guedes García
Nuria Martín Wentzien
Esperanza Sánchez Nieto

Hired Researchers

Martina Cardoni
Antonio José Fernández González
Natalia Isabel García Tomsig
Carmen Gómez-Lama Cabanás
Ana Vicente Lasa

Staff Technicians

José Mª del Arco Martín
Fernando Manuel García Rodríguez
Ascensión Martos Tejera
Mª Dolores Molina Sánchez
Pablo José Villadas Latorre

Hired Technicians

Vicenta Millán Casamayor

OVERVIEW

The Group focuses its research lines on the ecology of rhizospheric microorganisms and their use in the recovery of degraded soils, in the application of genomic approaches for the study of woody plant microbiomes, the characterization of the structure and function of the non-coding transcriptome in symbiotic microorganisms, and finally, in the basic knowledge and biotechnological development of reverse transcriptases in prokaryotes, those associated with CRISPR-Cas systems and others related to novel anti-phage systems.

LINES OF RESEARCH

1. Microbiology of Agroforestry Ecosystems (MAE: https://grupos.eez.csic.es/mae/).
2. Bacterial Reverse Transcriptases associated to Phage-Defense Systems.
3. Regulation by RNA in nitrogen-fixing symbiotic bacteria (RhizoRNA).

MOST RELEVANT PUBLICATIONS IN 2023

Cardoni, M.; Fernández-González, A.J.; Valverde-Corredor, A.; Fernández-López, M.; Mercado-Blanco, J. 2023. Co-occurrence network analysis unveils the actual differential impact on the olive root microbiota by two *Verticillium* wilt biocontrol rhizobacteria. *Environmental Microbiome,* 18: 21.

García-Tomsig, N.I.; García-Rodríguez, F.M.; Guedes-García, S.K.; Millán, V.; Becker, A.; Robledo, M.; Jiménez-Zurdo, J.I. 2023. A double-negative feedback loop between NtrBC and a small RNA rewires nitrogen metabolism in legume symbionts. *mBio,* 14: e02003-23.

Hernández-Soto, L.M.; Martínez-Abarca, F.; Ramírez-Saad, H.; López-Pérez, M.; Aguirre-Garrido, J.F. 2023. Genome analysis of haloalkaline isolates from the soda saline crater lake of Isabel Island; comparative genomics and potential metabolic analysis within the genus Halomonas. *BMC Genomics,* 24: 696.

Lasa, A.V.; Fernández-González, A.J.; Villadas, P.J.; Cobo-Díaz, J.F.; Fernández-López, M. 2023. Bacterial inoculation of *Quercus pyrenaica* trees alters co-occurrence patterns but not the composition of the rhizosphere bacteriome in wild conditions. *Environmental Microbiology,* 25: 1747-1761.

Wentzien, N.M.; Fernández-González, A.J.; Villadas, P.J.; Valverde-Corredor, A.; Mercado-Blanco, J.; Fernández-López, M. 2023. Thriving beneath olive trees: the influence of organic farming on microbial communities. *Computational and Structural Biotechnology Journal,* 21: 3575-3589.

*Leaves and bud of melojo oak (*Quercus pyrenaica*), a valuable forest species in the Sierra Nevada National Park*

PLANT-BACTERIA INTERACTIONS

MEMBERS

Senior Researchers
Juan Sanjuán Pinilla, *Group Leader*
Mª Trinidad Gallegos Fernández
Daniel Pérez Mendoza

Predoctoral Researchers
Ariana Casas Román

Hired Researchers
Juan Antonio Marchante Sánchez
Laura Martínez Rodríguez
Pedro J. Pacheco Márquez
Adriana Vásquez Rodríguez

Staff Technicians
Mª José Lorite Ortega
Socorro Muñoz Rodríguez

Hired Technicians
Silvia Moreno Morillas

OVERVIEW

The general objective of the Group is understanding molecular mechanisms governing bacteria-plant interactions and their biotechnological applications.

LINES OF RESEARCH

1. Identification of bacterial components and plant responses during the establishment of beneficial and pathogenic bacteria-plant associations.

2. Molecular signaling through cyclic di-GMP in mutualistic and pathogenic bacteria-plant interactions.

3. Bacterial pathways involved in signal exchange and infection of the host.

4. Discovery and biotechnological exploitation of bacterial extracellular polymers.

5. Genetic and functional diversity of plant beneficial bacteria.

6. Probiotics for plants.

MOST RELEVANT PUBLICATIONS IN 2023

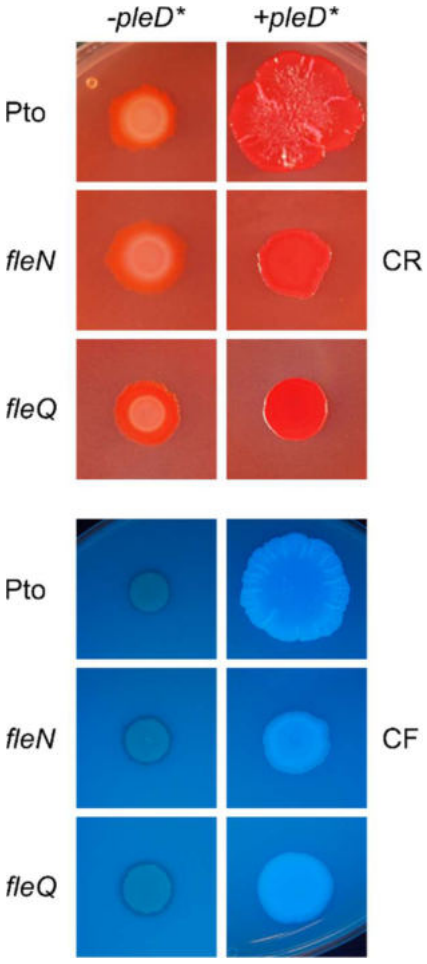
Lorite, M.J.; Casas-Román, A.; Girard, L.; Encarnación, S.; Díaz-Garrido, N.; Badía, J.; Baldomá, L.; Pérez-Mendoza, D.; Sanjuán, J. 2023. Impact of c-di-GMP on the extracellular proteome of *Rhizobium etli*. *Biology,* 12: 44.

Martínez-Rodríguez, L.; López-Sánchez, A.; García-Alcaide, A.; Govantes, F.; Gallegos, M.T. 2023. FleQ, FleN and c-di-GMP coordinately regulate cellulose production in *Pseudomonas syringae* pv. tomato DC3000. *Frontiers in Molecular Bioscience*, 10: 1155579.

Morel Revetria, M.A.; Berais-Rubio, A.; Giménez, M.; Sanjuán, J.; Signorelli, S.; Monza, J. 2023. Competitiveness and phylogenetic relationship of rhizobial strains with different symbiotic efficiency in *Trifolium repens*: conversion of parasitic into non-parasitic rhizobia by natural symbiotic gene transfer. *Biology,* 12: 243.

Sanjuán, J.; Nápoles, M.C.; Pérez-Mendoza, D.; Lorite, M.J.; Rodríguez-Navarro, D.N. 2023. Microbials for agriculture: why do they call them biostimulants when they mean probiotics? *Microorganisms,* 11: 153.

Zuber, N.E.; Fornasero, L.V.; Erdozain-Bagolín, S.A.; Lozano, M.J.; Sanjuán, J.; del Papa, M.F.; Lagares, A. 2023. Diversity, genomics and symbiotic characteristics of sinorhizobia that nodulate *Desmanthus* spp. in Northwest Argentina. *Biology,* 12: 958.



Colony morphology and cellulose production in the ΔfleN mutant. Representative colony morphology of the different strains grown in agar plates supplemented with Congo Red and Calcofluor in the presence and in the absence of pleD*. *(Martínez-Rodríguez* et al*. 2023. Frontiers in Molecular Bioscience, 10: 1155579)*

NITROGEN METABOLISM IN RHIZOSPHERIC BACTERIA

MEMBERS

Senior Researchers
Mª Jesús Delgado Igeño, *Group Leader*
Mª Socorro Mesa Banqueri

Predoctoral Researchers
Raquel Adriana Juárez Martos

Hired Researchers
Juan José Cabrera Rodríguez
Andrea Jiménez Leiva

Staff Technicians
Alba Hidalgo García
Germán Tortosa Muñoz

Hired Technicians
Sofía Guzmán García
Sara Pérez González

OVERVIEW

To gain knowledge about denitrification using the endosymbiotic bacterium *Bradyrhizobium diazoefficiens* as a model. For this purpose, the integrated study of the environmental factors, genes and enzymes involved in denitrification is contemplated, paying special interest to the identification of the transcriptional regulators of the process and the characterization of the molecular mechanisms involved. Another aim is to analyze the metagenome, including the relative abundance, functional diversity and activity of denitrifying bacteria populations in environmental samples, mainly nitrate-contaminated water and sediments. In the plant-bacteria-environment interaction, the group seeks to establish the N_2 fixation-denitrification interrelationship and to understand the processes, environmental factors and regulatory mechanisms involved in the production of the highly reactive nitric oxide (NO) and the potent greenhouse gas nitrous oxide (N_2O) by legume roots. In this context, another goal of the Group is the identification of efficient endosymbionts with high capacity to reduce N_2O. The generated knowledge will be essential for the development of strategies to reduce N_2O emissions from agricultural soils. Our group also offers knowledge transfer on the development and assessment in organic waste treatment by composting, organic and biological fertilisers (biostimulants and plant-growth promoting bacteria), and nitrogen fixation determination at both, gene expression, and nitrogenase activity.

LINES OF RESEARCH

1. Study the environmental factors, genes, and enzymes involved in the denitrification process of legume endosymbiotic bacteria.

2. Unravel the molecular mechanisms that control the expression, activity and regulation of denitrification and nitrogen fixation.

3. Analyse the molecular ecology of nitrifying and denitrifying bacteria in soils, waters and sediments contaminated with nitrates.

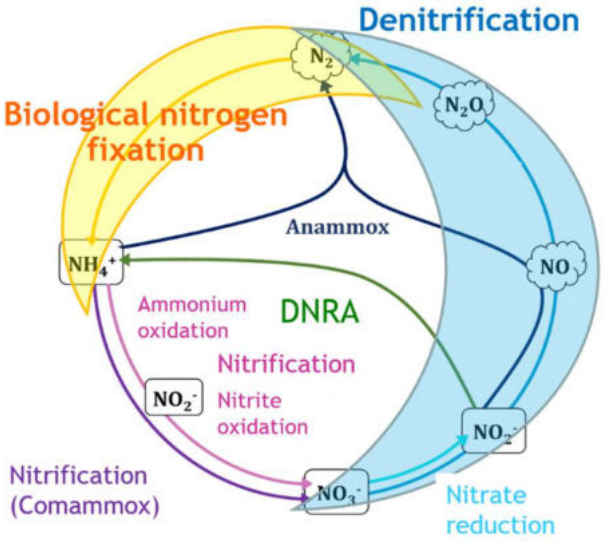
4. Determine the environmental and regulatory factors involved in reducing the emission of the greenhouse gas nitrous oxide by endosymbiotic bacteria-legumes associations.

5. Development of organic and biological fertilisers based on agricultural organic wastes composting.

MOST RELEVANT PUBLICATIONS IN 2023

Hidalgo-García, A.; Tortosa, G.; Pacheco, P.J.; Gates, A.J.; Richardson, D.J.; Bedmar, E.J.; Girard, L.; Torres, M.J.; Delgado, M.J. 2023. *Rhizobium etli* is able to emit nitrous oxide by connecting assimilatory nitrate reduction with nitrite respiration in the bacteroids of common bean nodules. *Journal of Plant Interactions,* 18: 2251511.

Pacheco, P.J.; Bedmar, E.J.; Mesa, S.; Tortosa, G.; Delgado, M.J. 2023. *Ensifer meliloti* denitrification is involved in infection effectiveness and N_2O emissions from alfalfa root nodules. *Plant and Soil,* 486: 519-534.



The Nitrogen Cycle

MYCORRHIZA

MEMBERS

Senior Researchers
Concepción Azcón González de Aguilar, *Group leader until June 2023*
Juan Antonio López Ráez, *Group leader since July 2023*
Ricardo Aroca Álvarez
Nuria Ferrol González
José Luis Garrido Sánchez
Mª José Pozo Jiménez
Juan Manuel Ruiz Lozano

Postdoctoral Researchers
Antonia Romero Munar
Olena Nesterenko

Predoctoral Researchers
Luis España Luque

Hired Researchers
Jesús Mª Bastida Alamillo
Laura Dejana
Sandra Lendínez Contreras
Javier Lidoy Logroño
María Muñoz Carrasco
Antonio Jesús Perea Martos
Jorge Prieto Rubio
Beatriz Ramírez Serrano
Andrea Ramos Molina
Zhivko Minchev Ivanov

Staff Technicians
Juan Manuel García Ramírez
Sonia Mª Molina Arias
Mª Jesús Molina Luzón
Eulogio Javier Palenzuela Jiménez
Mª Carmen Perálvarez Gutiérrez

Hired Technicians
Estefanía Berrio Pozo
Mª Dolores Hidalgo Gálvez
Olga Mª López Castillo
Ana Isabel Molina Santiago

OVERVIEW

The Group of Mycorrhiza is interested in aspects of the ecology, physiology, biochemistry, molecular biology and biotechnology of the arbuscular mycorrhizal (AM) symbiosis and AM fungi in relation to plant nutrition and health. Special attention is given to the signaling processes in AM symbioses, as well as to their role in plant protection against biotic (pathogens and pests) and abiotic (nutrient deficiency, metal toxicity, salinity and drought) stresses, as well as to the mechanisms involved in these processes. The diversity of AM fungi in natural communities and the plant-fungus interaction

networks they establish are also investigated. The final goal is to promote the rational use of mycorrhizas, in association with other soil microorganisms, with the aim of achieving sustained productivity with the minimal disturbance of the environment and in the current context of accelerated climate change.

LINES OF RESEARCH

1. Plant-AM fungi communication: Understanding the molecular signalling in the rhizosphere during the early stages of mycorrhizal colonization. The goal is to promote the establishment of AM symbiosis.

2. Mycorrhiza and nutrient transport: Understanding the molecular mechanisms involved in nutrient transport processes in AM symbioses and in the tolerance of AM plants to heavy metals.

3. Mycorrhiza and protection against osmotic stresses: Understanding the physiological and molecular mechanisms underlying the tolerance of AM plants to drought and salinity. Regulation of aquaporins by AM fungi in combination or not with other soil beneficial microorganisms.

4. Mycorrhiza and protection against biotic stresses: Understanding the molecular mechanisms by which AM fungi are able to boost plant defence responses making them more resistant/tolerant to diseases and pests.

5. Ecology of mycorrhizas and AM fungi: Studies of the diversity of AM fungi in Mediterranean environments. Factors driving AM fungal communities' assemblages. Life-history of AM fungi. Plant-fungus interaction networks and their implication in the recruitment dynamics in natural plant communities.

6. Interactions of AM fungi with other beneficial microorganisms. Multitrophic interactions. Mechanisms underlying the beneficial effects of PGPR.

MOST RELEVANT PUBLICATIONS IN 2023

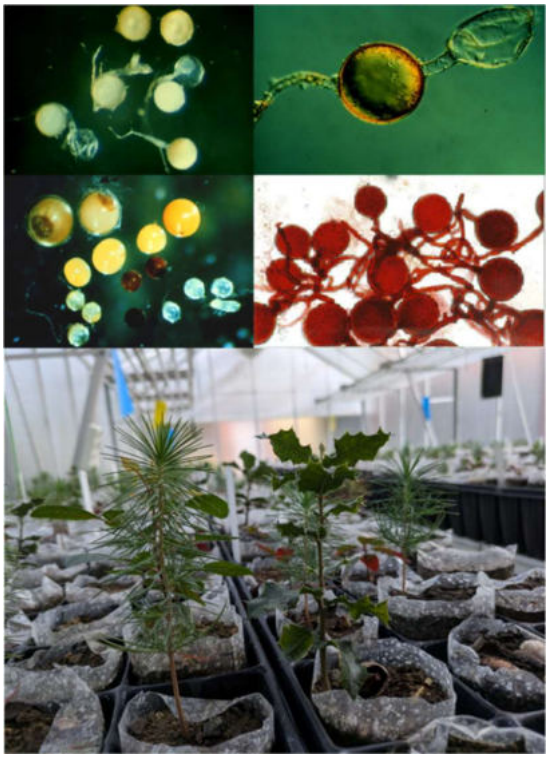
Garrido, J.L.; Alcántara, J.M.; López-García, A.; Ozuna, C.V.; Perea, A.J.; Prieto, J.; Rincón, A.; Azcón-Aguilar, C. 2023. The structure and ecological function of the interactions between plants and arbuscular mycorrhizal fungi through multilayer networks. *Functional Ecology,* 37: 2217-2230.

Lidoy, J.; Berrio, E.; García, M.; España-Luque, L.; Pozo, M.J.; López-Ráez, J.A. 2023. Flavonoids promote *Rhizophagus irregularis* spore germination and tomato root colonization: a target for sustainable agriculture. *Frontiers in Plant Science,* 13: 1094194.

Lidoy, J.; López-García, A.; Amate, C.; García, J.M.; Flors, V.; García-Garrido, J.M.; Azcón-Aguilar, C.; López-Ráez, J.A.; Pozo, M.J. 2023. Regulation of mycorrhizal colonization under stress in tomato depends on symbiotic efficiency. *Environmental and Experimental Botany,* 215: 105479.

Romero-Munar, A.; Aroca, R. 2023. A non-K^+-solubilizing PGPB (*Bacillus megaterium*) increased K^+ deprivation tolerance in *Oryza sativa* seedlings by up-regulating root K^+ transporters. *Plant Physiology and Biochemistry,* 196: 774-782.

Romero-Munar, A.; Aroca, R.; Zamarreño, A.M.; García-Mina, J.M.; Pérez-Hernández, N.; Ruiz-Lozano, J.M. 2023. Dual inoculation with Rhizophagus irregularis and *Bacillus megaterium* improves maize tolerance to combined drought and high temperature stress by enhancing root hydraulics, photosynthesis and hormonal responses. *International Journal of Molecular Sciences,* 24: 5193.



Establishment and maintenance of the germplasm bank of arbuscular mycorrhizal (AM) fungi. Bank consisting of more than 200 isolates, characterized molecularly and morphologically

DEPARTMENT OF PHYSIOLOGY AND BIOCHEMISTRY OF THE ANIMAL NUTRITION

ANIMAL NUTRITION

MEMBERS

Senior Researchers
Rosa Mª Nieto Liñán, *Group Leader*
Ignacio Fernández-Fígares Ibáñez
Manuel Lachica López
Isabel Seiquer Gómez-Pavón

Postdoctoral Researchers
Consolación García Contreras

Predoctoral Researchers
Andreea Roman

Staff Technicians
Alfonso Bartolomé García Écija

Hired Technicians
Miguel Ángel Liñán Fernández
Jesús Nieto Chica
Laura Rodríguez Jiménez

Department Hired Technicians
Alberto Carrera Henke
Ana Mª Haro García

OVERVIEW

The activity of the Group is focused on the study of energy and nutrient utilization in non-ruminant animals, and on the identification of processes and specific compounds involved in the metabolic response to feed intake, including bioaccesibility and bioavailability of nutrients (amino acids, minerals, antioxidant compounds, etc.) using *in vitro*, *ex vivo* and *in vivo* techniques.

The research activity is nowadays focused on pigs, mainly on native breeds (Iberian pig), known to have a wide genetic variation and high adaptability to local production systems. These breeds yield high-quality products with regional identity and highly appreciated by consumers, an aspect also covered by current research activities. However, autochthonous breeds show comparatively lower productivity than the modern, high yielding, commercial breeds. In this way, a contribution to the preservation and development of the diversity of local breeds will also be achieved. On the other hand, the efficiency of livestock production systems will be optimized by accurately defining the nutritional requirements of these local breeds and by increasing the quality and nutritional value of their products, while decreasing the environmental footprint associated. Whenever possible, local feeding resources and by-products will be involved in practical feeding and production systems. The

effects of climate change, particularly, heat stress effects on productive and physiological traits of Iberian pigs is currently under investigation.

LINES OF RESEARCH

1. Use of local feeding resources and agroindustrial by-products as ingredients in practical balanced diets for swine.

2. Impact of heat stress on physiology and productivity of pigs and nutritional strategies to mitigate its detrimental effects.

3. Effects and mechanism of action of substances with biological activity naturally present in feedstuffs or incorporated. Focus on additives which may alter the efficiency of nutrient utilization and the quality and healthy properties of animal products.

4. Effects of innovative management practices on productivity, animal welfare and product quality of local porcine breeds.

5. Nutritional and organoleptic evaluation of pig meat under different nutritional management and environmental challenges.

6. Evaluation of bioactive compounds in foods and effects of the digestive process on antioxidant properties and nutrient bioavailability.

MOST RELEVANT PUBLICATIONS IN 2023

Fernández-Fígares, I.; Haro, A.; Lachica, M.; Lara, L.; Seiquer, I.; Nieto, R. 2023. Metabolic profile of growing immune- and surgically castrated Iberian pigs fed diets of different amino acid concentration. *Animals,* 13: 2650.

Fernández-Fígares, I.; Sartin, J.L.; Pinotti, L. 2023. Editorial: 7th ISEP: present and future challenges in energy and protein metabolism and their implication in animal nutrition. *Animal,* 17: 100922.

Lachica, M.; Rodríguez-López, J.M.; González-Valero, L.; Fernández-Fígares, I. 2023. Net portal appearance of amino acids in Iberian and Landrace Pigs fed different protein content in the diet. *Animals,* 13: 1263.

Pardo, Z.; Lara, L.; Nieto, R.; Fernández-Fígares, I.; Seiquer, I. 2023. Muscle quality traits and oxidative status of Iberian pigs supplemented with zinc and betaine under heat stress. *Meat Science,* 198: 109119.

Parrini, S.; Sirtori, F.; Čandek-Potokar, M.; Charneca, R.; Crovetti, A.; Kušec, I.D.; Sánchez, E.G.; Cebrián, M.M.I.; Haro García, A.; Karolyi, D.; Lebret, B.; Ortiz, A.; Panella-Riera, N.; Petig, M.; Jesus da Costa Pires, P.; Tejerina, D.; Razmaite, V.; Aquilani, C.; Bozzi, R. 2023. Prediction of fatty acid composition in intact and minced fat of European autochthonous pigs breeds by near infrared spectroscopy. *Scientific Reports,* 13: 7874.

From the Mediterranean "dehesa" to the EEZ, working in farm and laboratory experiments

NUTRITION, GASTROINTESTINAL HEALTH AND FOOD SAFETY

MEMBERS

Senior Researchers
Alfonso Clemente Gimeno, *Group Leader*
Cristina Delgado Andrade
Raquel Olías Sánchez
Luis Ángel Rubio San Millán

Hired Researchers
Ana Mª Haro García
Mª Carmen Marín Manzano

Staff Technicians
Antonia Felipe Reyes

Hired Technicians
Gloria González Cañas
María Padial de Jáudenes

OVERVIEW

The research activity of the Group Gastrointestinal Health and Food Safety focuses on the study of aspects such as the digestive and metabolic use of nutrients, and the physiological effects at the local (intestine) or systemic level of food chemical fractions (proteins, carbohydrates, fibre, etc.). Through a multidisciplinary approach, special attention is paid to the study of the mechanisms of action and biological effects, both nutritional and/or non-nutritional, of active substances either present in food or added to the diet.

