



REPORT 2022

Estación Experimental del Zaidín



CSIC
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS



eez
Estación Experimental del Zaidín



REPORT

2022



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FOREWORD

Estación Experimental del Zaidín (EEZ) is a research center belonging to the Spanish National Research Council (CSIC). In its almost 70 years of existence it has acquired a great international reputation, being one of the leading centers in Andalusia in agrobiological research (<https://www.eez.csic.es/>). Activities at EEZ are mainly focused on the field of Agricultural Sciences, within the Global Life Area.

The main objectives at EEZ are:

1) to carry out cutting-edge research responding to the growing demand for sustainable, environmentally-friendly agriculture and animal husbandry; and

2) to develop multi- and interdisciplinary research in many different aspects related to environmental protection, biotechnological applications and studies on the interactions between plants, animals and microorganisms in different agroecosystems.

The strategic lines of research at EEZ are:

a) Research on plant responses to abiotic and biotic stresses (temperature, drought, salinity, elevated CO₂, pathogens and pests) as well as on plant reproduction. This line of research includes studies on plant stress tolerance, signaling and regulatory mechanisms, stress-induced physiological, biochemical and gene expression changes, and stress detection tools.

b) Beneficial plant-microbe interactions and environmental microbiology. Biotechnological strategies for environmental and agricultural sustainability. This line of research focuses on the study of the mechanisms underlying the establishment, regulation and function of plant-microbe interactions, microbial diversity and ecology, biofertilization, bioremediation and biodegradation pathways.

c) Studies on animal nutrition in terms of nutrients and energy metabolism and its impact on yield and product quality and, ultimately, on consumer health.

In the year 2022 a new strategic plan for the center (period 2022-2025) was initiated, the newly refurbished building called “Casa Roja” became fully operational with up to 40 new research labs, and a new management team led by Alfonso Clemente took office. The EEZ scientific committee was renewed with the major aim of making scientific excellence and leadership the real driving force of our activity. The attraction of research, technical and administrative talent and the strengthening of international activity through European programs are some of our current strategic objectives.

The research groups at EEZ have maintained an outstanding scientific production, both in terms of scientific publications (more than 150 publications, 85% of which are published in journals of high impact), as well as in terms of attracting resources through research projects funded at the regional, national and european level, as well as technological support and research contracts with a high number of national and international companies.

The EEZ is a center with a strong vocation to train new scientific and technical talents. Its researchers support and supervise the training of young talented scientists. Through a framework agreement with the University of

Granada, EEZ collaborates in 7 Master's degree programs, 3 PhD programs, final Degree and Master projects and curricular internships. Its researchers are currently supervising 35 doctoral theses and the research institute welcomes more than 70 university students, as well as national and foreign visitors every year.

It is a priority for the EEZ to make our work and results known to society and to the political and business sectors. In addition to the dissemination on the web and social networks, we carry out outreach activities: exhibitions, workshops, guided tours, introductory research programs and lectures for secondary, high school and university students and other vocational training. EEZ also collaborates with numerous institutions in the organization and development of events aimed at promoting scientific culture. In this sense, it is worth mentioning the participation of EEZ in the Science Platform of the City of Granada and in the recent renewal of the distinction Granada City of Science and Innovation, among other projects, which have, as one of their objectives, to enhance our ecosystem of science and innovation in the city of Granada, with national and international impact.

The research carried out at EEZ respects the ethics, biosafety and animal welfare principles, as well as good laboratory practices in accordance with the CSIC Code of Good Practices and the recommendations of the CSIC Ethics and Bioethics Commissions. In addition to science, the human aspect is important at EEZ. We have clear pol-

icies of non-discrimination and gender equality following the guidelines of the CSIC Equality Plan and the Women and Science Commission, and was awarded back in 2018 the accessit of the CSIC Gender Equality Accreditation Distinction by the CSIC Presidency. Since 2022 EEZ has its own Equality commission and has created a working group focused in energy savings and sustainability.

This report summarizes the scientific activity carried out during the year 2022 by its scientific and technical staff, with the support of the administrative staff and the services and support units at EEZ.