LINES OF RESEARCH

1. Nutritional value, biological effects and digestive behaviour of legume food proteins (peas, chickpeas, lentils, among others) and bioactive derived-compounds (e.g., protease inhibitors, oligosaccharides) involved in the prevention of inflammatory and carcinogenic processes within the gastrointestinal tract.

2. Investigation of the relationships between protein structure-functionality, digestibility, antigenicity and bioaccessibility of processing contaminants using in *vitro* digestion models. Studies of colonic fermentation of carbohydrates and survival of prebiotic compounds and probiotic strains.

3. Correlation between variations in the composition of the digestive microbiota and specific physiological, health and productive parameters in productive birds (broilers).

4. Evaluation of the prebiotic potential of oligosaccharides of different origin, both natural and from enzymatic synthesis, and their biological activities.

5. Developing mathematical models (R programming) able to simulate intestinal bacterial growth.

MOST RELEVANT PUBLICATIONS IN 2023

Olías, R.; Delgado-Andrade, C.; Padial, M.; Marín-Manzano, M.C.; Clemente, A. 2023. An updated review of soy-derived beverages: nutrition, processing, and bioactivity. *Foods,* 12: 2665.

Olías, R.; Rayner, T.; Clemente, A.; Domoney, C. 2023. Combination of three null mutations affecting seed protein accumulation in pea (*Pisum sativum* L.) impacts positively on digestibility. *Food Research International,* 169: 112825.

González-Mulero, L.; Mesías, M.; Morales, F.J.; Navajas-Porras, B.; Rufián-Henares, J.A.; Delgado-Andrade, C. 2023. Acrylamide bioaccessibility in potato and veggie chips. Impact of *in vitro* colonic fermentation on the non-bioaccessible fraction. *Food Research International*, 164: 112409.

González-Mulero, L.; Delgado-Andrade, C.; Morales, F.J.; Mesías, M. 2023. Dietary exposure to acrylamide in Spanish university canteens by the duplicate diet method. *Foods*, 12: 4263.

González-Mulero, L.; Delgado-Andrade, C.; Morales, F.J.; Mesías, M. 2023. Assessment of dietary acrylamide exposure in children attending Spanish school canteens using the duplicate diet method. *Food and Chemical Toxicology*, 181: 114066.

Food matrices investigated during the development of different projects of the research team

SUSTAINABLE PRODUCTION OF RUMINANTS

MEMBERS

Senior Researchers
David R. Yáñez Ruiz, *Group Leader*
A. Ignacio Martín García

Postdoctoral Researchers
Eva Ramos Morales
Mª Inés Rivelli Bixquert
Manuel Romero Huelva

Predoctoral Researchers
Mahmoud Hassan Abdelnabi Moham Hassan
Pedro Jesús Romero Márquez
Eva Mª Romero Recio

Hired Researchers
Verónica Verdejo Patón

Staff Technicians
Tamara García Leal
Isabel Mª Jiménez Romero

Hired Technicians
Lesly Arbesu Fernández
Aharón Gómez Mesonero
Elisabeth Jiménez Jiménez
Noemí Pino López

OVERVIEW

The research Group work in these four main areas:

1. Study of nutritional interventions to improve ruminal fermentation and in particular the reduction of methane emission in ruminants. This area of work includes a range of *in vitro* and *in vivo* techniques to screen and test feed additives of different nature.

2. Development and use of molecular techniques for the knowledge and manipulation of the rumen microbial ecosystem, specifically the reduction of enteric methane production.

3. Assessment of agro-industrial by-products as an alternative feed for sheep and goats feeding. The studies carried out in this area have allowed us to know in more detail the use of by-products derived from the olive industry and greenhouse agriculture, with practical proposals for employment in the dairy goats and sheep sectors.

4. Sustainability assessment of different livestock production systems, with special emphasis on overall GHG emissions and animal welfare in relation to young animals until weaning and heat stress events.

LINES OF RESEARCH

1. Environmental impact of livestock production.

2. Modulation of the rumen microbial fermentation.

3. Animal welfare.

MOST RELEVANT PUBLICATIONS IN 2023

Belanche, A.; Hristov, A.N.; van Lingen, H.J.; Denman, S.E.; Kebreab, E.; Schwarm, A.; Kreuzer, M.; Niu, M.; Eugène, M.; Niderkorn, V.; Martin, C.; Archimède, H.; McGee, M.; Reynolds, C.K.; Crompton, L.A.; Bayat, A.R.; Yu, Z.; Bannink, A.; Dijkstra, J.; Chaves, A.V.; Clark, H.; Muetzel, S.; Lind, V.; Moorby, J.M.; Rooke, J.A.; Aubry, A.; Antezana, W.; Wang, M.; Hegarty, R.; Hutton Oddy, V.; Hill, J.; Vercoe, P.E.; Savian, J.V.; Abdalla, A.L.; Soltan, Y.A.; Gomes Monteiro, A.L.; Ku-Vera, J.C.; Jaurena, G.; Gómez-Bravo, C.A.; Mayorga, O.L.; Congio, G.F.S.; Yáñez-Ruiz, D.R. 2023. Prediction of enteric methane emissions by sheep using an intercontinental database. *Journal of Cleaner Production,* 384: 135523.

Palma-Hidalgo, J.M.; Belanche, A.; Jiménez, E.; Newbold, C.J.; Denman, S.E.; Yáñez-Ruiz, D.R. 2023. Multi-omics *in vitro* study of the salivary modulation of the goat rumen microbiome. *Animal,* 17: 100895.

Romero, P.; Belanche, A.; Jiménez, E.; Hueso, R.; Ramos-Morales, E.; Salwen, J.K.; Kebreab, E.; Yáñez-Ruiz, D.R. 2023. Rumen microbial degradation of bromoform from red seaweed (*Asparagopsis taxiformis*) and the impact on rumen fermentation and methanogenic archaea. *Journal of Animal Science and Biotechnology,* 14: 133.

Romero, P.; Huang, R.; Jiménez, E.; Palma-Hidalgo, J.M.; Ungerfeld, E.M.; Popova, M.; Morgavi, D.P.; Belanche, A.; Yáñez-Ruiz, D.R. 2023. Evaluating the effect of phenolic compounds as hydrogen acceptors when ruminal methanogenesis is inhibited *in vitro* - Part 2. Dairy goats. *Animal,* 17: 100789.

Zhang, B.; Lin, S.; Moraes, L.; Firkins, J.; Hristov, A.N.; Kebreab, E.; Janssen, P.H.; Bannink, A.; Bayat, A.R.; Crompton, L.A.; Dijkstra, J.; Eugène, M.A.; Kreuzer, M.; McGee, M.; Reynolds, C.K.; Schwarm, A.; Yáñez-Ruiz, D.R.; Yu, Z. 2023. Methane prediction equations including genera of rumen bacteria as predictor variables improve prediction accuracy. *Scientific Reports,* 13: 21305.

Study of resilience in extensive livestock systems

R&D&I ASSOCIATED UNITS

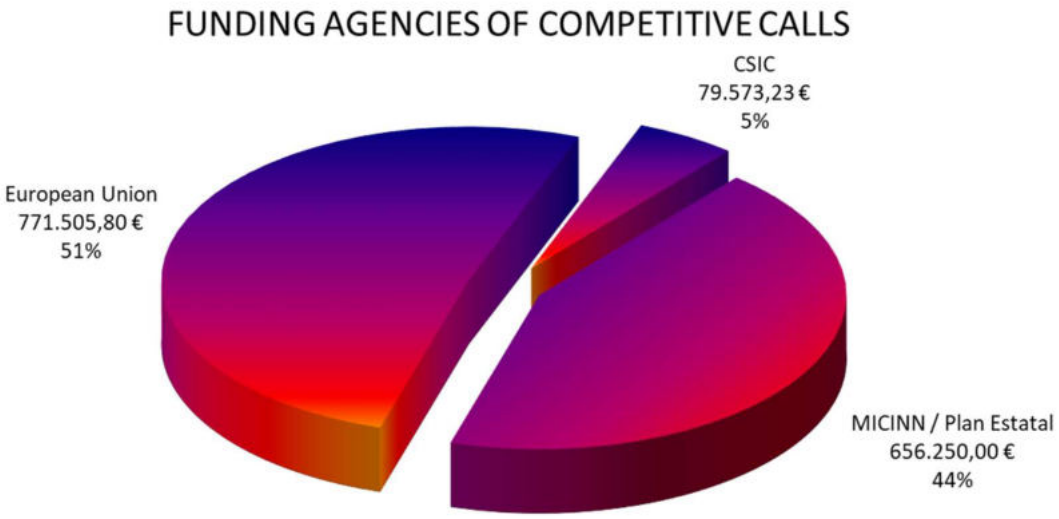
Cell Signaling and Metabolic Integration. 2014-2027. Group of Metabolic Integration and Cell Signaling, Department of Agricultural Sciences, Jaume I University, Castellón, PI: Víctor Flors Herrero. Group of Mycorrhiza, EEZ-CSIC, PI: Mª José Pozo Jiménez.

Plant Phenotyping by Imaging Techniques and Studies of Stomata Development for Stress Analysis. 2018-2024. Group of Biotechnology and Plant Molecular Biology, University of Castilla-La Mancha, PI: Carmen Fenoll Comes. Group of Redox Regulation, Sugar Signaling and Plant Phenotyping by Imaging Techniques for Stress Detection, EEZ-CSIC, PI: Matilde Barón Ayala.

Soil Bioremediation. 2020-2026. Department Soil Science and Agricultural Chemistry, University of Granada, PI: Fco. José Martín Peinado. Group of Biofertilization and Biodegradation by Rhizospheric Fungi, EEZ-CSIC, PI: Inmaculada García Romera.

FUNDING 2023

TOTAL INCOME 2023	**3.514.244,12 €**
Administrative Budget	799.171,00 €
Services Revenues	30.963,91 €
Investments & Special Actions (Buildings, constructions, etc.)	414.490,68 €
Competitive Calls Incomes	1.507.329,03 €
Contracts & Agreements Incomes	762.289,50 €



(Sources: PCO2023 and Sorolla)

ONGOING RESEARCH PROJECTS DURING 2023

NATIONAL PROJECTS

SPANISH R&D PLAN (PLAN ESTATAL MICINN)

A GRAS TFs network plays an essential role in transcriptional reprogramming for arbuscule homeostasis and mycorrhizal autoregulation (AOM) in tomato. Generación del Conocimiento (PID2020-115336GB-I00). PI: José Manuel García Garrido. 2021-2024.

Bacterial microaerophilic production of value added polymers from wastes and pollutants. Physiology, regulation and maximisation. Retos de la Sociedad (PID2020-113144RB-I00). PI: Silvia Marqués Martín. 2021-2024.

Bacterial reverse transcriptases and their associated systems as engines for biotechnology. Generación del Conocimiento (PID2020-113207GB-I00). PIs: Nicolás Toro García, Francisco Martínez-Abarca Pastor. 2021-2024.

Biofilms and colonization of plants by beneficial and pathogenic bacteria: Environmental and metabolic signals, regulation by c-di-GMP and relevance to plant protection. Generación de Conocimiento (PID2019-109372GB-I00). PIs: Manuel Espinosa Urgel, Mª Isabel Ramos González. 2020-2023.

Bioremediation in sustainable architecture. Transición Ecológica y Digital (TED2021-129398B-I00). PI: Ana Segura Carnicero, Pieter van Dillewijn. 2022-2024.

Boosting the use of nanocellulose for the development of new sustainable materials in cosmetics, biofertilizers and bioplastics applications. Líneas Estratégicas (PLEC2021-008210). PI: Silvia Marqués Martín. 2021-2024.

Closing the gap for the industrial production of bacterial nanocellulose from wastes: upscaling and profitability analysis for the development of market products. Pruebas de Concepto (PDC2021-121193-I00). PI: Silvia Marqués Martín. 2021-2023.

Combating the human pathogen *Pseudomonas aeruginosa* through inhibition of sigmaECF-mediated signalling. Generación del Conocimiento (PID2020-115682GB-I00). PI: Mª Antonia Llamas Lorente. 2021-2024.

Combined approaches to evaluate nutrient bioavailability and functionality of infant formula enriched with human milk oligosaccharides (HMOs). Generación del Conocimiento (PID2021-126101OB-I00). PIs: Alfonso Clemente Gimeno, Cristina Delgado Andrade. 2022-2026.

Computer vision and artificial intelligence analysis for the high-throughput phenotyping of botrytised plants and fruits of economic importance. Generación de Conocimiento (PID2022-139733OB-I00). PIs: Matilde Barón Ayala, Mónica Pineda Dorado. 2023-2026.

Cross-regulation insights of nitrogen fixation and denitrification in the soybean endosymbiont and model organism *Bradyrhizobium diazoefficiens*. Generación del Conocimiento (PID2020-114330GB-I00). PI: Mª Socorro Mesa Banqueri. 2021-2024.

Deciphering the rhizobial volatilome and the molecular bases underlying its emission and infochemical activity. Generación del Conocimiento (PID2021-123540NB-I00). PI: Mª José Soto Misffut. 2022-2025.

Directed evolution of improved microbial consortia for biocontrol of Fusarium wilt of banana in the Canary Islands. Líneas Estratégicas (PLEC2021-007777). CSIC PI: Jesús Mercado Blanco,

Coordinator: Antonio di Pietro (University of Cordoba). 2021-2024.

Exploitation of aquaporins and phytohormones for the improvement of root water transport by soil beneficial microorganisms under a scenario of drought and climate change. Retos de la Sociedad (PID2020-112816RB-I00). PIs: Juan Manuel Ruiz Lozano, Ricardo Aroca Álvarez. 2021-2024.

Extremophile enzymes for the agri-food sector. Generación del Conocimiento (PID2021-123469OB-I00). PI: Juan Luis Ramos Martín, Estrella Duque Martín de Oliva. 2022-2025.

Filling gaps in the peroxisome-organelles crosstalk and in the peroxisome-dependent signalling mechanisms. Generación del Conocimiento (PID2021-122280NB-I00). PIs: María C. Romero Puertas, Luisa M. Sandalio González. 2022-2025.

Functional analysis of candidate genes encoding Na^+ and Cl^- transporters included in QTL intervals of salt tolerance. Generación del Conocimiento (PID2021-124599OB-I00). PI: Andrés Belver Cano. 2022-2025.

Functional involvement of nitric oxide, hydrogen sulfide and antioxidants in pepper fruit ripening and quality. Generación del Conocimiento (PID2019-103924GB-I00). PIs: F. Javier Corpas Aguirre, José Manuel Palma Martínez. 2020-2024.

Fundamental and applied features of c-di-GMP regulation in beneficial plant-associated bacteria. Generación del Conocimiento (PID2022-140168NB-I00). PIs: Juan Sanjuán Pinilla, Daniel Pérez Mendoza. 2023-2026.

Heat stress in lactating Iberian sows: physiological and productive effects and nutritional mitigation strategies. Generación del Conocimiento (PID2021-125059OB-I00). PIs: Rosa Mª Nieto Liñán, Ignacio Fernández-Fígares Ibáñez. 2022-2026.

Identifying priming fingerprints in mycorrhiza-induced resistance against *Tuta absoluta*. Generación del Conocimiento (PID2021-124813OB-C31). PIs: Mª José Pozo Jiménez, Juan Antonio López Ráez. 2022-2025.

Improvement of the antioxidant capacity and nutraceutical value of pepper through the combined use of metabolomic and genetic approaches. Colaboración Público-Privada (CPP2021-008703). PI: José Manuel Palma Martínez. 2022-2025.

Integration of redox and sugar signalling through the photosynthetic ndh complex and uncovering new players in the regulation of plastid processes. Generación del Conocimiento (PID2021-125913NB-C22). PI: Mariam Sahrawy Barragán, Antonio Serrato Recio. 2022-2025.

Intra- and inter-kingdom signalling during rhizoremediation. Generación del Conocimiento (PID2020-116766GB-I00). PI: Ana Segura Carnicero. 2021-2024.

Iron homeostasis in arbuscular mycorrhiza. Generación del Conocimiento (PID2021-125521OB-I00). PI: Nuria Ferrol González. 2022-2025.

Mechanisms of auxin recognition by plant-associated beneficial bacteria. Generación del Conocimiento (PID2019-103972GA-I00). PI: Miguel A. Matilla Vázquez. 2020-2023.

Mechanisms of plant-soil feedback: contribution of different components of soil microbiota, soil reconditioning by plants and mycorrhizal types across climatic gradients. Generación de Conocimiento (PID2022-140086NB-C21). PI: José Luis Garrido Sánchez. 2023-2026.

New method for the detection and identification of pathogens in early stages of infection of crops of agro-industrial interest. Colaboración Público-Privada (CPP2021-008989). PI: José Carlos Jiménez López. 2022-2025.

Non-coding transcriptome and RNA regulation of symbiotic metabolism in nitrogen-fixing rhizobia. Generación del Conocimiento (PID2020-114782GB-I00). PI: José Ignacio Jiménez Zurdo. 2021-2024.

Novel bacterial polymers: exploiting the green commons. Transición Ecológica y Digital (TED2021-129640B-I00). PIs: Daniel Pérez Mendoza, Juan Sanjuán Pinilla. 2022-2024.

Nutritional strategies for a more efficient and sustainable management of dairy goat replacement. Retos de la Sociedad (PID2020-119746RB-I00). PIs: A. Ignacio Martín García, David R. Yáñez Ruiz. 2021-2024.

Oxidative and fatty acid-mediated post-translational modifications in pollen, and their role in plant reproduction. Generación del Conocimiento (PID2020-113324GB-I00). PIs: Juan de Dios Alché Ramírez, Antonio J. Castro López. 2021-2025.

Phenological, physiological and transcriptomic assessment of olive resilience in cultivars with differential sensitivity to salt stress. Transición Ecológica y Digital (TED2021-130015B-C22). PI: Juan de Dios Alché Ramírez, Andrés Belver Cano. 2022-2024.

Role of the Gac-Rsm pathway in the virulence of *Pseudomonas syringae* against tomato. Generación del Conocimiento (PID2021-122418NB-I00). PI: M. Trinidad Gallegos Fernández. 2022-2025.

Second generation approaches for the biological production of petrochemicals. Transición Ecológica y Digital (TED2021-129632B-I00). PI: Juan Luis Ramos Martín. 2022-2024.

Signaling circuits and multicellular strategies in bacteria of biotechnological interest. Generación del Conocimiento (PID2022-141962NB-I00). PIs: Mª Isabel Ramos González, Manuel Espinosa Urgel. 2023-2026.

Study of proton linked ion transport at the chloroplast envelope. Generación del Conocimiento (PID2019-105260GB-I00). PIs: Kees Venema, Mª Pilar Rodríguez Rosales. 2020-2024.

Sustainable legumes food production and mitigation of greenhouse gas emissions. Generación del Conocimiento (PID2021-124007OB-I00). PI: M. Jesús Delgado Igeño. 2022-2025.

The challenge of restoring, monitoring and valorizing biodiversity: above and belowground diversity, fuel load and ES in Mediterranean mountains managed with pyric herbivorism. Retos de la Sociedad (PID2020-116786RB-C32). PIs: Emilio Benítez León, Ana Belén Robles Cruz. 2021-2025.

The olive holobiont: linking plant microbiome and host tolerance to biotic and abiotic stresses. Retos de la Sociedad (PID2019-106283RB-I00). PIs: Manuel Fernández López, Jesús Mercado Blanco. 2020-2024.

Understanding chemoreceptor function in bacterial pathogens. Generación del Conocimiento (PID2020-112612GB-I00). PI: Tino Krell. 2021-2024.

Validating and monitoring Mycorrhiza Induced Resistance in Agronomic contexts (MIRFIELD). Prueba de concepto (PDC2022-133600-C21). PIs: Mª José Pozo Jiménez, Juan Antonio López Ráez. 2022-2025.

Valorization of hydrothermal carbonization products as new advanced and environmentally safe materials for remove organic contaminants from water. Retos de la Sociedad (PID2020-116210RB-I00). PI: Esperanza Romero Taboada. 2021-2024.

JUNTA DE ANDALUCÍA

Adaptation and evolutionary mechanisms of rhizobacteria as a basis for improving plant growth under stress conditions (RIZOS3). Proyectos de Generación de Conocimiento (P21_00293/CA20251). PI: Manuel Espinosa Urgel. Participating researcher: Mª Isabel Ramos González. 2022-2025.

Bioremediation of herbicide-contaminated soils with saprophytic fungi for the enhancement of biological nitrogen fixation by legumes. Retos de la Sociedad Andaluza (B-AGR-152-UGR20). PIs: Inmaculada García Romera, Miguel López Gómez (UGR). 2022-2023.

Characterization of the olive biodiversity of the PDO "Poniente de Granada" for its conservation and valorization. Proyectos de Interés Colaborativo-RIS3 Andalucía. PI: Juan de Dios Alché Ramírez. 2022-2023.

Effects of the Rhizobium volatilome on plants: growth, stress resistance and the associated microbiome. Proyectos de Generación de Conocimiento Frontera (PY20_00225/CA17213). PI: Mª José Soto Misffut. 2021-2022.

Identification and characterization of compounds from pepper fruits with anti-tumoral activity. Proyectos de Generación de Conocimiento Frontera (P18-FR-1359/CA11098). PIs: José Manuel Palma Martínez, F. Javier Corpas Aguirre. 2020-2023.

Identification and characterization of olive seeds components of interest for the agri-food industry and with healthy properties. Proyectos de Investigación orientados a los Retos de la Sociedad Andaluza (P18-RT-1577/CA11203). PIs: Juan de Dios Alché Ramírez, Antonio Jesús Castro López. 2020-2023.

Impact of cyclic diguanylate on the PTM proteome (PTMome) of *Rhizobium etli*. Proyectos de Generación de Conocimiento (P21_00464/CA20247). PIs: Juan Sanjuán Pinilla, Daniel Pérez Mendoza. 2022-2025.

Improving arbuscular mycorrhizal symbiosis by enhancing plant-fungus communication: from the lab to the field. Proyectos de Investigación orientados a los Retos de la Sociedad Andaluza (P20_00400/CA17185). PI: Juan Antonio López Ráez. 2021-2023.

Integrated study of mechanisms affecting greenhouse gas production by legume endosymbiotic bacteria. Proyectos de Investigación orientados a los Retos de la Sociedad Andaluza (P18-RT-1401/CA11207). PIs: Mª Jesús Delgado Igeño, Mª Socorro Mesa Banqueri. 2020-2023.

Ion homeostasis and metal toxicity: regulation by reactive oxygen species and autophagy. Proyectos de Generación de Conocimiento Frontera (PY20_00364/CA17214). PI: Luisa Mª Sandalio González. 2021-2023.

New strategies to enhance the biological control of plagues in olive trees. Proyectos de Investigación orientados a los Retos de la Sociedad Andaluza (PY20_00139/CA17181). PI: Emilio Benítez León. 2021-2022.

Nutritional properties, bioaccessibility and functionality of new legume-derived foods. Proyectos de Investigación orientados a los Retos de la Sociedad Andaluza (PY20_00242/CA17182). PI: Alfonso Clemente Gimeno. 2021-2023.

Opening new frontiers in RNA targeting: unique reverse transcriptases-encoding type III and type VI CRISPR-Cas systems. Proyectos de Generación de Conocimiento Frontera (PY20_0047/CA17210). PI: Nicolás Toro García. 2021-2023.

Physiological and functional studies of the activity of symbiotic GRAS transcription factors: effects on the development of arbuscular mycorrhiza in tomato. Proyectos de Investigación orientados a los Retos de la Sociedad Andaluza (PY20_00362/CA17184). PI: José Manuel García Garrido. 2021-2023.

Redox molecular basis for sugar production and stress tolerance in plants. Proyectos de Generación de Conocimiento Frontera (PY20_00401/CA17215). PI: Mariam Sahrawy Barragán. 2021-2023.

RNA regulation of nodulation and nitrogen fixation in legume symbionts of agronomic interest. Proyectos de Generación de Conocimiento Frontera (PY20_00185/CA17996). PI: José Ignacio Jiménez

Zurdo. 2021-2023.

CSIC

Biofilms and colonization of plants by beneficial and pathogenic bacteria: environmental and metabolic signals, c-di-GMP regulation, and relevance for plant protection. Ayudas Extraordinarias para Preparación de Proyectos 2023 (2023AEP004, Project PID2019-109372GB-I00). PIs: Manuel Espinosa Urgel, Mª Isabel Ramos González. 2023.

Deciphering the role of C178 in the 170's loop of the plastidial fructose-1,6-bisphosphatase. Proyecto Intramural (202240E153). PI: Mariam Sahrawy Barragán. 2022-2024.

Intercropping of nitrogen-fixing legumes for the sustainable and profitable rehabilitation of national cocoa plantations in Ecuador, Bolivia and Ghana. Programa CSIC de Cooperación Científico para el Desarrollo I-COOP 2021 (COOPB20592). PI: Juan Sanjuán Pinilla. 2022-2023.

Mechanisms of auxin sensing in beneficial plant-associated bacteria. Ayudas Extraordinarias para Preparación de Proyectos 2023 (2023AEP002, Project PID2019-103972GA-I00). PI: Miguel A. Matilla Vázquez. 2023.

Novel bacterial biopolymers activated by c-di-GMP. Proyecto Intramural Especial-Incorporación CT (202240I052). PI: Daniel Pérez Mendoza. 2022-2023.

Pastoralism and environment. Proyecto Intramural (202140E014). PI: Ana Belén Robles Cruz. 2021-2024.

Phenotyping of plant-pathogen interactions under different climate change scenarios. Proyecto Intramural (202340E012). PI: Matilde Barón Ayala. 2023.

Study of legume seed proteins as a basis for the development of a functional food and its health benefits. Intramural Especial - Incorporación CT. PI: José Carlos Jiménez López. 2022-2023.

OTHER NATIONAL PROJECTS

Bacterial nanocellulose production from waste and greenhouse gases: CO_2 capture, waste recycling and market product development. Programa COMTE-Innovación 2022, Fundación General CSIC. Programa COMTE (BNCO2). PI: Silvia Marqués Martín. 2023-2024.

Microbial ecology for agricultural improvement. Ayudas Ramón y Cajal (RYC2022-038499-I). PI: Álvaro López García. 2024-2029.

Regional development models on pyric herbivory, a tool for environmental conservation and population fixation and protection (COMPÁS). Fundación Biodiversidad, Ministerio Transición Ecológica (202142008). Andalusia subproject PI: Ana Belén Robles. 2022-2025.

NATIONAL EXTERNAL PROJECTS

Biocompost and cover crops: linking soil health, circular economy and profitability in Mediterranean organic farming. Proyectos de Transición Ecológica y Digital 2021 (TED2021-131346B-I00): PI: Engracia Madejón, IRNAS-CSIC. Participant of the EEZ: Emilio Benítez León. 2022-2024.

Characterisation of chloride homeostasis in plants: Interaction with nitrate, regulatory mechanisms and agronomic applications. Retos de la Sociedad (PID2021-125157OB-I00). IP: José M. Colmenero-Flores (IRNAS-CSIC). Participant of the EEZ: Miguel A. Rosales Villegas. 2022- 2025.

Development of a prognostic and predictive model of response to treatment in colorectal cancer based on the immunological context of the tumor. Acción Estratégica en Salud - Proyectos de Investigación en Salud 2021, Instituto de Salud Carlos III (PI21/01378). PIs: Josefa León López, Ángel Carazo Gallego, Instituto de Investigación Biosanitaria de Granada. Participants of the EEZ: José Carlos Jiménez López. 2022-2024.

Differential markers of organic extra virgin olive oils: physicochemical and sensometric characterization of oils from the main Andalusian varieties. Junta de Andalucía/University of Seville (US-1380836). PI: Raquel María Callejón Fernández, University of Seville. Participants of the EEZ: Eduardo López-Huertas León. 2022-2023.

Green extraction and encapsulation applied to the integrative circular economy for the revaluation of by-products from the olive and fruit and vegetable agri-food industry. Proyectos de Transición Ecológica y Digital 2021 (TED2021-132489A-I00). PI: Jesús Lozano, University of Granada. Participants of the EEZ: Isabel Seiquer Gómez-Pavón. 2022-2024.

Integration of a biomarker screening system into a commercial miRNA analysis device. Characterization of miRNA profiles as tumor phenotype markers and development of a predictive model of treatment response in colorectal cancer. Proyectos de Investigación e Innovación de Colaboración Público-Privada 2021, Consejería de Salud y Consumo, Junta de Andalucía (PIP-0236-2021). PIs: Ángel Carazo Gallego, Dolores Quintero Fuentes, Instituto de Investigación Biosanitaria de Granada, and Hospital San Cecilio. Participant of the EEZ: José Carlos Jiménez López. 2021-2023.

Lifestyle switch regulation in *Pseudomonas syringae* and its implications for plant infection. Ayuda I+D+I del Plan Andaluz de Investigación, Desarrollo e Innovación (P20_00834). PI: Fernando M. Govantes Romero, Pablo de Olavide University, Seville. Participants of the EEZ: Mª Trinidad Gallegos Fernández. 2021-2022.

Plant-based nutraceuticals and high-intensity exercise: treatment of obesity and associated metabolic disorders. Programa Operativo FEDER Andalucía 2014-2020 (AGR-662-UGR20), University of Granada and CSIC. PIs: Jesús María Porres Foulquié, María López-Jurado Romero de la Cruz, University of Granada. 2022-2023. Participants of the EEZ: Ignacio Fernández-Fígares Ibáñez, Manuel Lachica López.

INTERNATIONAL PROJECTS

CSIC BILATERAL PROJECTS

Application of silicon as a stimulator of rice response to abiotic and biotic stresses. Programa CSIC de Cooperación Científico para el Desarrollo I-COOP 2021 (COOPB20593). PI: José Manuel Palma Martínez. 2022-2023.

Improving soil quality: role of chemical signaling in mycorrhizal interactions in agriculturally important crops. Programa LINCGLOBAL2022 CSIC para la Interacción entre Investigadores Iberoamericanos y Españoles en el Ámbito del Cambio Global (INCGL20025). PI: Juan Antonio López Ráez. 2022-2024.

Role of oxylipins and metabolic reprograming in improved stress tolerance in mycorrhizal plants. Programa CSIC de Cooperación Científica con Ucrania (UCRAN20065). PI: Mª José Pozo Jiménez. 2022-2024.

Understanding salinity response in *Arabidopsis thaliana: the role of peroxisomal glycolate oxidase.* Programa CSIC de Cooperación Científico para el Desarrollo I-COOP 2021 (COOPA20471). PI: Luisa M. Sandalio González. 2022-2023.

EUROPEAN & INTERNATIONAL PROJECTS

Epigenetic control of nitrous oxide emission by denitrifying bacteria. BBSRC (BB/S008942/1). PIs: Andrew J. Gates, David J. Richardson, University of East Anglia, Norwich, United Kingdom. Participant of the EEZ: Mª Jesús Delgado Igeño. 2019-2023.

Facilitating Innovations for Resilient Livestock Farming Systems (Re-Livestock). European Project (HORIZON-CL6-2021-CLIMATE-01/101059609). Coordinator: David R. Yáñez Ruiz. Other PIs: Rosa Mª Nieto Liñán, Ignacio Fernández-Fígares Ibáñez. 2022-2027.

FERTI & GROW Academy. Erasmus+ KA220-VET (2023-1-FR01-KA220-VET-00015464). PI: Germán Tortosa Muñoz. 2023-2025.

Gestionando la vida en el suelo mediante los abonos verdes para promover seguridad alimentaria y producción sostenible de cosechas de agro-exportación. CONCYTEC, PROCIENCIA, Gobierno de Perú (PE501079087-2022). Coordinators: Manuel Fernández López, Gregorio J. Arone, National University of Barranca, Perú. 2022-2023.

Improvement of agricultural production with lower nitrous oxide emissions. Call 2020 Fontagro: Innovations for the sustainable increase of agricultural productivity in Latin America and the Caribbean in the context of climate change (ID 30/ATN-RF-18786-RG). PI: Nicolás Ayub, National Institute of Agricultural Technology (Argentina). Participants of the EEZ: Juan Sanjuán Pinilla, Mª Jesús Delgado Igeño. 2021-2023.

Improvement of symbiotic nitrogen fixation by modulating NO formation in soybean nodules. Japan Society for the Promotion of Science (JSPS, Japan). PI: Toshiki Uchiumi**,** University of Kakoshima, Japan**.** Participants of the EEZ: Mª Jesús Delgado Igeño. 2020-2023.

Integrated Crop-Ruminant Livestock Systems as a Strategy to increase Nutrient Circularity and promote Sustainability in the Context of Climate Change. AEI/MICINN Proyectos Colaboración Internacional/European Project CIRCULARITY 2021 (PCI2021-122107-2A). PI: David R. Yáñez Ruiz. 2021-2024.

Microbiome Applications for Sustainable food systems through Technologies and EnteRprise. European Project (H2020 LC-SFS-03-2018 / EU189746_31). PI: David R. Yáñez Ruiz. 2019-2023.

Modelling integrated biodiversity-based next generation Mediterranean farming systems. AEI/MICIN Proyectos Colaboración Internacional/European Project PRIMA 2021 (PCI2022-132979/OPE02398). PI: Nuria Ferrol González. 2022-2025.

New aspects of lipid metabolism in *Sinorhizobium meliloti*: functions of thioesterases and membrane remodeling. Programa de Apoyo a Proyectos de Investigación e Innovación Tecnológica (PAPIIT), UNAM, México (IN208222). PI: Isabel Mª López Lara, Center for Genome Sciences, National Autonomous University of Mexico. Participants of the EEZ: Mª José Soto Misffut. 2022-2024.

Open Researchers 2022-23. HORIZON-MSCA-2022-CITIZENS-01 (EU237890_02). PI: Manuel Espinosa Urgel. 2022-2023.

Pathways for Transitions to Sustainability in Livestock Husbandry and Food Systems. European Project (H2020-FOOD/0809 / RIA - Research & Innov. / EU217598_01). PI: David R. Yáñez Ruiz. 2021-2026.

Preparing for the "Soil Deal for Europe" Mission. HORIZON-MISS-SOIL-01-01 (EU240252_02). PI: Juan Luis Ramos Martín. 2022-2025.

Reducing bioprocess of the solubility rhizospheric Cd. Call 2020 Fontagro: Innovations for the sustainable increase of agricultural productivity in Latin America and the Caribbean in the context of

climate change (ID401/ATN-RF-18951-RG). Coordinator: Mª Luisa Izaguirre Mayoral, Technical University of Manabí, Ecuador. CSIC PI: Inmaculada García Romera. 2021-2023.

Regulation of plant development and crop management through chloride nutrition: a novel tool to improve water- and nitrogen-use efficiency. European Project ChlorPlant (H2020-MSCA-895613). PIs: Miguel A. Rosales, Antonio DÍaz-Espejo (IRNAS). 2020-2023.

Sustainability for Mediterranean Hotspots in Andalusia integrating LifeWatch ERIC (SUMHAL). WP5: eLabs-BioINTERACT: Ecological interactions as biodiversity and ecosystem service components. European Project UE - LifeWatch ERIC - 2019 (LIFEWATCH-2019-09-CSIC-1 WP5). PIs: José Luis Garrido Sánchez, Pedro Jordano Barbudo (EBD-CSIC). 2019-2023.

Sustainability for Mediterranean Hotspots in Andalusia integrating LifeWatch ERIC (SUMHAL). WP7/LWE2021-03-025: Improving sustainability of Mediterranean forests and silvopastoral agrosystems under climate change. European Project UE - LifeWatch ERIC - 2019 (LIFEWATCH-2019-09-CSIC-13 WP7- LWE2103025). PI: Manuel Fernández López. 2019-2023.

Sustainability for Mediterranean Hotspots in Andalusia integrating LifeWatch ERIC (SUMHAL). WP7/LWE2021-03-026 and WP7/LWE2103027: Improving sustainability of Mediterranean forests and silvopastoral agrosystems under climate change. European Project UE - LifeWatch ERIC - 2019. (LIFEWATCH-2019-09-CSIC-13 / (WP7) LWE2103026 / LWE2103027). PI-Coordinator of both subprojects: Ana Belén Robles Cruz. 2019-2023.

The challenge of restoring, monitoring and valorizing biodiversity: above and belowground diversity, fuel load and ES in Mediterranean mountains managed with pyric herbivorism. Retos de la Sociedad (PID2020-116786RB-C32). PIs: Emilio Benítez León, Ana Belén Robles Cruz. 2021-2025.

The soil biodiversity and functionality of Mediterranean olive groves: A holistic analysis of the influence of land management on olive oil quality and safety. European Project (HORIZON-MISS-2021-SOIL-02/EU256029_19). Coordinator: Antonio José Manzaneda Ávila, University of Jaén; PI: Nuria Ferrol González (CSIC Coordinator: Manuel Fernández López). 2023-2027.

The soil biodiversity and functionality of Mediterranean olive groves: A holistic analysis of the influence of land management on olive oil quality and safety. European Project (HORIZON-MISS-2021-SOIL-02/EU256029_1). Coordinator: Antonio José Manzaneda Ávila, University of Jaén, PI: Manuel Fernández López (CSIC Coordinator). 2023-2027.

TRACE-Soils: Mechanisms underlying TRAde-offs between Carbon sequestration, greenhouse gas Emissions and nutrient losses in Soils under conservation agriculture in Europe (Towards climate-smart sustainable management of agricultural soils). European Project (H2020-FOOD/0648). PI: Juan Luis Ramos Martín, European Project Coordinator: Marta Goberna, INIA. 2020-2025. Support structure for soil living labs. European Project (EU251611_2). PI: Juan Luis Ramos

Understanding Microbiomes of the Ruminant Holobiont. European Project (H2020-FOOD/0811 / RIA - Research & Innov. / EU217601_01). PI: David R. Yáñez Ruiz. 2021-2026.

NATIONAL AND INTERNATIONAL NETWORKS

Beneficial root-associated microorganisms for a more sustainable agriculture. EU COST Action (ROOT-BENEFIT, CA22142). Action Chair: Benoit Lefebvre, French National Institute for Agriculture, Food, and Environment (INRAE). WG2 Leader: Juan Antonio López Ráez. Participants of the EEZ: Martín Aguirrebengoa Barreña, Ricardo Aroca Álvarez, Mª Jesús Delgado Igeño, Luis España Luque, Manuel Espinosa Urgel, José Manuel García Garrido, Antonio José Fernández González, Nuria Ferrol González, Tania Ho Plagaro, José I. Jiménez Zurdo, Álvaro López García, Javier Lidoy Logroño, Miguel A. Matilla Vázquez, Mª Socorro Mesa Banqueri, Zhivko Minchev, Daniel Pérez Mendoza, Mª José Pozo

Jiménez, Mª Isabel Ramos González, Juan Sanjuán Pinilla, Mª José Soto Misffut, Pieter van Dillewijn, Ana Vicente Lasa. 2023-2027.

Biotechnology of beneficial plant-microorganism interactions: importance of plant-microbe interactions in crop resilience. Acciones de Dinamización-Redes de Investigación, AEI-MICIN (RED2022-134667-T). PI: Paula García Fraile, University of Salamanca. Participants of the EEZ: Ricardo Aroca Álvarez, Concepción Azcón González de Aguilar, Juan J. Cabrera Rodríguez, Mª Jesús Delgado Igeño, Nuria Ferrol González, José Luis Garrido Sánchez, Alba Hidalgo García, Andrea Jiménez Leiva, Juan Antonio López Ráez, Mª José Lorite Ortega, Mª Socorro Mesa Banqueri, Pedro J. Pacheco Márquez, Eulogio Javier Palenzuela Jiménez, Daniel Pérez Mendoza, Mª José Pozo Jiménez, Juan Manuel Ruiz Lozano, Juan Sanjuán Pinilla, Mª José Soto Misffut, Germán Tortosa Muñoz. 2023-2025.

Feed and Nutrition Network of the Livestock Research Group (GRA). Participant of the EEZ: David Yáñez-Ruiz. 2011-2025.

Integration of redox signaling in plant development and adaptation to environmental stresses. Acciones de Dinamización-Redes de Investigación AEI-MICINN (RED2022-134072-T). PI: Mónica Balsera Diéguez, Instituto de Recursos Naturales y Agrobiología de Salamanca (IRNASA-CSIC). Participants of the EEZ: Mariam Sahrawy Barragán, Antonio Serrato Recio, María C. Romero Puertas, Luisa Mª Sandalio González. 2023-2024.

Legume Research Network. Acciones de Dinamización-Redes de Investigación AEI-MICINN (RED2022-134237-T). PI: Diego Rubiales Olmedo, Instituto de Agricultura Sostenible (IAS-CSIC). Participants of the EEZ: Mª Jesús Delgado Igeño, Germán Tortosa Muñoz, Alfonso Clemente Gimeno, Raquel Olías Sánchez, Cristina Delgado Andrade, Luis Rubio San Millán, José Carlos Jiménez López. 2023-2025.

Livestock Research Group of the Global Research Alliance on Agricultural Greenhouse Gases. Participant of the EEZ: David R. Yáñez Ruiz. 2008-2025.

Medicinal plants for animal health care: Translating tradition into modern veterinary medicine. EU COST Action ((MedPlans4Vet CA22109). Action Chair: Theresa Schlittenlacher, Research Institute of Organic Agriculture, Switzerland. Participant of the EEZ: David R. Yáñez Ruiz. 2023-2027.

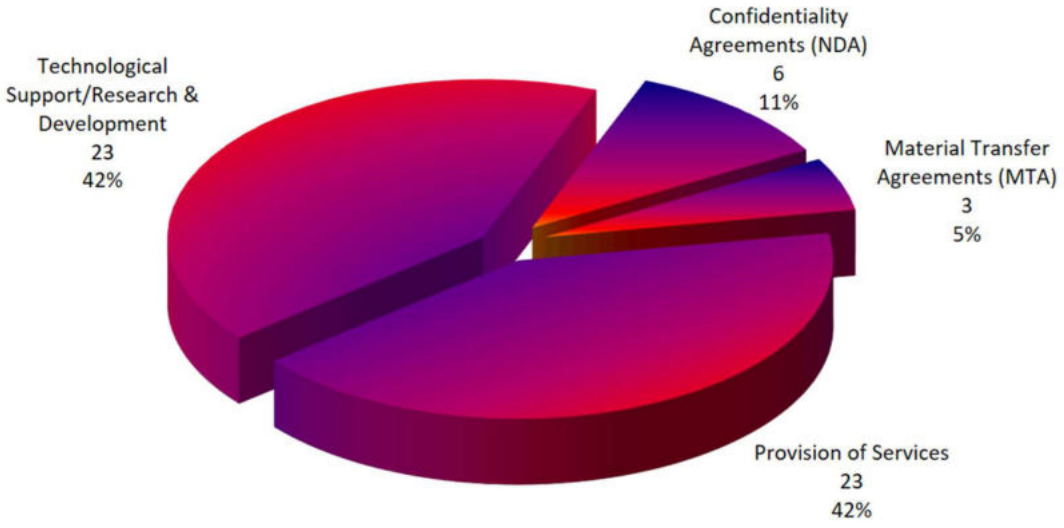
Plant Membrane Biology Network, Funded by the University of Málaga. Coordinator: Lourdes Rubio Valverde, University of Málaga. Participants of the EEZ: Kees Venema, Mª Pilar Rodríguez Rosales, Miguel A. Rosales Villegas.

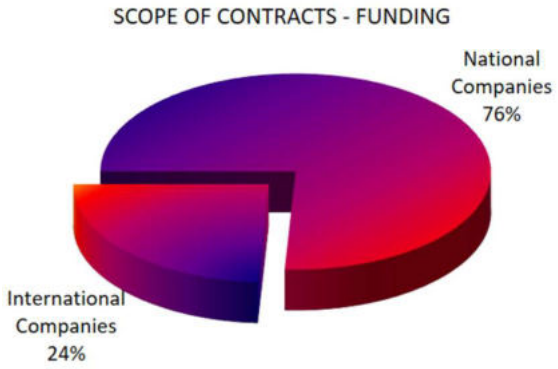
Roots for the future: know-how and biotechnological applications to improve productivity and resilience under stress conditions. Redes de Investigación RED2022-134836-T. Coordinador: Miguel A. Moreno Risueño, Polytechnic University of Madrid. Participant of the EEZ: José Manuel García Garrido.

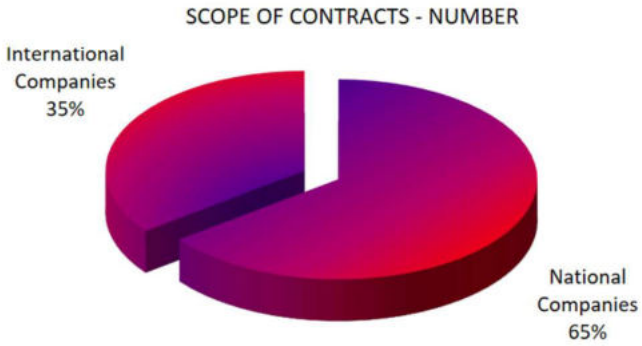
Spanish Network of Carotenoids. Acciones de Dinamización-Redes de Investigación, AEI-MICIN (RED2022-134577-T). PI: Mª Lourdes Gómez Gómez, University of Castilla-La Mancha. Participants of the EEZ: Juan Antonio López Ráez, Mª José Pozo Jiménez. 2023-2025.

RESEARCH, DEVELOPMENT & INNOVATION CONTRACTS AND COLLABORATION AGREEMENTS WITH COMPANIES

During 2023, apart from 6 NDA, 3 MTA, which do not involve income, 46 new contracts were signed (Technological Support/R&D contracts and provision of services), for a total amount of 876.478€. This is the distribution according to the type of contract and the national/international scope:







ONGOING CONTRACTS / COLLABORATION AGREEMENTS DURING 2024

Analysis of feed additives in animal nutrition. ADM International Sàrl, Suiza (20236854), PI: Alfonso Clemente Gimeno. 2023.

Analysis of uroporphyrinogen pathways in *Pseudomonas* fluorescens. HealthTech Bio Actives S.L.U. (20226558), PI: Juan Luis Ramos Martín. 2022-2023.

Analytical determinations of oils from the main Andalusian varieties. Project Ref. US-1380836 at Estación Experimental del Zaidín. University of Seville (20221509), PI: Eduardo López-Huertas León. 2022-2023.