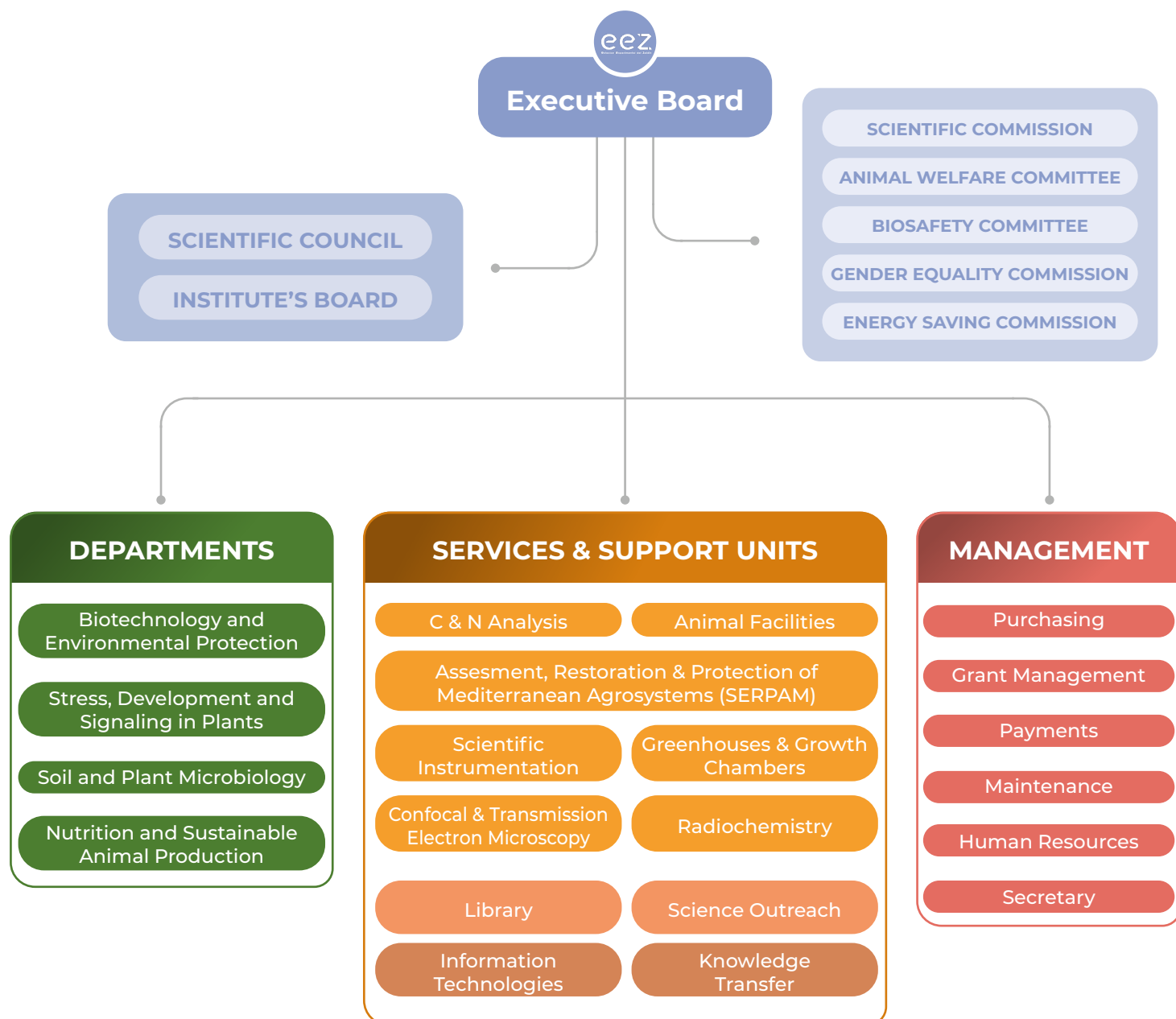


DR. ALFONSO CLEMENTE GIMENO

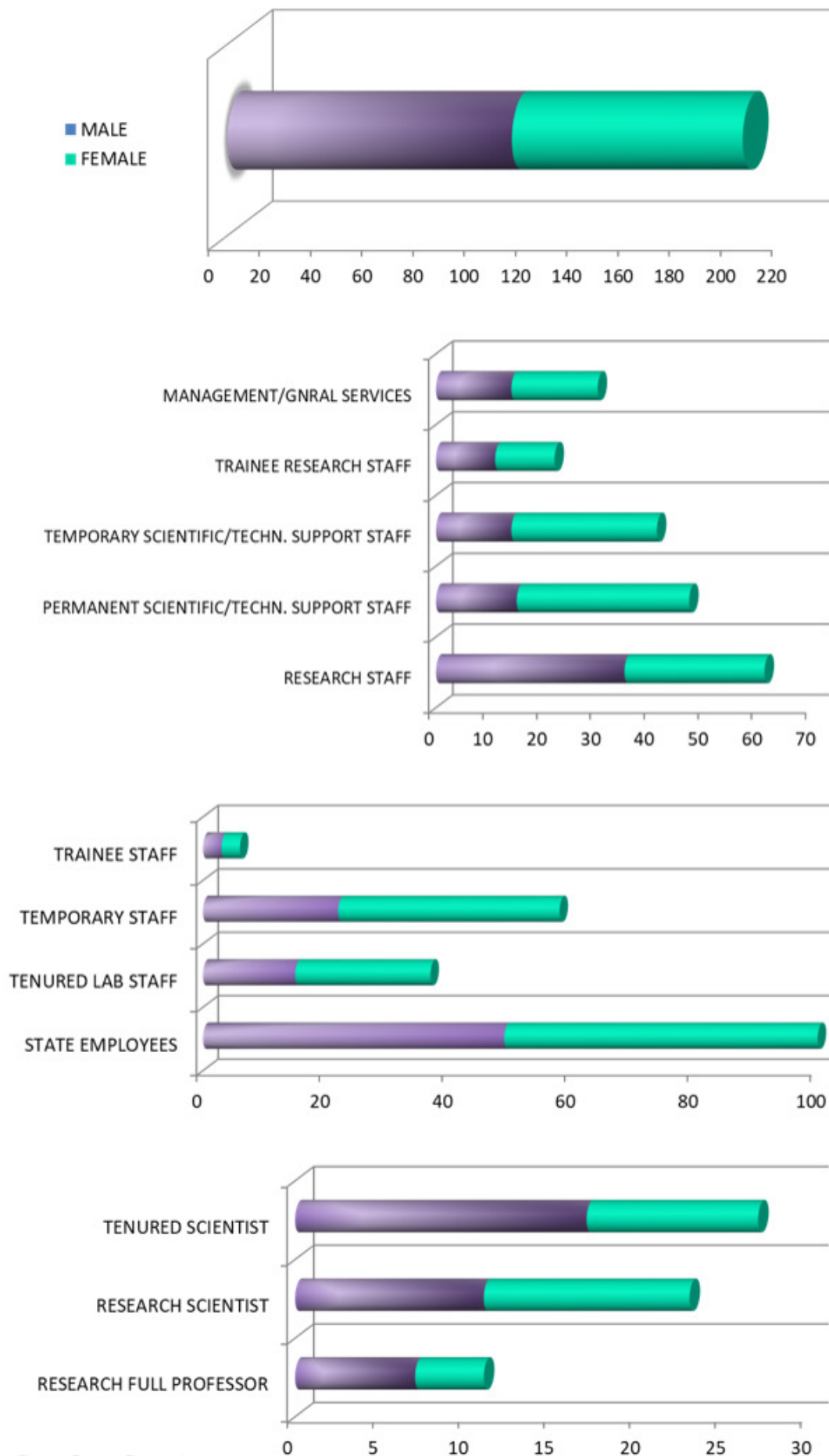
Director of the EEZ

THE INSTITUTE

ORGANIZATION CHART



STAFF



DIRECTION AND MANAGEMENT

■ **Dr. Alfonso Clemente Gimeno**
Director (since 4th May 2022)

■ **Dr. Matilde Barón Ayala**
Director (until 3rd May 2022)

■ **Dr. Nuria Ferrol González**
Deputy Director

■ **Dr. Juan de Dios Alché Ramírez**
Deputy Director (since 5th May 2022)

■ **Dr. Alfonso Clemente Gimeno**
Deputy Director (until 3rd May 2022)

■ **M^a del Rocío Santiago Rejón**
General Manager



From left to right: J.D. Alché, N. Ferrol, A. Clemente, M. Barón and R. Santiago

ADVISORY COMMITTEES

Scientific Council

- Juan de Dios Alché Ramírez
- Ricardo Aroca Álvarez
- Concepción Azcón González de Aguilar
- Alberto Bago Pastor
- Matilde Barón Ayala
- Eulogio José Bedmar Gómez
- Andrés Belver Cano
- Emilio Benítez León
- Antonio Jesús Castro López
- Alfonso Clemente Gimeno
- Francisco Javier Corpas Aguirre
- Cristina Delgado Andrade
- M^a Jesús Delgado Igeño
- Estrella Duque Martín de Oliva
- Manuel Espinosa Urgel
- Manuel Fernández López
- Ignacio Fernández-Fígares Ibañez
- Nuria Ferrol González
- M^a 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
- M^a Antonia Llamas Lorente
- Juan Antonio López Ráez
- Eduardo López-Huertas León
- Silvia Marqués Martín
- Antonio Ignacio Martín García
- Francisco Martínez-Abarca Pastor
- Miguel Ángel Matilla Vázquez
- Jesús Mercado Blanco
- Socorro Mesa Banqueri
- Eduarda Molina Alcaide
- Rosa M^a Nieto Liñán
- Rogelio Nogales Vargas-Machuca
- Raquel Olías Sánchez
- Adela Olmedilla Arnal
- José Manuel Palma Martínez
- Daniel Pérez Mendoza
- M^a José Pozo Jiménez
- M^a Isabel Ramos González
- Juan Luis Ramos Martín
- M^a Pilar Rodríguez Rosales
- Carmen Romero Puertas
- M^a Esperanza Romero Taboada
- Luis Rubio San Millán
- Juan Manuel Ruiz Lozano
- Mariam Sahrawy Barragán
- Luisa M^a Sandalio González
- Juan Sanjuán Pinilla
- Ana Segura Carnicero
- Isabel Seiquer Gómez-Pavón
- Antonio Jesús Serrato Recio
- M^a José Soto Misffut
- Nicolás Toro García
- Pieter Van Dillewijn
- Cornelis Marinus Venema
- Regina Michaela Wittich
- David Yáñez Ruiz

ADVISORY COMMITTEES

Institute's Board until April 2022

PRESIDENCY

Dr. Matilde Barón Ayala	Director
Dr. Nuria Ferrol González	Deputy Director
Dr. Alfonso Clemente Gimeno	Deputy Director

SECRETARY

M ^a del Rocío Santiago Rejón	General Manager
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HEADS OF DEPARTMENTS

Dr. Rogelio Nogales Vargas-Machuca	Dept. of Biotechnology and Environmental Protection
Dr. María C. Romero Puertas	Dept. of Stress, Development and Signaling in Plants
Dr. M ^a Jesús Delgado Igeño	Dept. of Soil and Plant Microbiology
Dr. Ignacio Martín García	Dept. of Nutrition and Sustainable Animal Production

STAFF REPRESENTATIVES

Dr. Cristina Delgado Andrade
Dr. José Luis Garrido Sánchez
Jaime C. Ramírez Melguizo
Dr. M ^a Eugenia Ramos Font

ADVISORY COMMITTEES

Institute's Board since May 2022

PRESIDENCY

Dr. Alfonso Clemente Gimeno	<i>Director</i>
Dr. Nuria Ferrol González	<i>Deputy Director</i>
Dr. Juan de Dios Alché Ramírez	<i>Deputy Director</i>

SECRETARY

M^a del Rocío Santiago Rejón	<i>General Manager</i>
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HEADS OF DEPARTMENTS

Dr. M^a Antonia Llamas Lorente <i>Dept. of Biotechnology and Environmental Protection</i>
Dr. María C. Romero Puertas <i>Dept. of Stress, Development and Signaling in Plants</i>
Dr. M^a Trinidad Gallegos Fernández <i>Dept. of Soil and Plant Microbiology</i>
Dr. Ignacio Fernández-Fígares Ibáñez <i>Dept. of Nutrition and Sustainable Animal Production</i>

STAFF REPRESENTATIVES

Dr. Cristina Delgado Andrade
Dr. José Luis Garrido Sánchez
Jaime C. Ramírez Melguizo
Dr. M^a Eugenia Ramos Font

ADVISORY COMMITTEES

Scientific Commission

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

Animal Welfare Committee

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

Biosafety Committee

- Alfonso Clemente Gimeno
- Antonio Jesús Castro López
- Rafael Hueso Ibáñez
- M^a Trinidad Gallegos Fernández
- Miguel A. Matilla Vázquez
- Francisco Sires Navarrete (associated member, as technician of the Greenhouses and Plant Growth Chambers Service)

Energy Saving Commission

Following the recommendations proposed in the CSIC Action Plan 2023, the Commission was created in September 2022 with the aim of analyzing the energy efficiency of all EEZ buildings, identifying improvements in air conditioning, and ensuring the efficiency and safety of electrical, plumbing, sanitation and fire protection installations.