Bioavailability and antioxidant effects of supplemental magnesium in broiler nutrition. K+S KALI GmbH, Alemania (20221077), PIs: Luis Rubio San Millán, Isabel Seiquer Gómez-Pavón. 2022-2024.

Bioavailability and antioxidant effects of supplemental Magnesium in broiler nutrition. K+S Minerals and Agriculture GmbH (20221077). IP: Luis Rubio and Isabel Seiquer. 2022-2024.

Determination of acetylene reduction activity (ARA) in bacterial isolates. Agroindustrial Kimitec, S.L. (20231983), PI: Germán Tortosa Muñoz. 2023.

Development of a new biofertilizer from the synergistic microbial interaction of strains from the phyllosphere. Herogra Especiales, S.L. (20232312), PI: Mª Jesús Delgado Igeño. 2023-2025.

Effect of the diet type on methane production in lambs. Interovic (20227758), PI: David R. Yáñez Ruiz. 2022-2023.

Effects of acetogenic strains in the presence of methane inhibitors in the rumen. Genencor International, B.V., Netherlands (20235359), PI: David R. Yáñez Ruiz. 2023-2024.

Efficacy of 3-nitrooxypropanol (3-NOP) in a slow release form in sheep. DSM Nutritional Products AG, Switzerland (20230131), PI: David R. Yáñez Ruiz. 2023.

Evaluation of methanogenic compounds in small ruminants. Norel, S.A. (20230105), PI: David R. Yáñez Ruiz. 2023.

Evaluation of mycoremediated alperujo as a biofertilizer. MAFA BioScience, S.A. (20238303), PI: Inmaculada García Romera. 2023-2024.

Evaluation of tannins and saponins for their antimethanogenic potential *in vitro* and *in vivo*. Aarhus Universty (Denmark), Société des Produits Nestlé, S.A. (Switzerland), University of Southern Denmark (20226794), PI: David R. Yáñez Ruiz. 2022-2023.

Evaluation of the use of sensory additives in goat production. Lucta, S.A. (20233639), PI: David R. Yáñez Ruiz. 2023-2024.

Exclusivity license of five mushroom strains: *Penicillium chrysogenum* EEZ-22, *Fusarium oxysporum* EEZ-28, *Pycnoporus cinnabarinus* EEZ-55, *Trichoderma harzianum* EEZ-4, and *Trametes versicolor* EEZ-13. MAFA BioScience, S.A. (20237005), PI: Inmaculada García Romera. 2023-2043.

GOA-BIORRUMIOLI - Bioeconomic products derived from small ruminants through the revalorization of olive oil by-products. Dcoop, S.C.A. (20233847), PI: A. Ignacio Martín García. 2023-2025.

***In vitro* effect of a bacteria strain, with or without encapsulation, on rumen fermentation and methanogenesis.** Agrifirm Group B.V. - T.A.V. Global R&D, Netherlands (20235169), PI: David R. Yáñez Ruiz. 2023.

***In vitro* screening of compounds for their potential to reduce enteric methane production.** Ref.: ADM International Sàrl, Switzerland (20235405), PI: David R. Yáñez Ruiz. 2023-2024.

Investigation of cultivation strategies and yields of *Cannabis sativa* L. varieties and the optimization, control, and quality of their pharmacologically active compounds. Trichome Pharma S.L (IDI-20220976). PIs: Miguel A. Rosales Villegas, José M. Colmenero Flores (IRNAS). 2022 -2024.

***In-vitro* cultivation of AMF isolates from the EEZ collection and efficacy tests.** Koppert Biological Systems, R.V. (20180727), PI: Mª José Pozo Jiménez. 2017-2023.

Memorandum of understanding between EEZ-CSIC and the SINCHI Amazonic Institute of Scientific Research (Colombia), to jointly carry out different academic and/or scientific activities. PI: Silvia Marqués Martín. 2022-2025.

New strategies for the prediction and quality control parameters and animal welfare in the Iberian pig. Sánchez Romero Carvajal Jabugo, S.A. (20214120). PI: Rosa Mª Nieto Liñán. 2021-2024.

Nutritional, sanitary and environmental strategies for sustainable pig farming. NUTEGA, S.L. (20222992). PI: Rosa Mª Nieto Liñán. 2022-2025.

Nutritional, sanitary and environmental strategies for sustainable pig farming. Cuarte, S.L. (20222993). PI: Rosa Mª Nieto Liñán. 2022-2025.

Nutritional, sanitary and environmental strategies for sustainable pig farming. MealFood Europe, S.L. (20222915). PI: Rosa Mª Nieto Liñán. 2022-2025.

Production of high added-value organic and biological fertilisers. Ecoindustria del Reciclado, S.L. (20215068), PI: Germán Tortosa Muñoz. 2021-2023.

Research and development of natural multi-layer dehydrated casings to improve the physicochemical, microbiological, nutritional and sensory properties of sausages. United Caro Research and Development, S.L.U. (20233663), PI: Isabel Seiquer Gómez-Pavón. 2023-2026.

Research and development of natural multi-layer dehydrated casings to improve the physicochemical, microbiological, nutritional and sensory properties of meat products. United Caro Research and Development, S.L.U. (20233661), PI: Eduardo López-Huertas León. 2023-2026.

Research, development and innovation consultancy in nutrition and health, quality and food legislation. United Caro Research and Development, S.L.U. (20228256), PI: Eduardo López-Huertas León. 2022-2023.

Scientific and Technology Contract for the ICCARE project: Indigenous and Community Conserved Area for social-ecological REsilience. Aix-Marseille University, France (20225183). PI: Ana Belén Robles Cruz. 2022-2024.

Study of the antihypertensive effects of olive extract. Istituto Nutrizionale Carapelli (20232629), PI: Eduardo López-Huertas León. 2023-2024.

Study of the effect of the biostimulant QUALIFUN on the model plant *Arabidopsis thaliana*. SERVALESA (20230027), PI: Antonio Serrato Recio. 2022-2023.

Technical support for animal experimentation. Abbott Laboratories, S.A. (20237966), PIs: A. Ignacio Martín García. Alfonso Clemente Gimeno. 2023-2024.

Technical support for animal experimentation. Abbott Laboratories, S.A. (20230366), PIs: Alfonso Clemente Gimeno, Ignacio Fernández-Fígares Ibáñez. 2023-2025.

Training in Agricultural Biology and Biotechnology. Studies in Spain (Mª Ángeles Guerrero Langa, 20230220), PI: Manuel Espinosa Urgel. 2022-2024.

Valorisation of mycoremediated olive mill waste (*alpeorujo*) as biofertiliser and biopesticide. Aceites Sierra Sur, S.A. (20214664), PIs: Inmaculada García Romera, Ana Azuzena González Coloma (UGR). 2021-2023.

PATENTS

Bacterial nanocellulose production
Authors: Silvia Marqués Martín, Sophie Marie Martirani von Abercron, Patricia Marín Quero, Daniel Pacheco Sánchez
Entity: CSIC
National Application number: P202030505
Priority Date: 1st June 2020
International publication number: WO/2021/245306A1
Publication Date: 9th December 2021
Entry into regional phase: 20th December 2022
European Patent application:
Number: 2021817696.4
Entry date: 2 nd January 2023
Publication date: 05.04.2023

Use of beta-conglutin proteins as radiosensitizing agents
Authors: Julia Escudero Feliú; Josefa León López; José Carlos Jiménez López, Mª Isabel Núñez Torres; Ángel Carazo Gallego; Mª Elena Lima Cabello; José David Puentes Pardo; Sara Moreno San Juan
Applicants: University of Granada (Ref. IPR-1052), Andalusia Health Service (Ref. FIBAO-23007), and Spanish National Research Council (Ref. UPR 100/2023)
Application number: P202330927
Application date: 13th November 2023

PUBLICATIONS

SCI PUBLICATIONS

Alcalá-Herrera, R.; Moreno, B.; Aguirrebengoa, M.; Winter, S.; Robles-Cruz, A.B.; Ramos-Font, M.E.; Benítez, E. 2023. Role of agricultural management in the provision of ecosystem services in warm climate vineyards: functional prediction of genes involved in nutrient cycling and carbon sequestration. *Plants,* 12: 527.

Anand, S.; Hallsworth, J.E.; Timmis, J.; Verstraete, W.; Casadevall, A.; Ramos, J.L.; Sood, U.; Kumar, R.; Hira, P.; Dogra Rawat, C.; Kumar, A.; Lal, S.; Lal, R.; Timmis, K. 2023. Weaponising microbes for peace. *Microbial Biotechnology,* 16: 1091-1111.

Arnaiz, A.; Romero-Puertas, M.C.; Santamaría, M.E.; Rosa-Díaz, I.; Arbona, V.; Muñoz, A.; Grbic, V.; González-Melendi, P.; Mar Castellano, M.; Sandalio, L.M.; Martínez, M.; Díaz, I. 2023. The *Arabidopsis* thioredoxin TRXh5 regulates the S-nitrosylation pattern of the TIRK receptor being both proteins essential in the modulation of defences to *Tetranychus urticae*. *Redox Biology,* 67: 102902.

Asins, M.J.; Bullones, A.; Raga, V.; Romero-Aranda, M.R.; Espinosa, J.; Triviño, J.C.; Bernet, G.P.; Traverso, J.A.; Carbonell, E.A.; Claros, M.G.; Belver, A. 2023. Combining genetic and transcriptomic approaches to identify transporter-coding genes as likely responsible for a repeatable salt tolerance QTL in citrus. *International Journal of Molecular Sciences,* 24: 15759.

Baghour, M.; Akodad, M.; Dariouche, A.; Maach, M.; Haddaji, H.E.; Moumen, A.; Skalli, A.; Venema, K.; Rodríguez-Rosales, M.P. 2023. Gibberellic acid and indole acetic acid improves salt tolerance in transgenic tomato plants overexpressing LeNHX4 antiporter. *Gesunde Pflanzen,* 75: 687-693.

Beaumelle, L.; Giffard, B.; Tolle, P.; Winter, S.; Entling, M.H.; Benítez, E.; Zaller, J.G.; Auriol, A.; Bonnard, O.; Charbonnier, Y.; Fabreguettes, O.; Joubard, B.; Kolb, S.; Ostandie, N.; Reiff, J.M.; Richart-Cervera, S.; Rusch, A. 2023. Biodiversity conservation, ecosystem services and organic viticulture: a glass half-full. *Agriculture, Ecosystems and Environment,* 351: 108474.

Belanche, A.; Arturo-Schaan, M.; Leboeuf, L.; Yáñez-Ruiz, D.; Martín-García, I. 2023. Early life supplementation with a natural blend containing turmeric, thymol, and yeast cell wall components to optimize rumen a natomical and microbiological development and productivity in dairy goats. *Journal of Dairy Science,* 106: 4634-4649.

Belanche, A.; Hristov, A.N.; van Lingen, H.J.; Denman, S.E.; Kebreab, E.; Schwarm, A.; Kreuzer, M.; Niu, M.; Eugène, M.; Niderkorn, V.; Martin, C.; Archimède, H.; McGee, M.; Reynolds, C.K.; Crompton, L.A.; Bayat, A.R.; Yu, Z.; Bannink, A.; Dijkstra, J.; Chaves, A.V.; Clark, H.; Muetzel, S.; Lind, V.; Moorby, J.M.; Rooke, J.A.; Aubry, A.; Antezana, W.; Wang, M.; Hegarty, R.; Hutton Oddy, V.; Hill, J.; Vercoe, P.E.; Savian, J.V.; Abdalla, A.L.; Soltan, Y.A.; Gomes Monteiro, A.L.; Ku-Vera, J.C.; Jaurena, G.; Gómez-Bravo, C.A.; Mayorga, O.L.; Congio, G.F.S.; Yáñez-Ruiz, D.R. 2023. Prediction of enteric methane emissions by sheep using an intercontinental database. *Journal of Cleaner Production,* 384: 135523.

Belanche, A.; Palma-Hidalgo, J.M.; Jiménez, E.; Yáñez-Ruiz, D.R. 2023. Enhancing rumen microbial diversity and its impact on energy and protein metabolism in forage-fed goats. *Frontiers in Veterinary Science,* 10: 1272835.

Bernal, P.; Civantos, C.; Pacheco-Sánchez, D.; Quesada, J.M.; Filloux, A.; Llamas, M.A. 2023. Transcriptional organization and regulation of the *Pseudomonas putida* K1 type VI secretion system gene cluster. *Microbiology,* 169: 001295.

Brito-Santana, P.; Duque-Pedraza, J.J.; Bernabéu-Roda, L.M.; Carvia-Hermoso, C.; Cuéllar, V.; Fuentes-Romero, F.; Acosta-Jurado, S.; Vinardell, J.M.; Soto, M.J. 2023. *Sinorhizobium meliloti* DnaJ is required for surface motility, stress tolerance, and for efficient nodulation and symbiotic nitrogen fixation. *International Journal of Molecular Sciences,* 24: 5848.

Bullones, A.; Castro, A.J.; Lima-Cabello, E.; Alché, J.D.; Luque, F.; Claros, M.G.; Fernández-Pozo, N. 2023. OliveAtlas: a gene expression atlas tool for *Olea europaea*. *Plants,* 12: 1274.

Bullones, A.; Castro, A.J.; Lima-Cabello, E.; Fernández-Pozo, N.; Bautista, R.; Alché, J.D.; Claros, M.G. 2023. Transcriptomic insight into the pollen tube growth of *Olea europaea* L. subsp. *europaea* reveals reprogramming and pollen-specific genes including new transcription factors. *Plants,* 12: 2894.

Cardoni, M.; Fernández-González, A.J.; Valverde-Corredor, A.; Fernández-López, M.; Mercado-Blanco, J. 2023. Co-occurrence network analysis unveils the actual differential impact on the olive root microbiota by two *Verticillium* wilt biocontrol rhizobacteria. *Environmental Microbiome,* 18: 21.

Cardoni, M.; Mercado-Blanco, J. 2023. Confronting stresses affecting olive cultivation from the holobiont perspective. *Frontiers in Plant Science,* 14: 1261754.

Cardoni, M.; Olmo-García, L.; Serrano-García, I.; Carrasco-Pancorbo, A.; Mercado-Blanco, J. 2023. The roots of olive cultivars differing in tolerance to *Verticillium dahliae* show quantitative differences in phenolic and triterpenic profiles. *Journal of Plant Interactions,* 18: 2206840.

Ceballos-Pérez, G.; Rico-Jiménez, M.; Gómez-Liñán, C.; Estévez, A.M. 2023. Role of the RNA-binding protein ZC3H41 in the regulation of ribosomal protein messenger RNAs in trypanosomes. *Parasites and Vectors,* 16: 118.

Cerna-Vargas, J.P.; Gumerov, V.M.; Krell, T.; Zhulin, I.B. 2023. Amine-recognizing domain in diverse receptors from bacteria and archaea evolved from the universal amino acid sensor. *Proceedings of the National Academy of Sciences of the United States of America,* 120: e2305837120.

Cerna-Vargas, J.P.; Sánchez-Romera, B.; Matilla, M.A.; Ortega, A.; Krell, T. 2023. Sensing preferences for prokaryotic solute binding protein families. *Microbial Biotechnology,* 16: 1823-1833.

Chávez, D.; Rivas, G.; Machuca, A.; Santos, C.; Deramond, C.; Aroca, R.; Cornejo, P. 2023. Contribution of arbuscular mycorrhizal and endophytic fungi to drought tolerance in *Araucaria araucana* seedlings. *Plants,* 12: 2116.

Cicatelli, A.; Guarino, F.; Ferrol, N.; Rozpądek, P.; Castiglione, S. 2023. Editorial: effects of plant-microbiome interactions on phyto- and bio-remediation capacity, volume II. *Frontiers in Plant Science,* 14: 1248248.

Corpas, F.J. 2023. H_2S: a simple molecule with multifaceted biochemistry and functions. *Antioxidants & Redox Signaling,* 39: 980-982.

Corpas, F.J.; Freschi, L.; Palma, J.M. 2023. ROS metabolism and ripening of fleshy fruits. *Advances in Botanical Research,* 105: 205-238.

Daddaoua, A.; Álvarez, C.; Oggerin, M.; Rodríguez, N.; Duque, E.; Amils, R.; Armengaud, J.; Segura, A.; Ramos, J.L. 2023. Rio Tinto as a niche for acidophilus enzymes of industrial relevance. *Microbial Biotechnology,* 16: 1069-1086.

de La O-Sánchez, J.; Muñoz-Vargas, M.A.; Palma, J.M.; Corpas, F.J. 2023. Isoenzymatic pattern of hydrogen sulfide (H_2S)-generating L-cysteine desulfhydrase (LCD) in *Arabidopsis thaliana* seedlings: effect of nitric oxide (NO) and H_2S. *Nitrogen,* 4: 231-238.

de la Sota Ricaldi, A.M.; Rengifo del Águila, S.; Blas Sevillano, R.; López-García, A.; Corazon-Guivin, M.A. 2023. Beta diversity of arbuscular mycorrhizal communities increases in time after crop establishment of Peruvian sacha inchi (*Plukenetia volubilis*). *Journal of Fungi,* 9: 194.

Demicheli, J.; Sabljic, I.; Beguy, G.; Ploschuk, E.; Sahrawy, M.; Serrato, A.J.; Pagano, E.A. 2023. Improving drought tolerance in soybean by classical breeding leads to physiological adjustments of photosynthesis and stomata functioning. *Plant Stress,* 10: 100275.

Escudero-Feliu, J.; García-Costela, M.; Moreno-SanJuan, S.; Puentes-Pardo, J.D.; Arrabal, S.R.; González-Novoa, P.; Núñez, M.I.; Carazo, A.; Jiménez-López, J.C.; León, J. 2023. Narrow leafed Lupin (*Lupinus angustifolius* L.) beta-conglutin seed proteins as a new natural cytotoxic agents against breast cancer cells. *Nutrients,* 15: 523.

Escudero-Feliu, J.; Lima-Cabello, E.; Rodríguez de Haro, E.; Morales-Santana, S.; Jiménez-López, J.C. 2023. Functional association between storage protein mobilization and redox signaling in narrow-leafed lupin (*Lupinus angustifolius* L.) seed germination and seedling development. *Genes,* 14: 1889.

Espinosa-Urgel, M. 2023. Connecting environmental and evolutionary microbiology for the development of new agrobiotechnological tools. *Environmental Microbiology,* 25: 87-90.

Espinosa-Urgel, M.; Ramos-González, M.I. 2023. Becoming settlers: elements and mechanisms for surface colonization by *Pseudomonas putida*. *Environmental Microbiology,* 25: 1575-1593.

Fernández-Fígares, I.; Haro, A.; Lachica, M.; Lara, L.; Seiquer, I.; Nieto, R. 2023. Metabolic profile of growing immune- and surgically castrated Iberian pigs fed diets of different amino acid concentration. *Animals,* 13: 2650.

Fernández-Fígares, I.; Sartin, J.L.; Pinotti, L. 2023. Editorial: 7th ISEP: present and future challenges in energy and protein metabolism and their implication in animal nutrition. *Animal,* 17: 100922.

Fernández-González, A.J.; Lasa, A.V.; Cobo-Díaz, J.F.; Villadas, P.J.; Pérez-Luque, A.J.; García-Rodríguez, F.M.; Tringe, S.G.; Fernández-López, M. 2023. Long-term persistence of three microbial wildfire biomarkers in forest soils. *Forests,* 14: 1383.

Foresto, E.; Revale, S.; Nievas, F.; Carezzano, M.E.; Puente, M.; Alzari, P.; Martínez, M.; Ben-Assaya, M.; Mornico, D.; Santoro, M.; Martínez-Abarca, F.; Giordano, W.; Bogino, P. 2023. Genome sequence of *Mesorhizobium mediterraneum* strain R31, a nitrogen-fixing rhizobium used as an inoculant for chickpea in Argentina. *Microbiology Resource Announcements,* 12: e00581-23.

Freschi, L.; Corpas, F.J.; Palma, J.M. 2023. Fruit physiology through signaling processes: latest advances and future challenges. *International Journal of Molecular Sciences,* 24: 976.

Gahlowt, P.; Tripathi, D.K.; Corpas, F.J.; Gupta, R.; Singh, V.P. 2023. Nitric oxide working: no worries about heat stress. *Trends in Plant Science,* 28: 867-869.

Gálvez-Roldán, C.; Cerna-Vargas, J.P.; Rodríguez-Herva, J.J.; Krell, T.; Santamaría-Hernando, S.; López-Solanilla, E. 2023. A nitrate-sensing domain-containing chemoreceptor is required for successful entry and virulence of *Dickeya dadantii* 3937 in potato plants. *Phytopathology,* 113: 390-399.

García-Franco, A.; Godoy, P.; Duque, E.; Ramos, J.L. 2023. Insights into the susceptibility of *Pseudomonas putida* to industrially relevant aromatic hydrocarbons that it can synthesize from sugars. *Microbial Cell Factories,* 22: 22.

García-Tomsig, N.I.; García-Rodríguez, F.M.; Guedes-García, S.K.; Millán, V.; Becker, A.; Robledo, M.; Jiménez-Zurdo, J.I. 2023. A double-negative feedback loop between NtrBC and a small RNA rewires nitrogen metabolism in legume symbionts. *mBio,* 14: e02003-23.

Garrido, J.L.; Alcántara, J.M.; López-García, A.; Ozuna, C.V.; Perea, A.J.; Prieto, J.; Rincón, A.; Azcón-Aguilar, C. 2023. The structure and ecological function of the interactions between plants and arbuscular mycorrhizal fungi through multilayer networks. *Functional Ecology,* 37: 2217-2230.

Gavira, J.A.; Rico-Jiménez, M.; Ortega, A.; V. Petukhova, N.; Bug, D.S.; Castellví, A.; Porozov, Y.B.; Zhulin, I.B.; Krell, T.; Matilla, M.A.; Gavira, J.A. 2023. Emergence of an auxin sensing domain in plant-

associated bacteria. *mBio,* 14: e03363-22.

Genova, R.; Gil-Gil, T.; Cuesta, T.; Martínez, J.L.; Sanz-García, F. 2023. The inactivation of the putative two-component system sensor PA14_27940 increases the susceptibility to several antibiotics and reduces the motility of *Pseudomonas aeruginosa*. *International Journal of Molecular Sciences,* 24: 17355.

Genova, R.; Laborda, P.; Cuesta, T.; Martínez, J.L.; Sanz-García, F. 2023. Collateral sensitivity to fosfomycin of tobramycin-resistant mutants of Pseudomonas aeruginosa is contingent on bacterial genomic background. *International Journal of Molecular Sciences,* 24: 6892.

Goglio, P.; Knudsen, M.T.; Van Mierlo, K.; Röhrig, N.; Fossey, M.; Maresca, A.; Hashemi, F.; Waqas, M.A.; Yngvesson, J.; Nassy, G.; Broekema, R.; Moakes, S.; Pfeifer, C.; Borek, R.; Yánez-Ruiz, D.; Cascante, M.Q.; Syp, A.; Zylowsky, T.; Romero-Huelva, M.; Smith, L.G. 2023. Defining common criteria for harmonizing life cycle assessments of livestock systems. *Cleaner Production Letters,* 4: 100035.

González, F.; Santander, C.; Ruiz, A.; Pérez, R.; Moreira, J.; Vidal, G.; Aroca, R.; Santos, C.; Cornejo, P. 2023. Inoculation with *Actinobacteria* spp. isolated from a hyper-arid environment enhances tolerance to salinity in lettuce plants (*Lactuca sativa* L.). *Plants,* 12: 2018.

González-Gordo, S.; López-Jaramillo, J.; Palma, J.M.; Corpas, F.J. 2023. Soybean (*Glycine max* L.) lipoxygenase 1 (LOX 1) is modulated by nitric oxide and hydrogen sulfide: an *in vitro* approach. *International Journal of Molecular Sciences,* 24: 8001.

González-Gordo, S.; Muñoz-Vargas, M.A.; Palma, J.M.; Corpas, F.J. 2023. Class III peroxidases (POD) in pepper (*Capsicum annuum* L.): genome-wide identification and regulation during nitric oxide (NO)-influenced fruit ripening. *Antioxidants,* 12: 1013.

González-Gordo, S.; Palma, J.M.; Corpas, F.J. 2023. Small Heat Shock Protein (sHSP) gene family from sweet pepper (*Capsicum annuum* L.) fruits: involvement in ripening and modulation by nitric oxide (NO). *Plants,* 12: 389.

Hassan, M.; Belanche, A.; Jiménez, E.; Rivelli, I.; Martín-García, A.I.; Margolles, A.; Yáñez-Ruiz, D.R. 2023. Evaluation of the nutritional value and presence of minerals and pesticides residues in agro-industrial by-products to replace conventional ingredients of small ruminant diets. *Small Ruminant Research,* 229: 107117.

Hernández-Soto, L.M.; Martínez-Abarca, F.; Ramírez-Saad, H.; López-Pérez, M.; Aguirre-Garrido, J.F. 2023. Genome analysis of haloalkaline isolates from the soda saline crater lake of Isabel Island; comparative genomics and potential metabolic analysis within the genus Halomonas. *BMC Genomics,* 24: 696.

Hidalgo-García, A.; Tortosa, G.; Pacheco, P.J.; Gates, A.J.; Richardson, D.J.; Bedmar, E.J.; Girard, L.; Torres, M.J.; Delgado, M.J. 2023. *Rhizobium etli* is able to emit nitrous oxide by connecting assimilatory nitrate reduction with nitrite respiration in the bacteroids of common bean nodules. *Journal of Plant Interactions,* 18: 2251511.

Hidri, R.; Metoui-Ben Mahmoud, O.; Zorrig, W.; Azcón, R.; Abdelly, C.; Debez, A. 2023. The halotolerant rizhobacterium *Glutamicibacter* sp. alleviates salt impact on *Phragmites australis* by producing exopolysaccharides and limiting plant sodium uptake. *Plant Direct,* 7: e535.

Houmani, H.; Palma, J.M.; Corpas, F.J. 2023. High salinity stimulates the adaptive response to potassium deficiency through the antioxidant and the NADPH-generating systems in the roots and leaves of the halophyte *Cakile maritima*. *Journal of Plant Growth Regulation,* 42: 6286-6306.

Huang, R.; Romero, P.; Belanche, A.; Ungerfeld, E.M.; Yáñez-Ruiz, D.; Morgavi, D.P.; Popova, M. 2023. Evaluating the effect of phenolic compounds as hydrogen acceptors when ruminal methanogenesis is inhibited *in vitro* - Part 1. Dairy cows. *Animal,* 17: 100788.

Hyde, K.D.; Abdel-Wahab, M.A.; Abdollahzadeh, J.; Abeywickrama, P.D.; Absalan, S.; Afshari, N.; Ainsworth, A.M.; Akulov, O.Y.; Aleoshin, V.V.; Al-Sadi, A.M.; Alvarado, P.; Alves, A.; Alves-Silva, G.; Amalfi, M.; Amira, Y.; Amuhenage, T.B.; Anderson, J.L.; Antonín, V.; Aouali, S.; Aptroot, A.; Apurillo, C.C.S.; Araújo, J.P.M.; Ariyawansa, H.A.; Armand, A.; Arumugam, E.; Asghari, R.; Assis, D.M.A.; Atienza, V.; Avasthi, S.; Azevedo, E.; Bahkali, A.H.; Bakhshi, M.; Banihashemi, Z.; Bao, D.F.; Baral, H.O.; Barata, M.; Barbosa, F.R.; Barbosa, R.N.; Barreto, R.W.; Baschien, C.; Belamesiatseva, D.B.; Reuel, M.B.; Bera, I.; Bezerra, J.D.P.; Bezerra, J.L.; Bhat, D.J.; Bhunjun, C.S.; Bianchinotti, M.V.; Błaszkowski, J.; Cano-Lira, J.F.; Carlavilla, J.R.; Gabaldón, T.; García, D.; Garrido-Benavent, I.; Gené, D.J.; Gorjón, S.P.; Lado, C.; Márquez, R.; Olariaga, I.; Perez-Ortega, S.; Prieto, M.; Sánchez-Castro, I.; Stchigel, A.M.; Torruella, G.; Valle, L.G. 2023. Global consortium for the classification of fungi and fungus-like taxa. *Mycosphere,* 14: 1960-2012.

Imtiaz, H.; Mir, A.R.; Corpas, F.J.; Hayat, S. 2023. Impact of potassium starvation on the uptake, transportation, photosynthesis, and abiotic stress tolerance. *Plant Growth Regulation,* 99: 429-448.

Iniesta-Pallarés, M.; Brenes-Álvarez, M.; Lasa, A.V.; Fernández-López, M.; Álvarez, C.; Molina-Heredia, F.P.; Mariscal, V. 2023. Changes in rice rhizosphere and bulk soil bacterial communities in the Doñana wetlands at different growth stages. *Applied Soil Ecology,* 190: 105013.

Islam, S.; Shah, S.H.; Corpas, F.J.; Alamri, S.; Mohammad, F. 2023. Plant growth regulators mediated mitigation of salt-induced toxicities in mustard (*Brassica juncea* L.) by modifying the inherent defense system. *Plant Physiology and Biochemistry,* 196: 1002-1018.

Jiménez-López, J.C.; Singh, K.B.; Clemente, A.; Czubinski, J.; Ochatt, S.; Von Wettberg, E.; Smýkal, P. 2023. Editorial: legumes for global food security - volume II. *Frontiers in Plant Science,* 14: 1273600.

Jorrin-Novo, J.V.; Aroca, R.; Rey, M.D.; Truniger, V.; Martínez-Gómez, P. 2023. State-of-the-art molecular plant biology research in Spain. *International Journal of Molecular Sciences,* 24: 16557.

Kandhol, N.; Rai, P.; Pandey, S.; Singh, S.; Sharma, S.; Corpas, F.J.; Singh, V.P.; Tripathi, D.K. 2023. Zinc induced regulation of PCR_1 gene for cadmium stress resistance in rice roots. *Plant Science,* 337: 111783.

Krell, T.; Gavira, J.A.; Roca, A.; Matilla, M.A. 2023. The emerging role of auxins as bacterial signal molecules: potential biotechnological applications. *Microbial Biotechnology,* 16: 1611-1615.

Kucko, A.; Alché, J.D.; Tranbarger, T.J.; Wilmowicz, E. 2023. Abscisic acid- and ethylene-induced abscission of yellow lupine flowers is mediated by jasmonates. *Journal of Plant Physiology,* 290: 154119.

Lachica, M.; Rodríguez-López, J.M.; González-Valero, L.; Fernández-Fígares, I. 2023. Net portal appearance of amino acids in Iberian and Landrace Pigs fed different protein content in the diet. *Animals,* 13: 1263.

Lasa, A.V.; Fernández-González, A.J.; Villadas, P.J.; Cobo-Díaz, J.F.; Fernández-López, M. 2023. Bacterial inoculation of *Quercus pyrenaica* trees alters co-occurrence patterns but not the composition of the rhizosphere bacteriome in wild conditions. *Environmental Microbiology,* 25: 1747-1761.

Lasa, A.V.; Guevara, M.A.; Villadas, P.J.; Fernández-González, A.J.; Cervera, M.T.; Fernández-López, M. 2023. Bacteriome dataset from the rhizosphere of trees in a *Pinus pinaster* and *Pinus halepensis* dominated forest subjected to drought conditions. *Data in Brief,* 46: 108805.

Lekmine, S.; Benslama, O.; Kadi, K.; Martín-García, A.I.; Yilmaz, M.A.; Akkal, S.; Boumegoura, A.; Alhomida, A.S.; Ola, M.S.; Ali, A. 2023. LC/MS-MS analysis of phenolic compounds in *Hyoscyamus albus* L. extract: *in vitro* antidiabetic activity, *in silico* molecular docking, and *in vivo* investigation against STZ-induced diabetic mice. *Pharmaceuticals,* 16: 1015.

Liao, W.; Igamberdiev, A.U.; Palma, J.M. 2023. Advances in nitric oxide signalling and metabolism in

plants. *International Journal of Molecular Sciences,* 24: 6397.

Lidoy, J.; Berrio, E.; García, M.; España-Luque, L.; Pozo, M.J.; López-Ráez, J.A. 2023. Flavonoids promote *Rhizophagus irregularis* spore germination and tomato root colonization: a target for sustainable agriculture. *Frontiers in Plant Science,* 13: 1094194.

Lidoy, J.; López-García, A.; Amate, C.; García, J.M.; Flors, V.; García-Garrido, J.M.; Azcón-Aguilar, C.; López-Ráez, J.A.; Pozo, M.J. 2023. Regulation of mycorrhizal colonization under stress in tomato depends on symbiotic efficiency. *Environmental and Experimental Botany,* 215: 105479.

Lima-Cabello, E.; Escudero-Feliu, J.; Peralta-Leal, A.; García-Fernández, P.; Siddique, K.H.M.; Singh, K.B.; Núñez, M.I.; León, J.; Jiménez-López, J.C. 2023. Beta conglutins' unique mobile arm is a key structural domain involved in molecular nutraceutical properties of narrow-leafed lupin (*Lupinus angustifolius* L.). *International Journal of Molecular Sciences,* 24: 7676.

López-Pedrouso, M.; Lorenzo, J.M.; Alché, J.D.; Moreira, R.; Franco, D. 2023. Advanced proteomic and bioinformatic tools for predictive analysis of allergens in novel foods. *Biology,* 12: 714.

Lorite, M.J.; Casas-Román, A.; Girard, L.; Encarnación, S.; Díaz-Garrido, N.; Badía, J.; Baldomá, L.; Pérez-Mendoza, D.; Sanjuán, J. 2023. Impact of c-di-GMP on the extracellular proteome of *Rhizobium etli*. *Biology,* 12: 44.

Lucena, C.; Aroca, R.; Wang, J.; Zimmermann, S.D. 2023. Editorial: beneficial microbes and the interconnection between crop mineral nutrition and induced systemic resistance, volume II. *Frontiers in Plant Science,* 14: 1157296.

Marcos-Torres, F.J.; Juniar, L.; Griese, J.J. 2023. The molecular mechanisms of the bacterial iron sensor IdeR. *Biochemical Society Transactions,* 51: 1319-1329.

Martínez-Rodríguez, L.; López-Sánchez, A.; García-Alcaide, A.; Govantes, F.; Gallegos, M.T. 2023. FleQ, FleN and c-di-GMP coordinately regulate cellulose production in *Pseudomonas syringae* pv. tomato DC3000. *Frontiers in Molecular Bioscience*, 10: 1155579.

Martirani-von Abercron, S.M.; Pacheco-Sánchez, D. 2023. Bacterial cellulose: a highly versatile nanomaterial. *Microbial Biotechnology,* 16: 1174-1178.

Matilla, M.A.; Evans, T.J.; Martín, J.; Udaondo, Z.; Lomas-Martínez, C.; Rico-Jiménez, M.; Reyes, F.; Salmond, G.P.C. 2023. Herbicolin A production and its modulation by quorum sensing in a *Pantoea agglomerans* rhizobacterium bioactive against a broad spectrum of plant-pathogenic fungi. *Microbial Biotechnology,* 16: 1690-1700.

Matilla, M.A.; Gavira, J.A.; Krell, T. 2023. Accessing nutrients as the primary benefit arising from chemotaxis. *Current Opinion in Microbiology,* 75: 102358.

Matilla, M.A.; Genova, R.; Martín-Mora, D.; Maaß, S.; Becher, D.; Krell, T. 2023. The cellular abundance of chemoreceptors, chemosensory signaling proteins, sensor histidine kinases, and solute binding proteins of *Pseudomonas aeruginosa* provides insight into sensory preferences and signaling mechanisms. *International Journal of Molecular Sciences,* 24: 1363.

Matilla, M.A.; Krell, T. 2023. Targeting motility and chemotaxis as a strategy to combat bacterial pathogens. *Microbial Biotechnology,* 16: 2205-2211.

Matilla, M.A.; Monson, R.E.; Salmond, G.P.C. 2023. *Dickeya solani*. *Trends in Microbiology,* 31: 1085-1086.

Matilla, M.A.; Monteagudo-Cascales, E.; Cerna-Vargas, J.P.; Gumerov, V.M.; Zhulin, I.B.; Krell, T. 2023. Is it possible to predict signal molecules that are recognized by bacterial receptors? *Environmental Microbiology,* 25: 11-16.

Matilla, M.A.; Monteagudo-Cascales, E.; Krell, T. 2023. Advances in the identification of signals and

novel sensing mechanisms for signal transduction systems. *Environmental Microbiology,* 25: 79-86.

Micol-Ponce, R.; García-Alcázar, M.; Lebrón, R.; Capel, C.; Pineda, B.; García-Sogo, B.; Alché, J.D.; Ortiz-Atienza, A.; Bretones, S.; Yuste-Lisbona, F.J.; Moreno, V.; Capel, J.; Lozano, R. 2023. Tomato POLLEN DEFICIENT 2 encodes a G-Type lectin receptor kinase required for viable pollen grain formation. *Journal of Experimental Botany,* 74: 178-193.

Miranda, V.; Silva-Castro, G.A.; Ruiz-Lozano, J.M.; Fracchia, S.; García-Romera, I. 2023. Fungal endophytes enhance wheat and tomato drought tolerance in terms of plant growth and biochemical parameters. *Journal of Fungi,* 3: 384.

Monteagudo-Cascales, E.; Ortega, A.; Velando, F.; Morel, B.; Matilla, M.A.; Krell, T. 2023. Study of NIT domain-containing chemoreceptors from two global phytopathogens and identification of NIT domains in eukaryotes. *Molecular Microbiology,* 119: 739-751.

Morel Revetria, M.A.; Berais-Rubio, A.; Giménez, M.; Sanjuán, J.; Signorelli, S.; Monza, J. 2023. Competitiveness and phylogenetic relationship of rhizobial strains with different symbiotic efficiency in *Trifolium repens*: conversion of parasitic into non-parasitic rhizobia by natural symbiotic gene transfer. *Biology,* 12: 243.

Mukarram, M.; Khan, M.M.A.; Kurjak, D.; Corpas, F.J. 2023. Chitosan oligomers (COS) trigger a coordinated biochemical response of lemongrass (*Cymbopogon flexuosus*) plants to palliate salinity-induced oxidative stress. *Scientific Reports,* 13: 8636.

Mukarram, M.; Khan, M.M.A.; Kurjak, D.; Lux, A.; Corpas, F.J. 2023. Silicon nanoparticles (SiNPs) restore photosynthesis and essential oil content by upgrading enzymatic antioxidant metabolism in lemongrass (*Cymbopogon flexuosus*) under salt stress. *Frontiers in Plant Science,* 14: 1116769.

Mukherjee, S.; Corpas, F.J. 2023. H_2O_2, NO, and H_2S networks during root development and signalling under physiological and challenging environments: beneficial or toxic? *Plant, Cell and Environment,* 46: 688-717.

Muñoz-Vargas, M.A.; González-Gordo, S.; Taboada, J.; Palma, J.M.; Corpas, F.J. 2023. In silico RNAseq and biochemical analyses of glucose-6-phosphate dehydrogenase (G6PDH) from sweet pepper fruits: involvement of nitric oxide (NO) in ripening and modulation. *Plants,* 12: 3408.

Muñoz-Vargas, M.A.; López-Jaramillo, J.; González-Gordo, S.; Paradela, A.; Palma, J.M.; Corpas, F.J. 2023. H_2S-generating cytosolic L-cysteine desulfhydrase and mitochondrial D-cysteine desulfhydrase from sweet pepper (*Capsicum annuum* L.) are regulated during fruit ripening and by nitric oxide. *Antioxidants & Redox Signaling,* 39: 2-18.

Olías, R.; Delgado-Andrade, C.; Padial, M.; Marín-Manzano, M.C.; Clemente, A. 2023. An updated review of soy-derived beverages: nutrition, processing, and bioactivity. *Foods,* 12: 2665.

Olías, R.; Rayner, T.; Clemente, A.; Domoney, C. 2023. Combination of three null mutations affecting seed protein accumulation in pea (*Pisum sativum* L.) impacts positively on digestibility. *Food Research International,* 169: 112825.

Otero-Asman, J.R.; Sánchez-Jiménez, A.; Bastiaansen, K.C.; Wettstadt, S.; Civantos, C.; García-Puente, A.; Bitter, W.; Llamas, M.A. 2023. The Prc and CtpA proteases modulate cell-surface signaling activity and virulence in *Pseudomonas aeruginosa*. *iScience,* 26: 107216.

Ouadih-Moran, M.; Muñoz-Hoyos, A.; D'Marco, L.; Molina-Carballo, A.; Seiquer, I.; Checa-Ros, A. 2023. Is S100B involved in attention-deficit/hyperactivity disorder (ADHD)? Comparisons with controls and changes following a triple therapy containing methylphenidate, melatonin and omega-3 PUFAs. *Nutrients,* 15: 712.

Pacheco, P.J.; Bedmar, E.J.; Mesa, S.; Tortosa, G.; Delgado, M.J. 2023. *Ensifer meliloti* denitrification is involved in infection effectiveness and N_2O emissions from alfalfa root nodules. *Plant and Soil,* 486:

519-534.

Pacheco, P.J.; Cabrera, J.J.; Jiménez-Leiva, A.; Torres, M.J.; Gates, A.J.; Bedmar, E.J.; Richardson, D.J.; Mesa, S.; Tortosa, G.; Delgado, M.J. 2023. The copper-responsive regulator CsoR is indirectly involved in *Bradyrhizobium diazoefficiens* denitrification. *FEMS Microbiology Letters,* 370: fnad084.

Pajares Murgó, M.; Garrido, J.L.; Perea, A.J.; López García, A.; Alcántara, J.M. 2023. Biotic filters driving the differentiation of decomposer, epiphytic and pathogenic phyllosphere fungi across plant species. *Oikos,* 2023: e09624.

Palma, J.M.; Rodríguez-Ruiz, M.; Foyer, C.H.; Corpas, F.J. 2023. Editorial: subcellular compartmentalization of plant antioxidants and ROS generating systems, volume II. *Frontiers in Plant Science,* 14: 1224289.

Palma-Hidalgo, J.M.; Belanche, A.; Jiménez, E.; Newbold, C.J.; Denman, S.E.; Yáñez-Ruiz, D.R. 2023. Multi-omics *in vitro* study of the salivary modulation of the goat rumen microbiome. *Animal,* 17: 100895.

Paniagua-López, M.; Aguilar-Garrido, A.; Contero-Hurtado, J.; García-Romera, I.; Sierra-Aragón, M.; Romero-Freire, A. 2023. Ecotoxicological assessment of polluted soils one year after the application of different soil remediation techniques. *Toxics,* 11: 298.

Pantelides, I.S.; Stringlis, I.A.; Finkel, O.M.; Mercado-Blanco, J. 2023. Editorial: organic amendments: microbial communities and their role in plant fitness and disease suppression. *Frontiers in Plant Science,* 14: 1213092.

Pardo, Z.; Lara, L.; Nieto, R.; Fernández-Fígares, I.; Seiquer, I. 2023. Muscle quality traits and oxidative status of Iberian pigs supplemented with zinc and betaine under heat stress. *Meat Science,* 198: 109119.

Pardo, Z.; Mateos, I.; Saro, C.; Campos, R.; Argüello, H.; Lachica, M.; Ranilla, M.J.; Fernández-Fígares, I. 2023. The effect of supplementation with betaine and zinc on *in vitro* large intestinal fermentation in Iberian pigs under heat stress. *Animals*, 13: 1102.

Parrini, S.; Sirtori, F.; Čandek-Potokar, M.; Charneca, R.; Crovetti, A.; Kušec, I.D.; Sánchez, E.G.; Cebrián, M.M.I.; Haro García, A.; Karolyi, D.; Lebret, B.; Ortiz, A.; Panella-Riera, N.; Petig, M.; Jesus da Costa Pires, P.; Tejerina, D.; Razmaite, V.; Aquilani, C.; Bozzi, R. 2023. Prediction of fatty acid composition in intact and minced fat of European autochthonous pigs breeds by near infrared spectroscopy. *Scientific Reports,* 13: 7874.

Parveen, N.; Kandhol, N.; Sharma, S.; Singh, V.P.; Chauhan, D.K.; Ludwig-Müller, J.; Corpas, F.J.; Tripathi, D.K. 2023. Auxin crosstalk with reactive oxygen and nitrogen species in plant development and abiotic stress. *Plant and Cell Physiology,* 63: 1814-1825.

Peinado-Torrubia, P.; Álvarez, R.; Lucas, M.; Franco-Navarro, J.D.; Durán-Gutiérrez, F.J.; Colmenero-Flores, J.M.; Rosales, M.A. 2023. Nitrogen assimilation and photorespiration become more efficient under chloride nutrition as a beneficial macronutrient. *Frontiers in Plant Science*, 13: 1058774.

Perdomo-González, A.; Pérez-Reverón, R.; Goberna, M.; León-Barrios, M.; Fernández-López, M.; Villadas, P.J.; Reyes-Betancort, J.A.; Díaz-Peña, F.J. 2023. How harmful are exotic plantations for soils and its microbiome? A case study in an arid island. *Science of the Total Environment,* 879: 163030.

Perea, A.J.; Merelas-Meijide, B.; Alguacil, M.M.; Prieto-Rubio, J.; Azcón-Aguilar, C.; Alcántara, J.M.; Garrido, J.L.; López-García, A. 2023. Counteracting effects of soil biota on emergence and growth of herbaceous plants. *Plant and Soil,* 490: 279-290.

Pineda, M.; Barón, M. 2023. Assessment of black rot in oilseed rape grown under climate change

conditions using biochemical methods and computer vision. *Plants,* 12: 1322.

Prieto-Rubio, J.; Perea, A.; Garrido, J.L.; Alcántara, J.M.; Azcón-Aguilar, C.; López-García, A.; Rincón, A. 2023. Plant traits and phylogeny predict soil carbon and nutrient cycling in mediterranean mixed forests. *Ecosystems,* 26: 1047-1060.

Ramos, J.L.; Bernal, P.; Salvachúa, D. 2023. Microbial biotechnology in the effort to end hunger. *Microbial Biotechnology,* 16: 1581-1583.

Raza, A.; Charagh, S.; Abbas, S.; Hassan, M.U.; Saeed, F.; Haider, S.; Sharif, R.; Anand, A.; Corpas, F.J.; Jin, W.; Varshney, R.K. 2023. Assessment of proline function in higher plants under extreme temperatures. *Plant Biology,* 25: 379-395.

Rico-Jiménez, M.; Muñoz-Mira, S.; Lomas-Martínez, C.; Krell, T.; Matilla, M.A. 2023. Regulation of indole-3-acetic acid biosynthesis and consequences of auxin production deficiency in *Serratia plymuthica*. *Microbial Biotechnology,* 16: 1671-1689.