Members

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

Gender Equality Commission

It was created in September 2022 as a support body to the Direction and Management of the EEZ on gender issues, as established in the II Plan for Equality between Women and Men at the AGE and its public institutions, approved in November 2015 and revised in 2017 and 2018. The Committee's mission is to promote equality between men and women in the course of the Centre's research activity. It includes among its components representation of all the groups of employees of the EEZ (<https://www.eez.csic.es/ciencia-en-igualdad>)

Members

Matilde Barón Ayala, who chairs the Commission

Alfonso Clemente Gimeno
Rocío Santiago Rejón
Nuria Martín Wentzien
Luisa M^a Sandalio González
Carmelo Ruiz Torres
Carmen Lorente Navarro
Consolación García Contreras

ADMINISTRATION AND GENERAL SERVICES

■ SECRETARY

Inés Abril Martí
Carmen Lorente Vázquez

■ PAYMENTS

Isabel Abril Álvarez
Salomé García Jiménez
M^a del Mar Romero Pérez

■ HUMAN RESOURCES

M^a del Mar Fandila Enrique
M^a Paz Montesinos Parra
Juan María Pérez Torres

■ ADMINISTRATIVE ASSISTANT

Ana M^a Esteban Muñoz (*Armilla*)

■ GRANT MANAGEMENT

Rosario Molina Quesada
Carmen Lorente Navarro
M^a José Pérez Jiménez
Ascensión Valderas Jiménez

■ OTHER PAYMENTS AND CONTRACTING

Victoria Macías Moreno
Eva M^a Sánchez Abolafia
Juan Carlos Vílchez Rojas
Manuel M. Zafra Sánchez

■ PURCHASING

Álvaro Mérida González
Carmen Camacho Guzmán
Luis Miguel García Rodríguez
Jaime Cecilio Ramírez Melguizo
Rafael Miguel Ruiz García

■ MAINTENANCE

Samuel Martínez Marruecos
Fernando Caro Fernández
Fernando Flores García
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 in-

formation 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

Technicians

Francisco Funes Madrid



Facilities and equipment

This animal facility makes its installations available to researchers from the Department of Nutrition and Sustainable Animal Production, as well as provides the conditions and requirements necessary for carrying out research projects with 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:

- Portable milking machine
- Metabolic cages for pigs, small ruminants and rodents
- Heating system for pigs
- Scales
- Cart to transport animals
- High pressure cleaner

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 2022

- Maintenance of small ruminants and pigs (accommodation, food, cleaning and sanitary control)
- Surgery on small ruminants (Project A18/03/2019/042)
- 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.)
- Pest control improvements



Animal Facility ES180210000016. Department of Nutrition and Sustainable Animal Production

CARBON AND NITROGEN ANALYSIS SERVICE

Personnel

Rafael Hueso Ibáñez
José Luis Luque Ojeda



Facilities and equipment

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

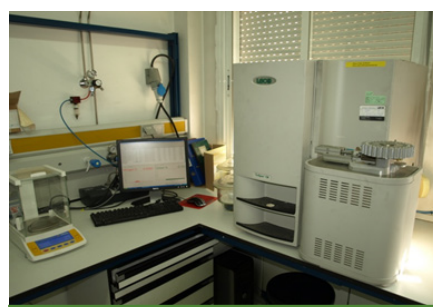
Analyses / Services offered

- 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 2022

- Quantification of organic carbon by low temperature combustion
- Monitoring of organic content in residual water from our treatment plan for animal residues



N/C Analyzer (TruSpec CN)

GREENHOUSES AND PLANT GROWTH CHAMBERS SERVICE

Head

Andrés Belver Cano

Technician

Francisco Sires Navarrete



Facilities and equipment

- 14 walk-in growth chambers provided with temperature control, LED illumination and ventilation, with a total cultivation area of approximately 130 m². One chamber is dedicated to the cultivation of plants under short-day conditions, another to *in vitro* cultivation, 2 are conditioned for studies at high ambient CO₂ 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 m², 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

Activities in 2022

- Growth chamber 8, back in service
- Installation of the Infrared Gas Analyzer-IRGA (granted in 2022, Call FAS2022_017, CSIC) for the determination of photosynthetic parameters, such as photosynthesis, transpiration and conductance among others



Infrared Gas Analyzer-IRGA

CONFOCAL AND TRANSMISSION ELECTRON MICROSCOPY SERVICE

Head

José Carlos Jiménez López

Technician

Alicia Rodríguez Sánchez

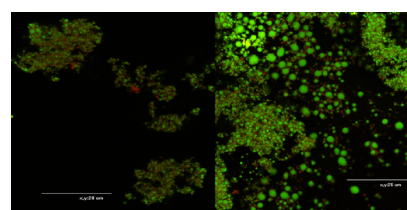
Andreína C. Peralta Leal



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 TP1020), processor for paraffin inclusion (Leica EG1150), vibratome (Leica VT1200s), microtome (Leica RM 2165) and ultramicrotome (Reichert-Jung ULTRACUT)



Soya milk. Digestive process viewed at Laser Scanning Confocal Microscopy. Image 100X magnification

RADIOCHEMISTRY LABORATORY

Head

Francisco Martínez-Abarca Pastor



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:

- ^3H (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

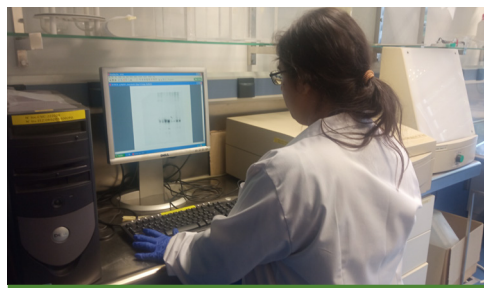
Facilities and equipment

- 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 labeling and probes-hybridization, autoradiography, incorporation of radioisotopes into cells, protein phosphorylation, in vitro transcription, etc.
- Armilla headquarters: Radioimmunoassays for determination/quantification of animal hormones



Operating the phosphorimager facilities of Radiochemistry Lab

SCIENTIFIC INSTRUMENTATION SERVICE

Head

Tino Krell, until August 2022

Eduardo López-Huertas León, since September 2022

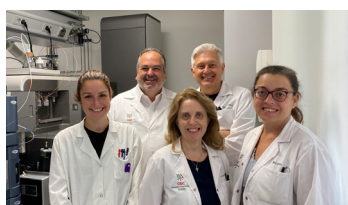
Technicians

Rafael Núñez Gómez

Lourdes Sánchez Moreno

Miryam Rojas Gómez

Beatriz Sánchez Romera



Facilities and equipment

Equipment for Liquid Chromatography and mass spectrometry:

- HPLC Waters Alliance 2695
- UPLC Waters Acquity H-Class
- UV, fluorescence and refractive index detectors
- Electrospray ionization mass spectrometer with triple quadrupole 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)

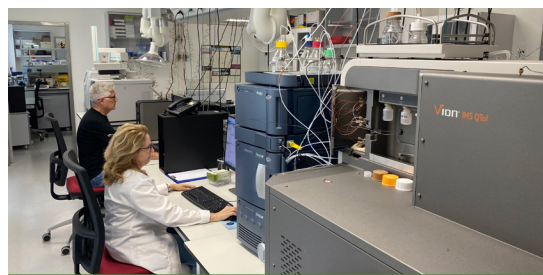
Analyses / Services offered

- 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, CO₂, N₂O, 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 2022

- Training Course on Chromatographic Techniques, Estación Experimental del Zaidín-CSIC, Granada, 17-21 October 2022, organized and administered by our staff members



Main laboratory of the Scientific Instrumentation Service

ASSESSMENT, RESTORATION AND PROTECTION OF MEDITERRANEAN AGROSYSTEMS (SERPAM)

Heads

Ana Belén Robles Cruz

Technicians

M^a Eugenia Ramos Font

Mauro Tognetti Barbieri

Antonio Jesús Pérez Luque



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

- Herborization, identification and determination of flora
- Evaluation and analysis of plant resources (floristic composition, structure, production)
- Evaluation of the carrying capacity of natural pastures
- Management of plant covers
- Management of vegetation cover with livestock
- Germplasm bank of native plant and forage species
- Collection of native seeds
- Characterization and seed germination tests
- Restoration and improvement of natural pastures
- Evaluation of the livestock impact on the vegetation cover

- Pastoral planning in fire prevention systems
- Training and participatory activities in the management of the natural and agricultural environment
- SERPAM's Drone Services. Service of acquisition of optical, thermal and multispectral imaging using drones and unmanned platforms
- Rental of sub-metric GPS equipment (differential correction). Differential GPS with sub-metre accuracy Base/Rover Kolida K5 UFO/Kolida K20S for field data acquisition, allowing a survey with a maximum tilt angle of 60°

Activities in 2022*

- Participation in 4 research projects funded by international and national agencies (LIFE-WATCH-ERIC, CSIC, MICINN, MITECO)
- Participation in a Scientific and Technology Contract with Aix-Marseille University (20225183)
- Publication of 3 peer-review articles

- Participation in various dissemination activities and training courses

**Reported in the corresponding sections*



*Prescribed burning. Sierra de los Filabres.
Pyticlabs-BiOPYMED Project*



eez
Estación Experimental del Zaidín

TECHNICAL RESEARCH SUPPORT UNITS

INFORMATION TECHNOLOGIES SERVICE (ITS)

Head

Francisco Javier Mengual Maldonado

Other members

César Azorín Márquez

Lourdes Salmerón García (*Armillar headquarters*)

Víctor Baena Vélchez (*Integra S.A.*)



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 and innovation.

Activities in 2022

- To strengthen the EEZ's cybersecurity. Constant emphasis on protection against persistent and evolving cyber threats. The primary is to prevent the spread of malware through meticulous network segmentation. This task requires significant dedication and continuous vigilance since cybersecurity is a constantly evolving field.
- To further enhance our defence mechanisms by deploying new corporate antiviruses and introduce them in all PCs ensuring that the operating systems are up to date and reducing potential vulnerabilities. Firewalls have been reinforced by incorporating new features and using block lists

provided by CCN-CERT (National Cryptologic Centre) to identify and block malicious websites. An additional CISCO firewall has been introduced to increase our capability to detect and to block potential threats.