Roca, A.; Matilla, M.A. 2023. Microbial antibiotics take the lead in the fight against plant pathogens. *Microbial Biotechnology,* 16: 28-33.

Rodríguez-Ruiz, M.; Ramos, M.C.; Campos, M.J.; Díaz-Sánchez, I.; Cautain, B.; Mackenzie, T.A.; Vicente, F.; Corpas, F.J.; Palma, J.M. 2023. Pepper fruit extracts show anti-proliferative activity against tumor cells altering their NADPH-generating dehydrogenase and catalase profiles. *Antioxidants,* 12: 1461.

Romero, P.; Belanche, A.; Jiménez, E.; Hueso, R.; Ramos-Morales, E.; Salwen, J.K.; Kebreab, E.; Yáñez-Ruiz, D.R. 2023. Rumen microbial degradation of bromoform from red seaweed (*Asparagopsis taxiformis*) and the impact on rumen fermentation and methanogenic archaea. *Journal of Animal Science and Biotechnology,* 14: 133.

Romero, P.; Huang, R.; Jiménez, E.; Palma-Hidalgo, J.M.; Ungerfeld, E.M.; Popova, M.; Morgavi, D.P.; Belanche, A.; Yáñez-Ruiz, D.R. 2023. Evaluating the effect of phenolic compounds as hydrogen acceptors when ruminal methanogenesis is inhibited *in vitro* - Part 2. Dairy goats. *Animal,* 17: 100789.

Romero-Munar, A.; Aroca, R. 2023. A non-K^+-solubilizing PGPB (*Bacillus megaterium*) increased K^+ deprivation tolerance in *Oryza sativa* seedlings by up-regulating root K^+ transporters. *Plant Physiology and Biochemistry,* 196: 774-782.

Romero-Munar, A.; Aroca, R.; Zamarreño, A.M.; García-Mina, J.M.; Pérez-Hernández, N.; Ruiz-Lozano, J.M. 2023. Dual inoculation with Rhizophagus irregularis and *Bacillus megaterium* improves maize tolerance to combined drought and high temperature stress by enhancing root hydraulics, photosynthesis and hormonal responses. *International Journal of Molecular Sciences,* 24: 5193.

Romero-Puertas, M.C.; Lüthje, S.; Zabalza, A.; de Gara, L.; Foyer, C.H. 2023. Editorial: women in plant science - redox biology of plant abiotic stress 2022. *Frontiers in Plant Science,* 14: 1236150.

Salmerón-Santiago, I.A.; Martínez-Trujillo, M.; Valdez-Alarcón, J.J.; Pedraza-Santos, M.E.; Santoyo, G.; López, P.A.; Larsen, J.; Pozo, M.J.; Chávez-Bárcenas, A.T. 2023. Carbohydrate and lipid balances in the positive plant phenotypic response to arbuscular mycorrhiza: increase in sink strength. *Physiologia Plantarum,* 175: e13857.

Sánchez-Castro, I.; Molina, L.; Prieto-Fernández, M.A.; Segura, A. 2023. Past, present and future trends in the remediation of heavy-metal contaminated soil - remediation techniques applied in real soil-contamination events. *Heliyon,* 9: e16692.

Sánchez-Jiménez, A.; Llamas, M.A.; Marcos-Torres, F.J. 2023. Transcriptional regulators controlling virulence in *Pseudomonas aeruginosa*. *International Journal of Molecular Sciences,* 24: 11895.

Sánchez-Jiménez, A.; Marcos-Torres, F.J.; Llamas, M.A. 2023. Mechanisms of iron homeostasis in *Pseudomonas aeruginosa* and emerging therapeutics directed to disrupt this vital process. *Microbial*

Biotechnology, 16: 1475-1491.

Sandalio, L.M.; Collado-Arenal, A.M.; Romero-Puertas, M.C. 2023. Deciphering peroxisomal reactive species interactome and redox signalling networks. *Free Radical Biology and Medicine,* 197: 58-70.

Sandalio, L.M.; Espinosa, J.; Shabala, S.; León, J.; Romero-Puertas, M.C. 2023. Reactive oxygen species- and nitric oxide-dependent regulation of ion and metal homeostasis in plants. *Journal of Experimental Botany,* 74: 5970-5988.

Sanjuán, J.; Nápoles, M.C.; Pérez-Mendoza, D.; Lorite, M.J.; Rodríguez-Navarro, D.N. 2023. Microbials for agriculture: why do they call them biostimulants when they mean probiotics? *Microorganisms,* 11: 153.

Santos, A.M.; González, A.M.; Alché, J.D.; Santalla, M. 2023. Microscopical analysis of autofluorescence as a complementary and useful method to assess differences in anatomy and structural distribution underlying evolutive variation in loss of seed dispersal in common bean. *Plants,* 12: 2212.

Scribani Rossi, C.; Eckartt, K.; Scarchilli, E.; Angeli, S.; Price-Whelan, A.; Di Matteo, A.; Chevreuil, M.; Raynal, B.; Arcovito, A.; Giacon, N.; Fiorentino, F.; Rotili, D.; Mai, A.; Espinosa-Urgel, M.; Cutruzzolà, F.; Dietrich, L.E.P.; Paone, A.; Paiardini, A.; Rinaldo, S. 2023. Molecular insights into RmcA-mediated c-di-GMP consumption: linking redox potential to biofilm morphogenesis in *Pseudomonas aeruginosa*. *Microbiological Research,* 277: 127498.

Scribani-Rossi, C.; Molina-Henares, M.A.; Angeli, S.; Cutruzzolà, F.; Paiardini, A.; Espinosa-Urgel, M.; Rinaldo, S. 2023. The phosphodiesterase RmcA contributes to the adaptation of *Pseudomonas putida* to L-Arginine. *FEMS Microbiology Letters,* 370: fnad077.

Segura, A.; Jiménez, L.; Molina, L. 2023. Can microbiology help to make aviation more sustainable? *Microbial Biotechnology,* 16: 190-194.

Segura, A.; Molina, L. 2023. LuxR402 of *Novosphingobium* sp. HR1a regulates the correct configuration of cell envelopes. *Frontiers in Microbiology,* 14: 1205860.

Silva-Castro, G.A.; Cano, C.; Moreno-Morillas, S.; Bago, A.; García-Romera, I. 2023. Inoculation of indigenous arbuscular mycorrhizal fungi as a strategy for the recovery of long-term heavy metal-contaminated soils in a mine-spill area. *Journal of Fungi,* 9: 56.

Soto, M.J.; Pérez, J.; Muñoz-Dorado, J.; Contreras-Moreno, F.J.; Moraleda-Muñoz, A. 2023. Transcriptomic response of *Sinorhizobium meliloti* to the predatory attack of *Myxococcus xanthus*. *Frontiers in Microbiology,* 14: 1213659.

Taboada, J.; González-Gordo, S.; Muñoz-Vargas, M.A.; Palma, J.M.; Corpas, F.J. 2023. NADP-dependent malic enzyme genes in sweet pepper fruits: involvement in ripening and modulation by nitric oxide (NO). *Plants,* 12: 2353.

Terrón-Camero, L.C.; Molina-Moya, E.; Peláez-Vico, M.A.; Sandalio, L.M.; Romero-Puertas, M.C. 2023. Nitric oxide and globin Glb1 regulate *Fusarium oxysporum* infection of *Arabidopsis thaliana*. *Antioxidants,* 12: 1321.

Toral, P.G.; Abecia, L.; Hervás, G.; Yáñez-Ruiz, D.R.; Frutos, P. 2023. Plasma and milk metabolimics in lactating sheep divergent for feed efficiency. *Journal of Dairy Science,* 106: 3947-3960.

Tortosa, G.; Mesa, S.; Delgado, M.J.; Amaya-Gómez, C.V. 2023. “Alperujo" compost improves nodulation and symbiotic nitrogen fixation of soybean inoculated with *Bradyrhizobium diazoefficiens*. *Nitrogen,* 4: 223-230.

Tripathi, D.K.; Rai, P.; Kandhol, N.; Kumar, A.; Sahi, S.; Corpas, F.J.; Sharma, S.; Singh, V.P. 2023. Silicon palliates chromium toxicity through the formation of root hairs in rice (*Oryza sativa*) mediated by GSH and IAA. *Plant and Cell Physiology,* 63: 1943-1953.

Velando, F.; Matilla, M.A.; Zhulin, I.B.; Krell, T. 2023. Three unrelated chemoreceptors provide *Pectobacterium atrosepticum* with a broad-spectrum amino acid sensing capability. *Microbial Biotechnology,* 16: 1548-1560.

Verdú, M; Garrido, J.L. *et al.* 2023. RecruitNet: a global database of plant recruitment networks. *Ecology,* 104: e3923.

Wentzien, N.M.; Fernández-González, A.J.; Villadas, P.J.; Valverde-Corredor, A.; Mercado-Blanco, J.; Fernández-López, M. 2023. Thriving beneath olive trees: the influence of organic farming on microbial communities. *Computational and Structural Biotechnology Journal,* 21: 3575-3589.

Wittich, R.M.; Haïdour, A.; Aguilar-Romero, I.; de la Torre-Zúñiga, J.; van Dillewijn, P. 2023. Biodegradation of microtoxic phenylpropanoids (phenylpropanoic acid and ibuprofen) by bacteria and the relevance for their removal from wastewater treatment plants. *Genes,* 14: 442.

Xu, W.; Cerna-Vargas, J.P.; Tajuelo, A.; Lozano-Montoya, A.; Kivoloka, M.; Krink, N.; Monteagudo-Cascales, E.; Matilla, M.A.; Krell, T.; Sourjik, V. 2023. Systematic mapping of chemoreceptor specificities for *Pseudomonas aeruginosa*. *mBio,* 14: e02099-23.

Zhang, B.; Lin, S.; Moraes, L.; Firkins, J.; Hristov, A.N.; Kebreab, E.; Janssen, P.H.; Bannink, A.; Bayat, A.R.; Crompton, L.A.; Dijkstra, J.; Eugène, M.A.; Kreuzer, M.; McGee, M.; Reynolds, C.K.; Schwarm, A.; Yáñez-Ruiz, D.R.; Yu, Z. 2023. Methane prediction equations including genera of rumen bacteria as predictor variables improve prediction accuracy. *Scientific Reports,* 13: 21305.

Zuber, N.E.; Fornasero, L.V.; Erdozain Bagolín, S.A.; Lozano, M.J.; Sanjuán, J.; del Papa, M.F.; Lagares, A. 2023. Diversity, genomics and symbiotic characteristics of sinorhizobia that nodulate *Desmanthus* spp. in Northwest Argentina. *Biology,* 12: 958.

Zuccarelli, R.; Rodríguez-Ruiz, M.; Silva, F.O.; Gomes, L.D.L.; Lopes-Oliveira, P.J.; Zsögön, A.; Andrade, S.C.S.; Demarco, D.; Corpas, F.J.; Peres, L.E.P.; Rossi, M.; Freschi, L. 2023. Loss of S-nitrosoglutathione reductase disturbs phytohormone homeostasis and regulates shoot side branching and fruit growth in tomato. *Journal of Experimental Botany,* 74: 6349-6368.

EDITION OF BOOKS

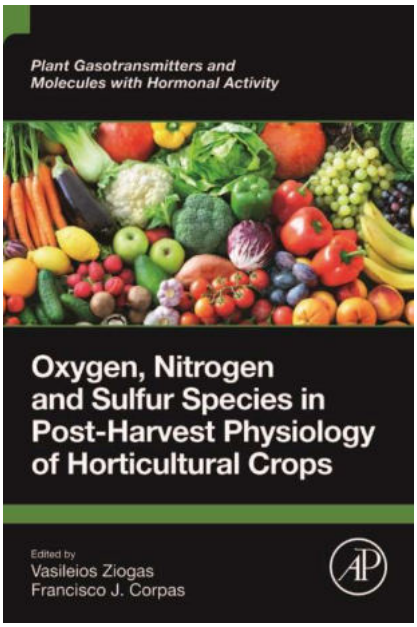
Drought. Science for Public Policy. 2023. Editors/coordinators: Rosales Villegas, M.A.; Vicente Serrano, S.M.; Beguería Portugués, S.; Hernández Santana, V.; Durán Valsero, J.J.; Camarero Martínez, J.J. Ed.: Consejo Superior de Investigaciones Científicas, 80 pp. NIPO: 155-24-096-4.

High School Students for Agricultural Science Research, Vol. 12. 2023. Editors: Alché, J.D.; Espinosa, M.; Martínez-Abarca, F.; Palma, J.M.; Quesada, A. Estación Experimental del Zaidín-CSIC. 102 pp. ISSN: 2340-9746.

La Barraca de la Ciencia. 2023. Editors: Rodríguez Arós, I. "Esfenodon"; Sánchez, J.; Docampo Fernández, M.; Carmona Peral, O.; García Martínez, V.; Cordón, J.M.; Cárcamo Rojas, F. "Panchulei"; Arias Baldrich, C.; Vaca, M.; Tortosa Muñoz, G. (Coordinator). Ed.: Hablando de Ciencia y Ciencia en Cómic. 32 pp. ISBN: 978-84-09-49709-6.

Oxygen, Nitrogen and Sulfur Species in Post-Harvest Physiology of Horticultural Crops. 2023. Editors: Ziogas, V; Corpas, F.J. Academic Press. 394 pp. ISBN: 978-0-323-91798-8.

Sequías. Ciencia para las políticas públicas. 2023. Editors/coordinators: Rosales Villegas, M.A.; Vicente Serrano, S.M.; Beguería Portugués, S.; Hernández Santana, V.; Durán Valsero, J.J.; Camarero Martínez, J.J. Ed.: Consejo Superior de Investigaciones Científicas, 79 pp. NIPO: 833-23-081-9.



Cover of the book "Oxygen, Nitrogen and Sulfur Species in Post-Harvest Physiology of Horticultural Crops", which was edited by V. Ziogas and F.J. Corpas

BOOK CHAPTERS

Bedmar, E.J.; Delgado, M.J.; Mesa, S.; Tortosa, G.; Rodiño, A.P.; Tejada-Hinojoza, J.L.; De Ron, A.M. 2023. Legume inoculants using rhizobia strains effective to reduce nitrous oxide emissions. In: *Climate change and legumes: stress mitigation for sustainability and food security*. CRC Press, pp. 43-59. ISBN: 978-1-032-07984-4.

Belanche, A.; Yáñez-Ruiz, D.R. 2023. Microbiota digestiva en rumiantes. In: *La Microbiota en el Ámbito Veterinario y su Modulación*. Ergon Verlag, pp. 55-60. ISBN: 978-84-19230-20-1.

Belanche, A.; Yáñez-Ruiz, D.R. 2023. Trasplante de microbiota digestiva en rumiantes. In: *La Microbiota en el Ámbito Veterinario y su Modulación*. Ergon Verlag, pp. 291-295. ISBN: 978-84-19230-20-1.

Corpas, F.J.; Palma, J.M. 2023. Assay of Reactive Oxygen/Nitrogen Species (ROS/RNS) in Arabidopsis peroxisomes through fluorescent protein containing a type1 Peroxisomal Targeting Signal (PTS1). In: *Peroxisomes: Methods and Protocols, Methods in Molecular Biology, 2643*. Humana Press, pp. 149-160. ISBN: 978-1-0716-3047-1.

Corpas, F.J.; Palma, J.M. 2023. Functions of NO and H_2S signal molecules against plant abiotic stress. In: *Plant Abiotic Stress Signaling, Methods in Molecular Biology*, 2642. Humana Press, pp. 97-107. ISBN: 978-1-0716-3043-3.

González-Gordo, S.; Palma, J.M.; Corpas, F.J. 2023. Assessment of the subcellular generation of hydrogen sulfide (H_2S) in fleshy fruits: tomato and pepper. In: *Oxygen, Nitrogen and Sulfur Species in Post-Harvest Physiology of Horticultural Crops*. Academic Press, pp. 163-179. ISBN: 978-0-323-91798-8.

Mesías, M.; Delgado-Andrade, C.; Morales Navas, F.J. 2023. Acrylamide in Bakery Products. In: *Acrylamide in Foods. Secondd Edition*. Academic Press, Elsevier S&T Books; United Kingdom, pp. 133-160. ISBN: 978-0-323-99119-3.

Palma, J.M.; Pérez del Palacio, J.; Rodríguez-Ruiz, M.; González-Gordo, S.; Díaz, C.; Ramos, C.; Cautain, B.; Vicente, F.; Corpas F.J. 2023. Pepper fruit, as a nutraceutical food, shows antiproliferative activity against tumor cells and it is potentiatied by nitric oxide (NO). In: *Nitric Oxide in Health and Disease. Therapeutic Applications in Cancer and Inflammatory Disorders*. Academic Press-Elsevier, pp. 193-210. ISBN: 978-0-443-13342-8.

Rodríguez Gómez, J.M.; Clemente, A.; Requena, T. 2023. Métodos de manipulación de la microbiota. Conceptos generales. In: *La Microbiota en el Ámbito Veterinario y su Modulación*. Ergon Verlag, pp. 221-228. ISBN: 978-84-19230-20-1.

Taboada, J.; Reiter, R.J.; Palma, J.M.; Corpas, F.J. 2023. Melatonin and the metabolism of Reactive Oxygen Species (ROS) in higher plants. In: *Melatonin: Role in Plant Signaling, Growth and Stress Tolerance, Plant in Challenging Environments 4*. Springer Nature, pp. 3-25. ISBN: 978-3-031-40172-5.

Yáñez-Ruiz, D.R.; Belanche, A. 2023. Probióticos y prebióticos en rumiantes. In: *La Microbiota en el Ámbito Veterinario y su Modulación*. Ergon Verlag, pp. 249-253. ISBN: 978-84-19230-20-1.

Ziogas, V.; Hancock, J.T.; Corpas, F.J. 2023. Reactive oxygen, nitrogen, and sulfur species cellular crosstalk. In: *Oxygen, Nitrogen and Sulfur Species in Post-Harvest Physiology of Horticultural Crops*. Academic Press, pp. 247-271. ISBN: 978-0-323-91798-8.

WORKSHOPS AND MEETINGS

Bacterial Locomotion and Signal Transduction XVII (BLAST XVII)
Member of the Organizing Committee: Tino Krell
Charleston, USA, 15-20 January 2023

XIV Workshop of the Spanish Society of Microbiota, Probiotics and Prebiotics
Member of the Scientific Committee: Alfonso Clemente Gimeno
Pamplona, 8-10 March 2023

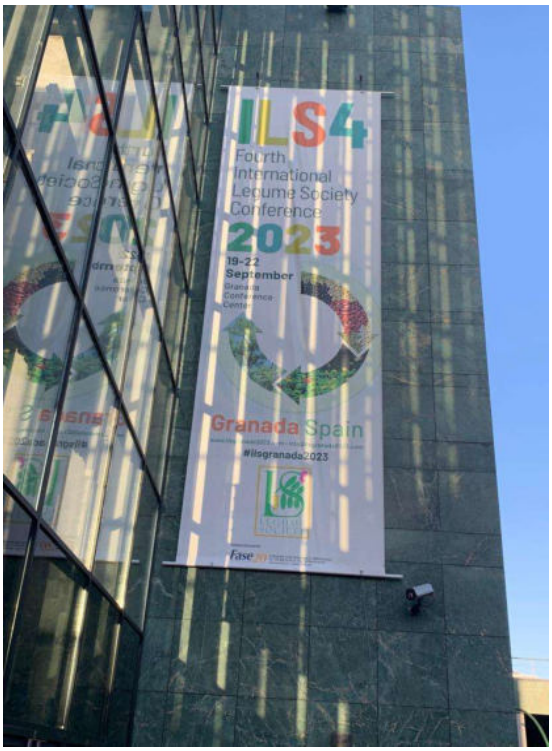
III Symposium of the Plant-Soil Interactions Group, Ecological Asociation of Terrestrial Ecology (AEET)
Member of the Organizing Committee: Álvaro López García
Barcelona, 6-7 June 2023

International Workshop Plant-Microbe-Soil Interactions in the Context of Climate Change
EEZ-CSIC, Granada, 5-7 July 2023
Organizer: Concepción Azcón González de Aguilar

Plant Biology 2023 Congress (IPB2023). XVIII Portuguese-Spanish Congress on Plant Biology and the XXV Meeting of the Spanish Society of Plant Biology
Braga, Portugal, 9-12 July 2023
Member of the Scientific Committee: José Manuel Palma Martínez

---

4th International Legume Society Conference 2023 (ILS4)
Granada, 19-22 September de 2023
Member of the Scientific Committee: Alfonso Clemente Gimeno
Members of the Organizing Committee: Alfonso Clemente Gimeno, Cristina Delgado Andrade, Mª Jesús Delgado Igeño, José Carlos Jiménez López, Raquel Olías Sánchez, Juan Sanjuán Pinilla, Luis Rubio San Millán



Microscopy at the Frontiers of Science Conference (MFS2023)
Congress of the Portuguese and Spanish Microscopy Societies
Braga, Portugal, 26-29 September 2023
Member of the Organizing and Scientific Committees: Juan de Dios Alché

II Conference of Young Researchers of the EEZ
Granada, EEZ-CSIC, 30th November 2023
Organizing Committee: Mª Isabel Recio Muñoz, Eva Mª Romera Recio, Roberta Genova, Mª del Rocío Fernández González, José Manuel Palma

Project Meeting: Towards identifying Common Patterns of Microbe-induced Plant Resistance against Insect Pests (European Project, H2020-MSCA-ITN-ETN/0359)
PI and Meeting organizer: Mª José Pozo Jiménez
EEZ-CSIC, 6-10 March 2023

AWARDS

Matilde Barón received the Special Distinction to Women at the 9th edition of the AOVE Awards for the Best Extra Virgin Olive Oils "SABOR GRANADA", awarded by the Diputación de Granada. 30th May 2023.

Award to Cooperativa San Isidro de Loja for the "Best Circular Economy Project", which is based on the European research project H2020 AgriForValor, from the Operational Group OLEOVALORIZA, PI the EEZ: Rogelio Nogales.
II Edition of the Andalucía ES Awards, Department of Employment, Enterprise and Self-Employment, Junta de Andalucía (Consejería de Empleo, Empresa y Trabajo Autónomo).
Sevilla, 27th March 2023.

of

XXV Fertiberia Award for the Best Doctoral Thesis in agricultural topics to Dr. Juan de Dios Franco Navarro (Fertiberia/Universidad Politécnica de Madrid). Title: Chloride functions as a beneficial macronutrient in higher plants, supervisors: **Miguel A. Rosales Villegas** and José Manuel Colmenero Flores. Award presented on 15th February 2024, in a ceremony presided by the Director General for Rural Development, Innovation and Agri-Food Training, of the Ministry of Agriculture, Fisheries and Food, Isabel Bombal.