- To implement measures to protect the EEZ's physical network and prevent unauthorized access, thereby minimizing the risk of attacks based on known vulnerabilities.
- Regarding the management of our infrastructure, a comprehensive restructuring and reprogramming of our network management software at the EEZ has been undertaken. According to the needs of each team, different levels of security and limited access have been established, ensuring robust and personalized protection. These actions have been essential to protect our systems and strengthen the security of our infrastructure against potential threats.
- To improve energy efficiency and comply with the security measures proposed by the Cybersecurity Operations Centre, new functionalities in the Calipso system for remote booting at the EEZ have been implemented. It is now possible to automatically shut down equipment at the end of the workday, providing users with the option to delay the shutdown or schedule it at different intervals. This functionality allows to effectively optimize energy consumption while ensuring compliance with the security standards established by the relevant authorities



KNOWLEDGE TRANSFER UNIT

Head

Alfonso Clemente Gimeno, *until May 2022*

Juan de Dios Alché, *since June 2022*

In collaboration with:

Juan Carlos Vilchez Rojas, *until May 2022*

Victoria Macías Moreno, *since March 2022*



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

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



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

López-Huertas and Juan M. Alcaide-Hidalgo was registered (EPO application No 15 380 049.5)

- Meetings and attendance at trade fairs and congresses:
 - Alhambra Venture 2022, Granada, 12-13 July 2022
 - Smart Agrifood Summit, Málaga, 29-30 July 2022
 - Biotech Attraction - Fruit Attraction 2022, Madrid, 5th October 2022



JORNADA BIOTECH ATTRACTION 2022

Biotechnología e innovación para la agricultura del futuro



Activities in 2022

- Advice on the signing of contracts, including 21 Technological Support/R&D contracts, 6 NDA, 2 MTA and 28 contracts to provide services with 43 companies (29 Spanish and 14 from abroad).
- An international patent on "Antihypertensive peptides from olive oil" invented by Drs. Eduardo

LIBRARY

Head

Felicitas 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 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 a newspaper archive with over 300 journal titles. Since 2015 the Library acts as curator of historical archives (1940-1980) to preserve the institute's historical documents. Since 2000, it offers access to 90% digital books and journals.

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



Library staff opening one of the modules of the journal compact's Library storage

SCIENCE OUTREACH UNIT

Head

Manuel Espinosa Urgel

Other members

Mágina Cruz Caballero



Public outreach and Science education

- A project funded by FECYT, coordinated by EEZ-CSIC with the collaboration of IACT-CSIC and IAA-

CSIC. A combination of theater play, images, live music, and dance, to show research of the three institutes, connected through the idea of isolation during scientific exploration. In 2022 it was presented twice to the general public in different theaters, one of them as part of the event "Desgranando Ciencia".

- Science Area in Granada's Book Fair 2022. 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, and workshops for kids and families, during the 10 days of the Book Fair.

- *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.
- *CAOS 2*. 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. 11, ISSN 2340-9746.
- *Three evenings of... science*. As part of the Science Week at CSIC, activities for the general public were programmed at EEZ: videos, talks, scientific improvisation theater, etc.

Press releases and social media

- During 2022, the Unit has issued 36 web news and press releases. The highest media coverage regarding scientific issues was received by projects on resilient livestock production, wild fire prevention, and signal molecules in bacteria. The inauguration of the new "Casa Roja" facilities and some of our outreach activities also received special attention.

- A new institutional video to present the EEZ was released: <https://youtu.be/MVO-SRbfDug>
- Data for our social media show a steady increase in impact:
 - ✕ Twitter: 2.742 followers (+8% with respect to 2021)
 - f Facebook: 2.240 followers (+10%)
 - @ Instagram: 689 followers (+32%)
 - 📺 Youtube: 363 suscriptors (+21%)

Women in Science

- *International Day of Women and Girls in Science* (11th February): several on-line talks by female EEZ scientists with high school students
- *Women's Day* (8th March): Meeting of the Association of Female Researchers and Technologists (AMIT – Andalucía) at EEZ
- *Other activities*: Several talks on the role of female scientists throughout history were presented in different locations



eez
Estación Experimental del Zaidín

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

Estación Experimental del Zaidín

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

Estación Experimental del Zaidín

Department 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

Estación Experimental del Zaidín

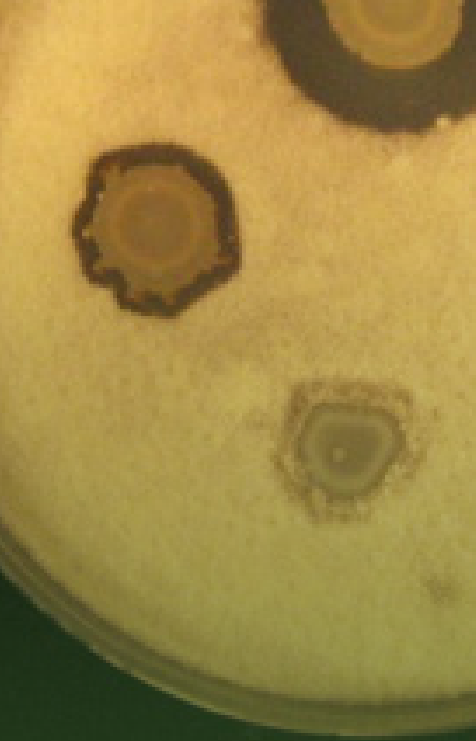
Department of Nutrition and Sustainable Animal Production

Animal Nutrition

Gastrointestinal Health and Food Safety

Sustainable Production of Ruminants

Estación Experimental del Zaidín



REPORT | 2022 |

DEPARTMENT OF BIOTECHNOLOGY AND ENVIRONMENTAL PROTECTION

Genetics of Phytobacterial Infections

Environmental Microbiology and Biodegradation

Sustainability of Soil-Plant Systems and
Environmental Decontamination

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GENETICS OF PHYTOBACTERIAL INFECTIONS

MEMBERS



Senior Researchers

M^a José Soto Misffut, *Group Leader*

Hired Researchers

Lidia M^a 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: Identification of the regulatory mechanisms that affect the volatile profile in rhizobia, the bioactivities associated to the different volatile compounds

produced by these bacteria, their mechanism of action and biosynthetic pathways.

2. Identification of the molecular bases responsible for the different types of surface motility exhibited by *Sinorhizobium meliloti* as a strategy to unveil mechanisms with a role in plant colonization.

5 MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

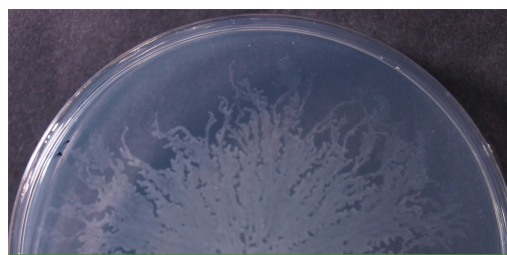
Calatrava-Morales, N.; McIntosh, M.; Soto, M.J. 2018. Regulation mediated by *N*-acyl homoserine lactone quorum sensing signals in the *Rhizobium*-legume symbiosis. *Genes*, 9: 263.

Crespo-Rivas, J.C.; Navarro-Gómez, P.; Alias-Villegas, C.; Shi, J.; Zhen, T.; Niu, Y.; Cuéllar, V.; Moreno, J.; Cubo, T.; Vinardell, J.M.; Ruiz-Sainz, J.E.; Acosta-Jurado, S.; Soto, M.J. 2019. *Sinorhizobium fredii* HH103 RirA is required for oxidative stress resistance and efficient symbiosis with soybean. *International Journal of Molecular Sciences*, 20: 787.

López-Lara, I.M.; Nogales, J.; Pech-Canul, A.; Calatrava-Morales, N.; Bernabéu-Roda, L.M.; Cuéllar, V.; Durán, P.; Olivares, J.; Alvarez, L.; Palenzuela-Bretones, D.; Romero, M.; Heeb, S.; Cámara, M.; Geiger, O.; Soto, M.J. 2018. 2-Tridecanone impacts surface-associated bacterial behaviours and hinders plant-bacteria interactions. *Environmental Microbiology* 20: 2049-2065.

Soto, M.J.; López-Lara, I.M.; Geiger, O.; Romero-Puertas, M.C.; van Dillewijn, P. 2021. Rhizobial volatiles: potential new players in the complex interkingdom signaling with legumes. *Frontiers in Plant Science*, 12: 698912.

Soto, M.J.; Staehelin, C.; Gourion, B.; Cárdenas, L.; Vinardell, J.M. 2022. Editorial: early signaling in the rhizobium-legume symbiosis. *Frontiers in Plant Science*, 13: 1056830.



Surface motility exhibited by *Sinorhizobium meliloti*

ENVIRONMENTAL MICROBIOLOGY AND BIODEGRADATION

MEMBERS



Senior Researchers

Miguel Ángel Matilla Vázquez, *Group Leader* until May 2022

Manuel Espinosa Urgel, *Group Leader* since June 2022

Estrella Duque Martín de Oliva

Tino Krell

Marian Llamas Lorente

Silvia Marqués Martín

M^a Isabel Ramos González

Juan Luis Ramos Martín

Ana Segura Carnicero

Pieter van Dillewijn

Regina Michaela Wittich

Postdoctoral Researchers

Jean Paul Cerna-Vargas

Predoctoral Researchers

Ana Ángeles García Franco

Roberta Genova

Verónica Pérez Padilla

M^a Isabel Recio Muñoz

Félix Velando Soriano

Hired Researchers

Inés Castillo Rodríguez

M^a del Rocío Fernández González

Patricia Godoy Alba

Tamara M^a Gómez Gallego

Francisco Javier Marcos Torres

Sophie Marie Martirani von Abercron

Sabina Moles Santiago

Elizabet Monteagudo Cascales

Rafael Nisa Martínez

M^a del Rocío Palacios Ferrer

Miriam Rico Jiménez

Iván Sánchez Castro

Ana Sánchez Jiménez

Raquel Vázquez Santiago

Staff Technicians

Jesús de la Torre Zúñiga

Alicia Inmaculada García Puente

Patricia Marín Quero

Lázaro Molina Delgado

M^a Antonia Molina Henares

Daniel Pacheco Sánchez

M^a Luisa Travieso Huertas

Hired Technicians

Marina Fernández López

Irene Hurtado Fernández

Cristina Lomas Martínez

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 bioproducts, 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, antibiotic production and regulation in phytobacteria.

5 MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

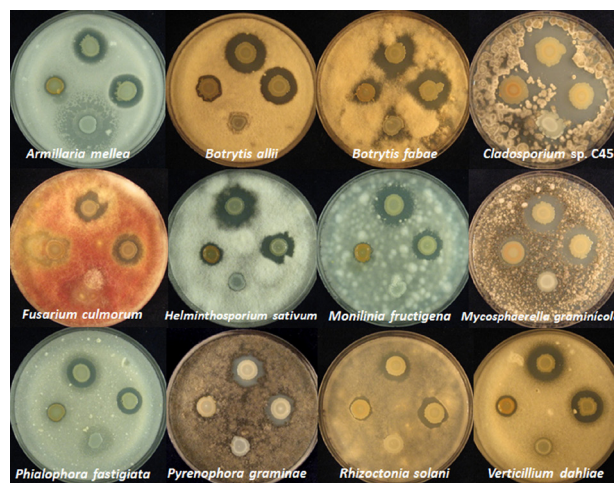
Godoy, P.; García-Franco, A.; Recio, M.I.; Ramos, J.L.; Duque, E. 2021. Synthesis of aromatic amino acids from 2G lignocellulosic substrates. *Microbial Biotechnology*, 14: 1931-1943.

Gumerov, V.M.; Andrianova, E.P.; Matilla, M.A.; Page, K.M.; Monteagudo-Cascales, E.; Dolphin, A.C.; Krell, T.; Zhulin, I.B. 2022. Amino acid sensor conserved from bacteria to humans. *Proceedings of the National Academy of Sciences USA*, 119: e2110415119.