Eighteen active EEZ-CSIC researchers are included in the list of the most cited researchers in the world in 2022. The report updated annually by Stanford University, USA, (Ranking of the World

Scientists: World's Top 2% Scientists), has been published in October 2023. It analyzes the production and impact of scientific publications, as well as the number of times their work has been cited in other publications. Regarding the total research career (until the end of 2022), the report includes a total of **13 active EEZ-CSIC researchers** as part of the group of most outstanding authors. In both cases, the number of people from the Center in this list is increased with respect to the 2021 data. These are the most cited active EEZ authors in 2022:

- Plant Biology and Botany: Francisco Javier Corpas, Juan Manuel Ruiz Lozano, Ricardo Aroca, Mª José Pozo, José Manuel Palma, Luisa Mª Sandalio, Jesús Mercado Blanco, Juan A. López Raez, María C. Romero Puertas, Concepción Azcón, Juan de Dios Alché
- Microbiology: Juan L. Ramos, Tino Krell, Miguel Matilla
- Food Science: Alfonso Clemente, Cristina Delgado
- Nutrition and Dietetics: Eduardo López-Huertas
- Dairy and Animal Science: David R. Yáñez

The University of Granada recognized the **EEZ for its contribution to the practical training of students**, during the academic year 2022-2023, by the Employment and Work Placement Office of the UGR, and at the proposal of the organization of the UGR Bachelor's Degree in Biotechnology. The ceremony was attended by the Rector of the UGR, Pedro Mercado, the Vice-Rector for Social Innovation, Employability and Entrepreneurship, Esteban Romero, and the Director of the Employment and Work Placement Office, María del Mar Ortiz. 9th November 2023.

TEACHING ACTIVITIES

DOCTORAL PROGRAMMES

Participation in Commitees and/or teaching activities in the next Doctoral programmes:

Doctoral Programme in Biochemistry and Molecular Biology. University of Granada
Academic Committee member: Mariam Sahrawy Barragán
https://doctorados.ugr.es/bioquimicaybiologiamolecular/

Doctoral Programme in Fundamental and Systems Biology. University of Granada
Academic Committee secretary: Nuria Ferrol González
Academic Committee members: José Manuel Palma Martínez, Nuria Ferrol González, Mª Jesús Delgado Igeño, Marian llamas Lorente
Committee for Internal Quality members: Nuria Ferrol González, Juan Manuel Palma Hidalgo
https://doctorados.ugr.es/biologiafundamentalydesistemas/

Doctoral Programme in Nutrition and Food Sciences. University of Granada
Academic Committee members: Cristina Delgado Andrade, Isabel Seiquer Gómez-Pavón
Committee for Internal Quality members: Cristina Delgado Andrade
https://doctorados.ugr.es/nutricion-alimentacion/

Doctoral Programme in Sustainable Development: Environment, Food and Health (Dottorato di Ricerca in Sviluppo Sostenibile: Ambiente, Alimenti e Salute). Universita Campus Bio-Medico di Roma, Italy
Academic Committee member: Luisa Mª Sandalio González
https://www.unicampus.it/master-phd/ciclo-xxxviii-dottorato-di-ricerca-in-sviluppo-sostenibile-ambiente-alimenti-e-salute/

Doctoral Programme in Environmental and Evolutionary Biology. Università di Roma "La Sapienza"
Member of the Scientific Board: F. Javier Corpas Aguirre
https://phd.uniroma1.it/web/ENVIRONMENTAL-AND-EVOLUTIONARY-BIOLOGY_nD3488_EN.aspx

MASTER PROGRAMMES

Participation in Commitees and/or teaching activities in the next Master programmes:

Master in Advances in Agricultural Biology and Aquaculture. University of Granada
Academic Committee members: María C. Romero Puertas, A. Ignacio Martín García
Committee for Internal Quality member: Juan de Dios Alché Ramírez
https://masteres.ugr.es/agraria-acuicultura/

Master in Biotechnology. University of Granada
Academic Committee member: Manuel Fernández López
https://masteres.ugr.es/biotecnologia/

Master in Genetics and Evolution. University of Granada
Academic Committee member: Francisco Martínez-Abarca Pastor
https://masteres.ugr.es/genevol/

Master in Microbiota, Probiotics and Prebiotics. European University Madrid and Spanish Society of Microbiota, Probiotics and Prebiotics (SEMIPyP)
Co-director of the Master: Alfonso Clemente Gimeno
https://universidadeuropea.com/master-microbiota-probioticos-prebioticos-online/

Master in Research and Advances in Microbiology. University of Granada
Academic Committee member: Mª Socorro Mesa Banqueri
Committee for Internal Quality member: Mª Socorro Mesa Banqueri
Evaluation Committee Member: Miguel A. Matilla Vázquez.
https://masteres.ugr.es/microbiologia/

Master in Advanced Biotechnology. University of Málaga and International University of Andalusia
https://www.uma.es/master-en-biotecnologia-avanzada/

Master in Agroecology, Food Sovereignty, Urban Ecology and Cooperation in Rural Development. University of La Laguna (ULL), Institute of Ecological and Sustainable Agriculture Foundation and Agricultural Research Institute of Canarias (ICIA)
https://www.ull.es/titulospropios/master-propio-agroecologia-soberania-alimentaria/

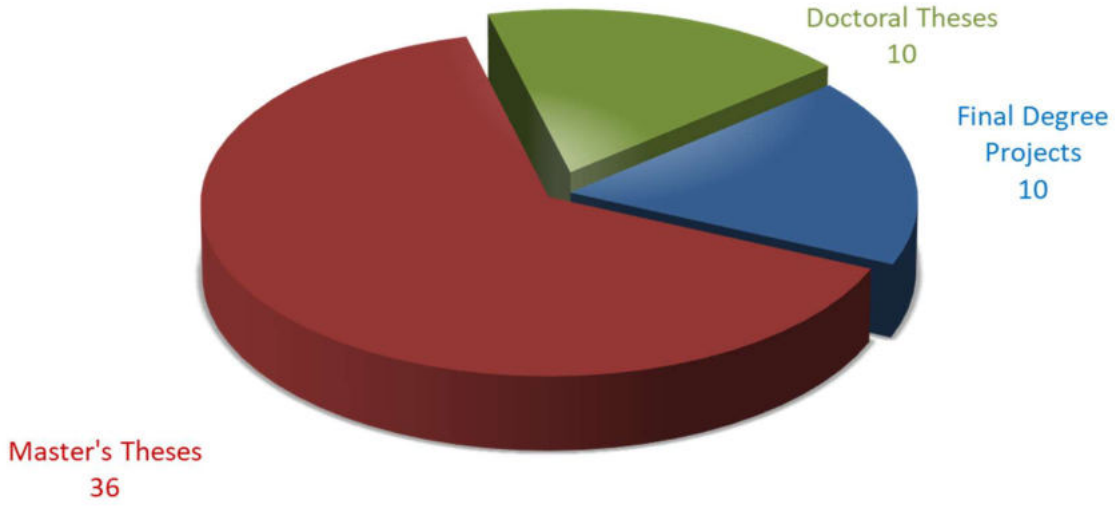
Master in Conservation, Management and Restoration of Biodiversity. University of Granada
https://www.ugr.es/en/study/masters-degree/masters-degree-biodiversity-conservation-management-and-restoration

Master in Management, Treatment and Use of Organic Waste. Miguel Hernandez University of Elche
http://masterresiduos.edu.umh.es/

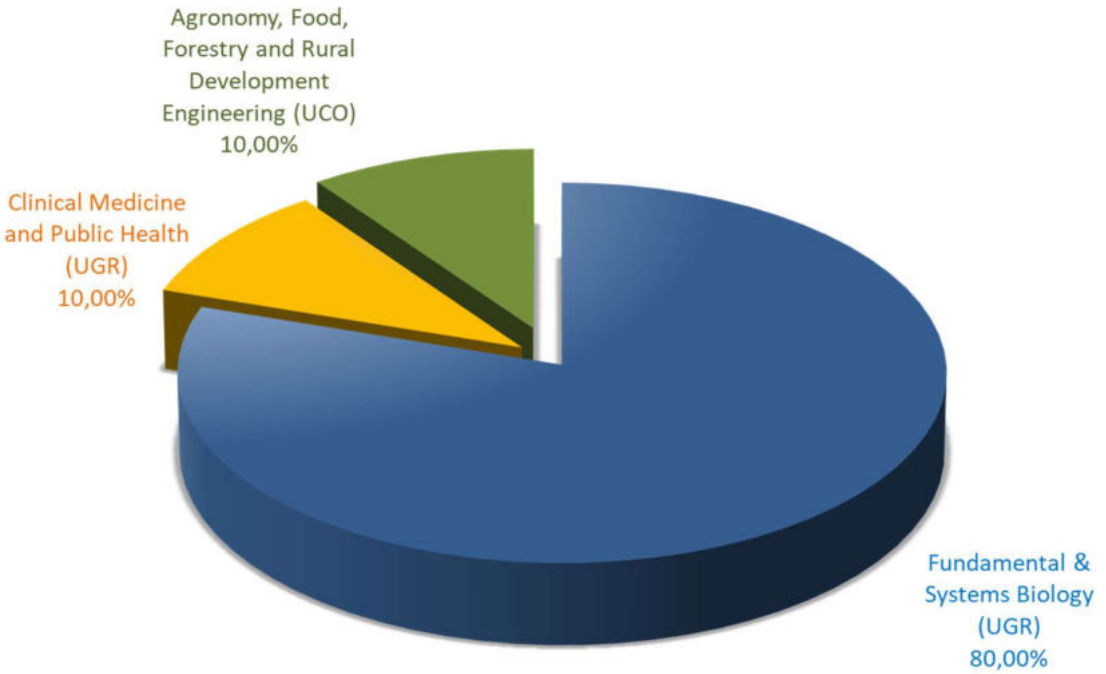
Master in Molecular Biology Applied to Biotechnology Companies (BioEnterprise). University of Granada
https://masteres.ugr.es/bioenterprise/

Master in Organic Agriculture and Livestock. International University of Andalusia (UNIA)
https://www.upo.es/postgrado/Master-Oficial-Agricultura-y-Ganaderia-Ecologicas

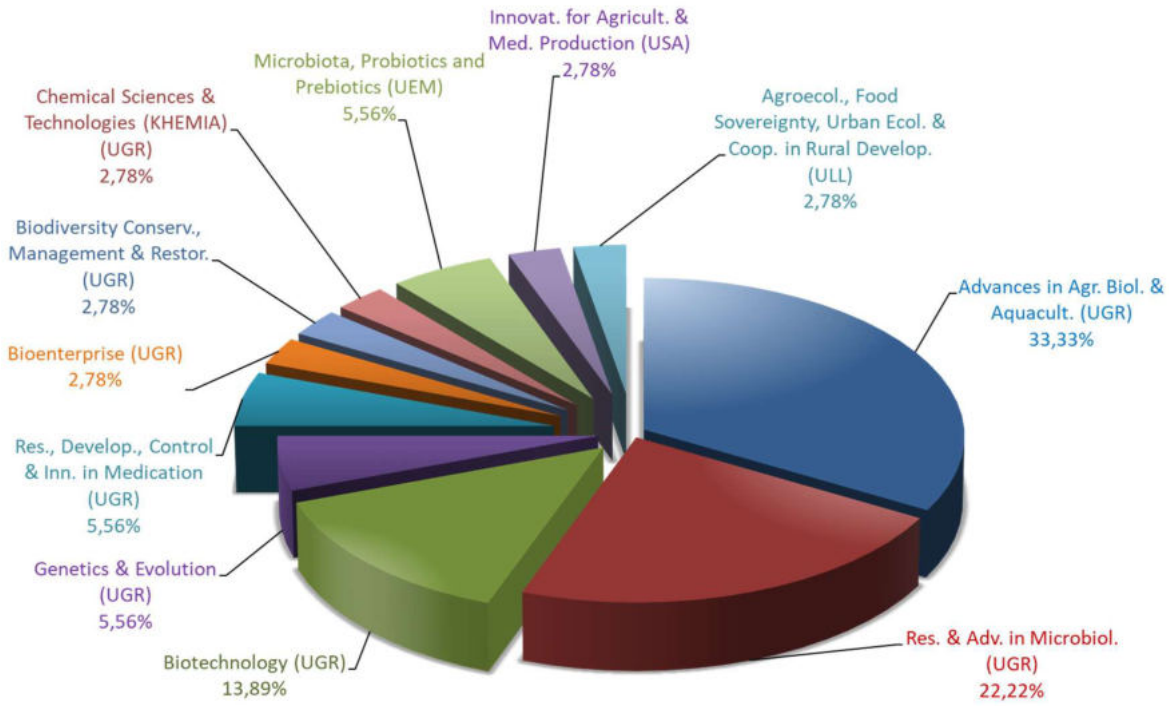
DOCTORAL THESES, MASTER´S THESES & FINAL DEGREE PROJECTS



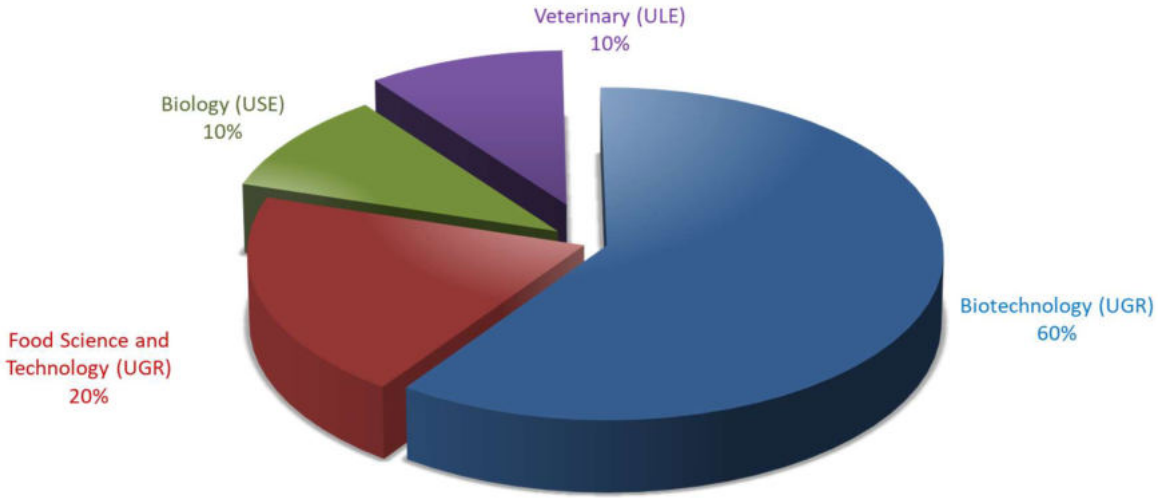
Number of Doctoral Theses, Master's Theses & Final Degree Projects defended at EEZ during 2023



PhD Theses distribution in different Doctoral Programmes



Master's Theses distribution in different Master Programmes



Final Degree Projects distribution in different Degree Programmes

DOCTORAL THESES

Omic approaches to manage Verticillium wilt of olive: the olive root microbiome and host and pathogen gene expression patterns in relation with disease susceptibility
Author: **Martina Cardoni**
Supervisors: Jesús Mercado Blanco
University of Córdoba, 16th June 2023

Signaling in induced resistance by arbuscular mycorrhizal fungi against insect pests in tomato
Author: **Laura Dejana**
Supervisors: Jordi Gamir Felip, Mª José Pozo Jiménez
University of Granada, 20th July de 2023

Narrow leafed lupin (*Lupinus angustifolius* L.) SS-conglutin proteins as new preventive, cytotoxic and radiosensitizing agents against breast cancer cells
Author: **Julia Escudero Feliu**
Supervisor: José Carlos Jiménez López
University of Granada, 31st March 2023

Emission of the greenhouse gas nitrous oxide by the *Rhizobium etli-Phaseolus vulgaris* symbiosis
Author: **Alba Hidalgo García**
Supervisors: Mª Jesús Delgado Igeño and María Jesús Torres Porras
University of Granada, 16th June 2023

Signaling in mycorrhizal symbiosis: regulation of colonization and mycorrhiza-induced resistance against pests in tomato
Author**: Javier Lidoy Logroño**
Supervisors: Juan Antonio López Ráez, Mª José Pozo Jiménez
University of Granada, 20th January 2023

Characterization of iron transporters in arbuscular mycorrhiza and their impact on symbiotic functioning
Author: **Víctor Manuel López Lorca**
Supervisor: Nuria Ferrol González
University of Granada, 10th March 2023

Design and characterization of microbial consortia as inoculants for sustainable crop protection
Author: **Zhikvo Minchev Ivanov**
Supervisor: Mª José Pozo Jiménez
University of Granada, 14th June 2023

Effect of copper on the nitrous oxide emission from denitrification by the rhizobium-legume symbiosis
Author: **Pedro José Pacheco Márquez**
Supervisors: Germán Tortosa Muñoz, Mª Jesús Delgado Igeño
University of Granada, 13th January 2023

Nutritional strategies for reducing methane production and improving the efficiency of rumen fermentation
Author: **Pedro Jesús Romero Márquez**

Supervisor(s): David R. Yáñez Ruiz, Alejandro Belanche Gracia
University of Granada, 18th December 2023

Chemotaxis in *Pectobacterium atrosepticum* Scri1043: functional and structural studies on chemotaxis adaptation proteins and chemoreceptors
Author: **Félix Velando Soriano**
Supervisors: Tino Krell, Miguel Ángel Matilla Vázquez
University of Granada, 29 September 2023

MASTER´S THESES

Capacidad de germinación y colonización de esporas encapsuladas de *Rhizophagus irregularis* en lechuga y tomate
Author: Abraham Araña Padilla
Supervisors: Juan Antonio López Ráez, Mª José Pozo Jiménez
University of Granada

Estudios sobre un regulador de tipo TetR de *Myxococcus xanthus* que actúa durante la depredación sobre *Sinorhizobium meliloti*
Author: Mario Araujo Garrido
Supervisors: Mª Trinidad Gallegos Fernández, José Muñoz Dorado (UGR)
University of Granada

Use of remote sensing (drone and Sentinel-2 satellite) and GIS tools to evaluate the effect of prescribed burning on. Different rush communities in the Sierra de los Filabres
Author: Luis Benito González
Supervisors: Ana Belén Robles Cruz, Mª Eugenia Ramos Font
University of Granada

Implicación de la sensibilidad a las citoquininas en la regulación de las características hidráulicas de la raíz mediada por la simbiosis micorrícico arbuscular en condiciones de sequía
Author: Ana Isabel Berrocal Calle
Supervisors: Ricardo Aroca Álvarez, Antonia Romero Munar
University of Granada

Identificación de biomarcadores genéticos en la vía WNT asociados a la Enfermedad Cardiovascular y la DM2
Author: Miguel Briegas Macías
Supervisors: José C. Jiménez López, Sonia Morales Santana
University of Granada

Efecto de las micorrizas sobre la interacción fósforo-hierro en plantas de tomate
Author: Nerea Cáceres Ortega
Supervisor: Nuria Ferrol González
University of Granada

Bases moleculares de la emisión y actividad biológica de volátiles bacterianos con aplicaciones en Agrobiotecnología
Author: Cristina Carvia Hermoso
Supervisors: Pieter van Dillewijn, Mª José Soto Misffut
University of Granada

Estudios sobre el factor de transcripción Dof Affecting Germination 1 (DAG1) y su relación con las enzimas FBPasa citosólica y cloroplastídica en muestras vegetales de *Arabidopsis thaliana*
Author: Rafael Cazorla Vilches
Supervisor: Mariam Sahrawy Barragán
University of Granada

Caracterización de mutantes del gen ATG8h y su relación en la respuesta de la autofagia al estrés por cadmio
Author: Laura Domínguez Pérez
Supervisor: Luisa Mª Sandalio González
University of Granada

Efecto de una intervención inmnonutricional en la población de bacteroidetes implicada en patologías metabólicas
Author: Mª Victoria Espada Aguirre Mier
Supervisor: Alfonso Clemente Gimeno
European University of Madrid

Evaluación de la actividad fitoestimulante del alpeorujo biorremediado por hongos saprobios
Author: Mª Camila Espinosa Araque
Supervisors: Gloria Andrea Silva Castro, Inmaculada García Romera
University of Granada

Mechanisms involved in the protection of tomato plants by mycorrhiza against *Tuta absoluta*
Author: Marina García Alonso
Supervisors: Martín Aguirrebengoa, Mª José Pozo Jiménez
University of Granada

Estudio del efecto del riego con agua salina sobre el crecimiento, la nutrición mineral y los niveles de estrés oxidativo en el olivo (Olea europaea L. cv. Arbequina)
Author: Estela Gázquez Rodríguez
Supervisors: Juan de Dios Alché Ramírez, Antonio Jesús Castro López
University of Granada

Análisis de mutantes afectados en la producción de celulosa por *Starkeya* sp.
Author: Lidia Generelo Casajús
Supervisors: Silvia Marqués, Sophie Marie Martirani von Avercron
University of Granada

Identificación de aislados obtenidos de nódulos de *Phaseolus vulgaris* y evaluación de su eficiencia **simbiótica**
Author: Manuel Jesús Gilabert Ruiz
Supervisors: Germán Tortosa Muñoz, Mª Jesús Delgado Igeño
University of Granada

Aproximación biotecnológica de reguladores de tipo NnrR de rizobios
Author: Miguel Ángel Giménez Parra
Supervisors: Juan José Cabrera Rodríguez, Mª Socorro Mesa Banqueri
University of Granada

Análisis funcional de las peroxidasas en frutos de pimiento con contenido diferencial de capsaicinoides
Author: Candela Guiral Sánchez
Supervisors: F. Javier Corpas, José Manuel Palma
University of Granada

Revalorización de subproductos del aceite de oliva mediante su utilización en alimentación de rumiantes
Author: María de la Luz Hernández Acosta
Supervisor: Antonio Ignacio Martín García
University of Granada

Productos naturales con poder terapéutico identificados en frutos de pimiento dulce
Author: Bibiana Herrera García
Supervisors: José Manuel Palma, José Pérez del Palacio (Fundación MEDINA)
University of Granada

Regulación de la resistencia inducida por micorrizas por condiciones de deficiencia de hierro
Author: Martin Juárez Fernández
Supervisors: Mª José Pozo Jiménez, Nuria Ferrol González
University of Granada

Modulación de la síntesis de capsaicina en frutos de pimiento (*Capsicum annuum* L)
Author: Alberto Jurado Flores
Supervisors: José Manuel Palma, F. Javier Corpas
University of Granada

Análisis de la interacción fósforo-hierro en plantas micorrizadas de tomate (*Solanum Lycopersicum* L.)
Author: Alessandra Lepore
Supervisor: Nuria Ferrol González
University of Salerno, Italy

Función de la Acil-CoA oxidasa 1 (ACX1) en la regulación de la entrada y translocación de metales en plantas de *Arabidopsis thaliana*
Author: Rosa López García
Supervisors: Luisa Mª Sandalio González, María C. Romero Puertas
University of Granada

Landscape didactic guide: species selection. A bridge towards a sustainable and resilient gardening
Author: Carlos David Marrero Robayna
Supervisor: Mª Eugenia Ramos Font
University of La Laguna

Mecanismos moleculares de la quimiotaxis a acetilcolina en bacterias fitopatógenas
Author: Ana Molina Ollero
Supervisors: Miguel Ángel Matilla Vázquez, Miriam Rico Jiménez
University of Granada

Producción del gas de efecto invernadero N_2O por la simbiosis *Bradyrhizobium diazoefficiens Glycine max*
Author: Sara Pérez González
Supervisors: Mª Jesús Delgado Igeño, Alba Hidalgo García

University of Granada

Aislamiento y caracterización de bacterias fijadoras de nitrógeno presentes en la filosfera, rizosfera y endosfera de un cultivo de tomate ecológico
Author: Ana María Ramírez Martín
Supervisors: Germán Tortosa Muñoz, Mª Jesús Delgado Igeño
University of Granada

Estudio de la estructura-función de proteínas de semillas de legumbres con interés agro-industrial y biomédico
Author: Cristina Reyes Ruiz
Supervisor: José Carlos Jimenez Lopez
University of Granada

Modulación de la microbiota intestinal con efectos positivos en la salud a través de una intervención inmunonutricional
Author: Clarissa Richell de la Cruz
Supervisor: Alfonso Clemente Gimeno
European University of Madrid

Optimización de la producción de biopolímeros bacterianos
Author: Lucía Ruiz Sáez
Supervisors: Daniel Pérez Mendoza, Juan Sanjuán Pinilla
University of Granada

Regulación de la expresión de las proteínas Rsm en *Pseudomonas* syringae pv. tomato DC3000
Author: María Rusillo Rodríguez
Supervisor: Mª Trinidad Gallegos Fernández
University of Granada

Efectos potenciadores de diversos aceites sobre la normofisiología de células sanguíneas en patologías de origen oxidativo e inflamatorio
Author: María Salas Sánchez
Supervisors: Elena Lima Cabello, Juan de Dios Alché Ramírez
University of Granada

Encapsulación de un aditivo antimetanogénico para la opimización de su eficacia
Author: Alberto Manuel Sánchez García
Supervisor: Antonio Ignacio Martín García
University of Granada

Análisis transcriptómico del metabolismo de la melatonina en frutos de pimiento
Author: Jorge Taboada de la Rosa
Supervisors: F. Javier Corpas, José Manuel Palma
University of Granada

Application of distribution models of *Androcymbium europaeum* as a conservation tool
Author: Claudia Tribaldos Anda
Supervisors: Antonio J. Pérez Luque, Ana Belén Robles Cruz
University of Granada

Regulación de la expresión de los ARN Rsm en *Pseudomonas syringae* pv. tomato DC3000
Author: Adriana Vásquez Rodríguez
Supervisor: Mª Trinidad Gallegos Fernández
University of Granada

FINAL DEGREE PROJECTS

Caracterización del proteoma del mesocarpo de la aceituna
Author: Paula Ellson García
Supervisor: Juan de Dios Alché Ramírez
University of Granada

Uso de insectos como ingrediente alternativo en nutrición de rumiantes
Author: Cristina Fernández González
Supervisors: Ignacio Fernández-Fígares Ibáñez, Iván Mateos Álvarez (University of León)
University of León

Estudio de rizoremediación para la eliminación de diésel en suelos contaminados
Author: Pablo Garrido Peláez
Supervisor: Pieter van Dillewijn
University of Granada

Mecanismo de acción de compuestos de frutos de pimiento sobre células tumorales
Author: María Lacalle García
Supervisors: José Manuel Palma, Rafael Giménez (University of Granada)
University of Granada

Construcción de un biosensor de c-di-GMP para Rizobiáceas
Author: Marta Maldonado Moreno
Supervisors: Daniel Pérez Mendoza, Vanessa Martos Núñez (University of Granada)
University of Granada

Estudio de la fertilización con cloruro en plantas de lechuga para mejorar el uso del nitrato en la agricultura
Author: Victoria María Quintero Muñiz
Supervisors: Miguel Ángel Rosales Villegas, Rosario Álvarez Morales (University of Sevilla)
University of Sevilla

Papel de determinadas señales ambientales en la formación de biopelículas por *Pseudomonas stutzeri*
Author: Mª Teresa Rodríguez González
Supervisor: Manuel Espinosa Urgel
University of Granada

Caracterización de factores de transcripción dependiente de H_2O_2 peroxisomal en la interacción planta-microorganismo
Author: Alonso Rojas Navarro
Supervisor: María C. Romero Puertas
University of Granada

Análisis funcional de transportadores de Cl- incluidos en QTLs de tolerancia a salinidad en cítricos
Author: Álvaro Ruiz San José
Supervisors: Andrés Belver Cano, José Ángel Traverso Gutiérrez (University of Granada)
University of Granada

Estudios de interacción proteína-ADN con el regulador PhaR de *Bradyrhizobium diazoefficiens*
Author: Lucía Sánchez Schneider
Supervisors: Mª Socorro Mesa Banqueri, Coral del Val Muñoz (University of Granada)
University of Granada

TRAINING GRANTS AND CONTRACTS

JAE-Intro Students

Laura del Pilar Cano Gómez
Supervisores: Silvia Marqués Martín, Daniel Pacheco Sánchez

Cristina Carvia Hermoso
Supervisor: Mª José Soto Misffut

Mª Camila Espinosa Araque
Supervisor: Juan Sanjuán Pinilla

Marina García Alonso
Supervisor: Mª José Pozo Jiménez

Antonio García Rodríguez
Supervisor: Esperanza Romero Taboada

Lidia Generelo Casajús
Supervisores: Silvia Marqués Martín, Sophie Martirani von Abercron

Alba Magarzo Manchón
Supervisor: Nuria Ferrol González

Lucía Ruiz Sáez
Supervisor: Daniel Pérez Mendoza

Alberto Manuel Sánchez García
Supervisor: A. Ignacio Martín García

Marta Suárez Calvache
Supervisor: Nuria Ferrol González

Erasmus Students

Bianca Dumea
Supervisor: Emilio Benítez León

Sarvnaz Gostary
Supervisor: Juan Antonio López Ráez

Onur Kayabaşı
Supervisor: F. Javier Corpas Aguirre

Youth Guarantee Students

GRANTS FROM THE NATIONAL YOUTH GUARANTEE SYSTEM IN THE REGIONAL GOVERNMENT OF ANDALUSIA 2021
(PERIOD 2022-2023)

María Padial de Jáudenes
PI: Alfonso Clemente Gimeno

Jesús Nieto Chico
PI: Rosa Mª Nieto Liñán

Luis España Luque
PI: Juan Antonio López Ráez

Sofía Guzmán García
PI: Mª Socorro Mesa Banqueri

Juan Antonio Marchante Sánchez
PI: Juan Sanjuán Pinilla

Diego Becerra Mora
PI: María C Romero Puertas

Andrea García Alcaide
PI: Mariam Sahrawy Barragán

Jaime Mañas Galindo
PI: M Pilar Rodríguez Rosales

Esther Rodríguez de Haro
PI: José Carlos Jiménez López

José Manuel Rubí Villegas
PI: Eduardo López-Huertas León

Cristina Lomas Martínez
PI: Miguel A Matilla Vázquez

GRANTS FOR THE FINANCING OF THE INVESTIGO PROGRAM WITHIN THE FRAMEWORK OF THE RECOVERY, TRANSFORMATION AND RESILIENCE PLAN
(PERIOD 2022-2024)

Alberto Carrera Henke
PI: Ignacio Fernández-Fígares Ibáñez

Miriam Lucas Fernández
PI: Andrés Belver Cano

FIRST PROFESSIONAL EXPERIENCE PROGRAM IN PUBLIC ADMINISTRATIONS (PEX2022)

María Jurado Torres
Supervisor: Rocío Santiago Rejón

Jesús Sierra Duarte
Supervisor: F. Javier Mengual Maldonado

IN-HOUSE COURSES

LIX Soil Fertility and Plant Biology International Course

On 6th February started the LIX edition of the International Course of Soil Fertility and Plant Biology. This Course, hosted by the CSIC and the University of Granada, is one of the most emblematic activities of the EEZ, since it has been imparted during 59 years continuously. Since 2021 it is coordinated by Dr. Concepción Azcón.

The EEZ supports this Course with most of the professors, installations and equipment. The Andalusian Institute of Earth Sciences and the University of Granada also support the Course with lecturers. It includes from biogeochemical aspects of the soil to plant biology, passing through plant-microbe interactions, environmental microbiology and biotechnology.

This Course is recognized by the University of Granada as an "Own Training", dispatching an official diploma to the students, sixteen in this edition.

STUDENTS

Berrocal Calle, Ana Isabel
Cáceres Ortega, Nerea
España Luque, Luis
García Alcaide, Andrea
García Alonso, Marina
Juárez Fernández, Martín
Juárez Martos, Raquel Adriana
Lomas Martínez, Cristina
Lucas Fernández, Miriam
Mañas Galindo, Jaime
Marchante Sánchez, Juan Antonio
Muñoz Carrasco, María
Palacios Ferrer, María del Rocío
Pérez González, Sara
Recio Muñoz, María Isabel
Román Mateo, Andrea

The closing ceremony was held on 3rd July. It was presided by the Rector of the University of Granada, Dr. Pedro Mercado Pacheco, and the Director of the EEZ, Dr. Alfonso Clemente Gimeno. Dr. Pilar Aranda Ramírez, former Rector of the UGR, was also invited, since she had been closing this Course for several years.

The "last lesson" of the Course, entitled "Soil crisis threats global food security, climate emergency and peace", was given by Dr. A. Chabbi, Research Director at the French National Institute for Agricultural Research (INRA).

(More information at: https://www.eez.csic.es/sites/default/files/curso-internacional-de-fertilidad-de-suelos-y-biologia-vegetal-presentacion-2024-eez.pdf)

Presidential board: from left to righ: Pilar Aranda, Pedro Mercado, Alfonso Clemente and Concepción Azcón; Dr. Chabbi during his lecture.

CSIC Specialisation Courses

Electrophoretic Techniques and their Applications in Agri-Food Research
Organization: CSIC Training Office, Deputy General Secretary for Human Resources, in collaboration with the EEZ Department of Biochemistry and Molecular and Cellular Biology of Plants
Granada, 2-6 October, 2023
Teachers: Antonio Jesús Castro López, Juan de Dios Alché Ramírez, José Manuel Palma Martínez, F. Javier Corpas Aguirre, Carmelo Ruiz Torres

Microscopy Techniques
Organization: CSIC Training Office, Deputy General Secretary for Human Resources, in collaboration with the EEZ Confocal and Transmission Electron Microscopy Service and the Group of Plant Reproductive Biology
Granada, 31 March-4 April, 2023
Teachers: Juan de Dios Alché Ramírez, Antonio Jesús Castro López, José Carlos Jiménez López

Reproductive Biology in Higher Plants. Agronomic and Biotechnological Implications.
Organization: CSIC Department for Postgraduate and Specialisation. CSIC-High Specialization Course.
Granada, 27-30 November, 2023
Teachers: Juan de Dios Alché Ramírez, Antonio Jesús Castro López, Adoración Zafra Álvarez, José Carlos Jiménez López, Mª Elena Lima Cabello

Chromatographic Techniques: GC-MS, LC-MS
Organization: CSIC Training Office, Deputy General Secretary for Human Resources, in collaboration with the EEZ Scientific Instrumentation Service

Granada, 2-6 October, 2023
Teachers: Rafael Núñez Gómez, Lourdes Sánchez Moreno

OTHER COLLABORATIONS IN TRAINING & SCIENTIFIC EDUCATION

11th Cycle of Postgraduate Lectures of the University Master's Degree "Olive groves and olive oil", organized by the University of Jaén. EEZ Teacher: Jesús Mercado Blanco.

Agricultural Sciences Online in Secondary School (CAOS III) Programme, organized by EEZ-CSIC, 2022 - 2023 academic year. Funding: Acción Marie Skłodowska-Curie, Researchers' Night**,** Grant Agreement 1101061307; WP3: Researchers at School). Collaboration with: Centro Integrado de Formación Experiencias Agrarias (CIFEA) (Lorca, Murcia), Colegio Internacional de Granada (Otura, Granada), IES Francisco Ayala (Granada), IES Jándula (Andújar, Jaén), IES Mariana Pineda (Granada), IES Zaidín Vergeles (Granada), IES Jándula, Andújar (Jaén). Teachers/Researchers: Juan de Dios Alché Ramírez; Mª Jesús Campos Ramos; Antonio J. Castro López; Manuel Espinosa Urgel; Estela Gázquez Rodríguez, Elena Lima Cabello; Juan Antonio López Ráez; Francisco Martínez-Abarca Pastor; José Manuel Palma Martínez; Mª Eugenia Ramos Font; Esther Rodríguez de Haro; Carmelo Ruiz Torres; María Salas Sánchez; Esperanza Sánchez Nieto; Germán Tortosa Muñoz.

CRISPR/Cas systems associated with Reverse Transciptases, organized by the III CRISPR/CAS Conference. Genome Editing: Origin and Applications. Darwin Eventur Association, Granada. EEZ Teacher: Francisco Martínez-Abarca.

Elimination of emerging pollutants through the revalorisation of organic waste. Programa de Formación Complementaria (FoCO Generación UJA), University of Jaén. EEZ Teacher: Esperanza Romero Taboada.

Expertise Training in Composting, levels 2: Operating personnel, and 3: Master composter. Organized by: State Network of Local Entities for Home and Community Composting (Red Estatal de Entidades Locales por el Compostaje Doméstico y Comunitario, Composta en Red). EEZ Teacher: Germán Tortosa Muñoz.

Innovative biotechnologies to remove emerging pollutants from water and valorise agro-industrial biomass waste. V Scientific-Technical Conference of the DAM Chair, University of Valencia. EEZ Teacher: Esperanza Romero Taboada

Innovative technologies for removing emerging contaminants from water and valorizing agroindustry biomass waste. "DQB talks", organized by the Department of Chemistry and Biochemistry, University of Lisbon, Portugal. EEZ Teacher: Esperanza Romero Taboada.

New chemical contaminants in food processing, Summer Course "Controlling and improving food quality and safety", organized by the University of Alcalá de Henares. EEZ Teacher: Cristina Delgado Andrade.

Summer Training Course in Root Exudates Collection, organized by Juan Antonio López Ráez and Mª José Pozo Jiménez. EEZ-CSIC.

SEMINARS

Scientific and informative seminars are organized annually at the EEZ. During 2023 the coordinators of these cycles were Drs. Daniel Pérez Mendoza and Isabel Seiquer Gómez-Pavón. The variety of topics and invited speakers reflects the multidisciplinary nature of the EEZ. Attendance to these seminars is also open to the rest of the scientific and university community of Granada. The seminars are part of the training plan for personnel hired through the Youth Guarantee Fund and for students in Doctoral Programmes, for whom the corresponding certificates of attendance are issued.

- Luis Alcalá Martínez, Director of the the Granada Science Park. The role of the Granada Science Park in scientific outreach. 26/01/2023.

- Elvira Marín Irigaray, Director of the Aland Foundation. The restoration of degraded territories through the "4 returns model". The success case of the AlvelAl Association in the *Altiplano Estepario*. 09/02/2023.

- Jesús Mercado Blanco, Department of Soil and Plant Microbiology, EEZ-CSIC. On the versatility of a bacterial biocontrol agent and its impact on the plant holobiont. 23/02/2023.

- Juan Carlos Morales Sánchez, Department de Biochemistry and Molecular Pharmacology, Institute of Parasitology and Biomedicine López-Neyra (IPBLN-CSIC), Valencia. Limnopharma: the adventure of setting up a biotech company. 09/03/2023.

- Luis Cañas Clemente, Group of Biology and Biotechnology of Reproductive Development, Institute of Molecular and Cellular Biology of Plants (IBMCP-CSIC). Biotechnology and integrated pest management: tomatoes resistant to *Tuta absoluta*. 30/03/2023.

- Mª Antonia Cobacho Vargas, Department of International Relations, Andalusia Agency for Agriculture and Fisheries Development (AGAPA). International and innovation projects at the AGAPA. 13/04/2023.

- Pedro Iñaki González Torres, Co-Founder, CEO y COO of Microomics Systems S.L. Metagenomics in agriculture, animal production and clinical practice: technical approaches, challenges and future perspectives. 27/04/2023.

- Manuel Rodríguez Concepción, Group of Carotenoid and Isoprenoid Biotechnology, Institute of Molecular and Cellular Biology of Plants (IBMCP-CSIC). Golden plants: strategies to increase the content of carotenoid pigments in leaves. 04/05/2023.

- Rafael León Morcillo, Department of Plant Breeding and Biotechnology, Institute for Mediterranean and Subtropical Horticulture "La Mayora" (UMA-CSIC). Molecular basis of plant growth biostimulation by application of microbial volatile compounds. 18/05/2023.

- Raúl de la Rosa Navarro, Plant Breeding and Biotechnology Area, Andalusian Institute of Agricultural and Fisheries Research and Training (IFAPA), Alameda del Obispo (Córdoba). Contribution of genetic improvement to the current challenges in olive growing. 01/06/2023.

- Salvador Gutiérrez Salcedo, Department of Computer Science and Artificial Intelligence, University of Granada, Ceuta Campus. Artificial intelligence in the new digital agriculture. 29/06/2023.

- Rafael Muñoz-Tamayo, French National Institute for Agriculture, Food, and Environment (INRAE), AgroParisTech, Paris-Saclay University, France. Peer Community In: a free publication model for open and transparent science based on peer review. (Online) 21/09/2023.

- Ángel Gil Hernández, Department of Biochemistry and Molecular Biology, University of Granada, Iberoamerican Nutrition. Foundation. Childhood obesity and cardiometabolic risk. 05/10/2023.

- Juana Mª Gil Ruiz, Andalusian Women's Institute - Junta de Andalucía, Department of Philosophy of Law, Unverstity of Granada. Building a new legal framework: towards full citizenship for women. 19/10/2023.

- Julia Escudero Feliú, Department of Stress, Development and Signaling in Plants, EEZ-CSIC. Narrow-leafed lupin (*Lupinus Angustifolius* L.) β-conglutin seed proteins and their potential role in the treatment of breast cancer. 02/11/2023.

- Francisco Javier Romera Ruiz, Department of Agronomy, University of Córdoba. Ethylene and nitric oxide: two simple gases with a complicated life in the ferric nutrition of dicotyledonous plants. 24/11/2023.

- Ana Vicente Lasa, Department of Soil and Plant Microbiology, EEZ-CSIC. *Pinus sylvestris* and phytoplasma: Chronicle of a death foretold? 14/12/2023.

Other Seminars:

- Mª Luisa Pérez Bueno. Department of de Plant Physiology, University of Granada. Imaging-PAM, how to quantify photosynthetic activity by fluorescence. 14/09/2023. Organized by the EEZ Greenhouses and Plant Growth Chambers Service.

- Carmelo Ruiz Morales, Ángel González Pérez. GLT-Labs. Maintenance of water purification equipment: types of water and applications. 23/11/2023.

VISITING SCIENTISTS

Juan Luis Araujo Garrido. University of Seville. Group of Redox Regulation, Sugar Signaling and Phenotyping using Imaging Techniques to detect Plant Stress.

Wided Bem Slima. Université Tunis el Manar, Tunis. Group of ROS and NITRIC Oxide-Signaling and Peroxisomal Dynamics in Plants.

Emiliano Ben Guerrero. Center for Research in Veterinary and Agricultural Sciences, INTA Castelar, Buenos Aires, Argentina. Group of Structure, Dynamics and Function of Rhizobacterial Genomes.

Valentina Borda. Universidad Nacional de Córdoba, Argentina. Group of Mycorrhiza.

Desiré Cano Yelo. CEBAS-CSIC, Murcia. Group of ROS and NITRIC Oxide-Signaling and Peroxisomal Dynamics in Plants.

Liz E. Cumpa Velásquez. Toribio Rodríguez de Mendoza National University of Amazonas (UNTRM). Group of Plant-Bacteria Interactions.

Aman Deep Kaur, Long Island University, Brooklyn, New York. Group of Animal Nutrition.

Ignacio García Berro. University of Granada. Service of Assessment, Restoration and Protection of Mediterranean Agrosystems Service (SERPAM).

Francisca Gómez Hinostrosa. Universidad de la Frontera, Temuco, Chile. Group of Mycorrhiza.

Sarvnaz Gostary. Ghent University, Belgium. Group of Mycorrhiza.

Rodrigo Manjarín, California Polytechnic State University, California, United States. Group of Animal Nutrition.

Nicolás Marro. Universidad Nacional de Córdoba, Argentina. Group of Mycorrhiza.

Jorge Monza. Faculty of Agronomy, University of the Republic, Uruguay. Group of Plant-Bacteria Interactions.

Mustapha Mohammed. University for Developmental Studies, Tamale, Ghana. Group of Plant-Bacteria Interactions.

Mohammed M'Rani Alaoui. Abdelmalek Essaâdi University, Tétouan, Morocco. Group of Plant Reproductive Biology and Advanced Microscopy Laboratory (BReMAP).

Santiago Parra Bulacio. Université Aix-Marseille, France. Service of Assessment, Restoration and Protection of Mediterranean Agrosystems Service (SERPAM).

Adrià Peña Enguix. Université Aix-Marseille, France**.** Service of Assessment, Restoration and Protection of Mediterranean Agrosystems Service (SERPAM).

Ernestina Solórzano Álvarez. University of Havana, Cuba. Group of Antioxidants, Free Radicals and Nitric Oxide in Biotechnology, Food and Agriculture (ARNOBA).

Denisa Tichá. Czech University of Life Sciences, Prague, Czech Republic. Group of Animal Nutrition.

Bethsabe Belem Villagómez González. Instituto Politécnico Nacional CIIDIR Unidad Oaxaca, México. Group of Mycorrhiza.

STAYS OF EEZ STAFF IN OTHER RESEARCH INSTITUTIONS

Mª Ángeles Muñoz Vargas. Instituto de Bioquímica Vegetal y Fotosíntesis, CSIC, Sevilla.

Verónica Perez Padilla. INSIBIO (CONICET-UNT), Tucumán, Argentina.

Alejandro Rodríguez González. National Institute of Biology, Ljubljana. Slovenia.

Esperanza Romero Taboada. University of Lisbon (FCUL), Portugal.

Miguel Ángel Rosales Villegas. Institute for Plant Sciences of Montpellier (INRAE/CNRS/Agro-M/University of Montpellier), Montpellier, Francia.

LOCATION AND CONTACT

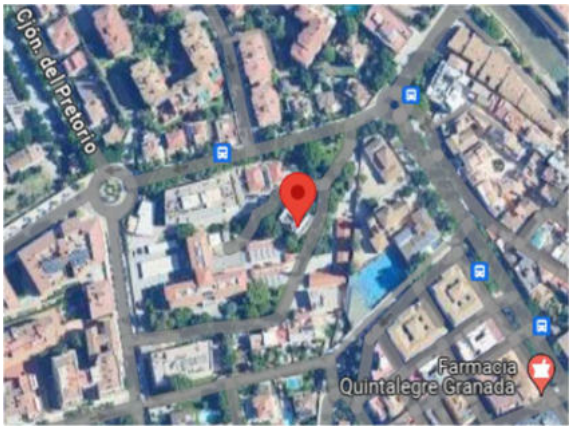
ADDRESS

ESTACIÓN EXPERIMENTAL DEL ZAIDÍN
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS
APDO. DE CORREOS 419
E-18080 GRANADA
ESPAÑA

GRANADA HEADQUARTERS
C/ PROFESOR ALBAREDA Nº 1
E-18008 GRANADA
ESPAÑA
TELÉFONO:
(34) 958 18 16 00

ARMILLA HEADQUARTERS
C/ SAN MIGUEL, Nº 101
E-18100 ARMILLA (GRANADA)
ESPAÑA
TELÉFONO
(34) 958 57 27 57

Link to Maps - EEZ Headquarters



Link to Maps - EEZ Armilla Headquarters

Twitter / @EEZCSIC Facebook / @EEZCSIC Youtube / @EEZCSIC

ESTACIÓN EXPERIMENTAL DEL ZAIDÍN REPORT 2023