Matilla, M.A.; Monson, R.E.; Murphy, A.; Schicketz, M.; Rawlinson, A.; Duncan, C.; Mata, J.; Leeper, F.; Salmond, G.P.C. 2022. Solanimycin: biosynthesis and distribution of a new antifungal antibiotic regulated by two quorum-sensing systems. *mBio*, 13: e0247222.

Pacheco-Sánchez, D.; Marín, P.; Molina-Fuentes, A.; Marqués, S. 2022. Subtle sequence differences between two interacting σ^{54} -dependent regulators lead to different activation mechanisms. *FEBS Journal*, 289: 7582-7604.

Tagua, V.G.; Molina-Henares, M.A.; Travieso, M.L.; Nisa-Martínez, R.; Quesada, J.M.; Espinosa-Urgel, M.; Ramos-González, M.I. 2022. C-di-GMP and biofilm are regulated in *Pseudomonas putida* by the CfcA/CfcR two-component system in response to salts. *Environmental Microbiology*, 24: 158-178.



Solanimycin, a new antifungal metabolite. Matilla et al. (2022) *mBio*, 13: e0247222

EEZ
Estación Experimental del Zaidín

SUSTAINABILITY OF SOIL-PLANT SYSTEMS AND ENVIRONMENTAL DECONTAMINATION

MEMBERS



Senior Researchers

Rogelio Nogales Vargas-Machuca, *Group Leader*

Emilio Benítez León

Esperanza Romero Taboada

Predoctoral Researchers

Lisanne Smulders

Hired Researchers

Martín Aguerrebengoa Barreña

Rafael Alcalá Herrera

Nuria Guirado Romero

Staff Technicians

Celia Cifuentes Urién

M^a 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 of organic wastes using low-cost biotechnologies to promote a circular bioeconomy.
2. Development of low-temperature thermochemical conversion processes (hydrothermal carbonization) as a means to sustainably convert residual biomass into value-added products for application as adsorbents of emerging contaminants.
3. Development of new strategies for the sustainable management of agroecosystems and the maintenance of multiple ecosystem services.

5 MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

Aguilar-Romero, I.; Romero, E.; Wittich, R.-M.; van Dillewijn, P. 2020. Bacterial ecotoxicity and shifts in bacterial communities associated with the removal of ibuprofen, diclofenac and triclosan in biopurification systems. *Science of The Total Environment*, 741: 140461.

Aguilar-Romero, I.; van Dillewijn, P.; Nesme, J.; Sørensen, S.J.; Nogales, R.; Delgado-Moreno, L.; Romero, E. 2022. A novel and affordable bioaugmentation strategy with microbial extracts to accelerate the biodegradation of emerging contaminants in different media. *Science of the Total Environment*, 834: 155234.

Badagliacca, G.; Benítez, E.; Amato, G.; Badalucco, L.; Giambalvo, D.; Laudicina, V.A.; Ruisi, P. 2018. Long-term no-tillage application increases soil organic carbon, nitrous oxide emissions and faba bean (*Vicia faba* L.) yields under rain-fed Mediterranean conditions. *Science of the Total Environment*, 639: 350-359.

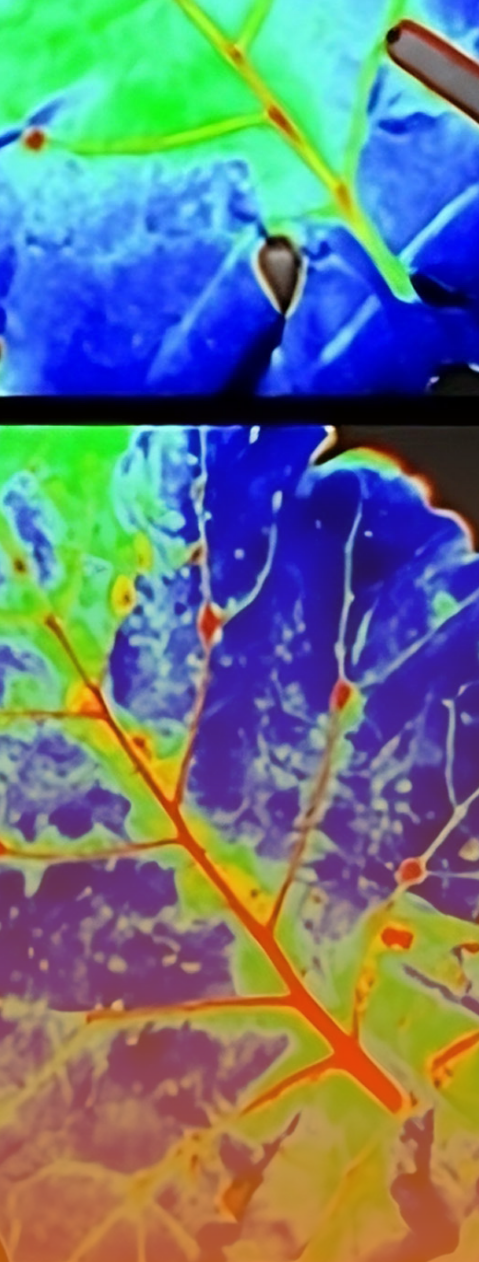
Delgado-Moreno, L.; Bazhari, S.; Gasco, G.; Méndez, A.; El Azzouzi, M.; Romero, E. 2021. New insights into the efficient removal of emerging contaminants by biochars and hydrochars derived from olive oil wastes. *Science of the Total Environment*, 752: 141838.

Smulders, L.; Ferrero, V.; de la Peña, E.; Pozo, M.J.; Pendón, J.A.D.; Benítez, E.; López-García, A. 2022. Resistance and not plant fruit traits determine root-associated bacterial community composition along a domestication gradient in tomato. *Plants*, 11: 43.



Organic olive grove





REPORT | 2022 |

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

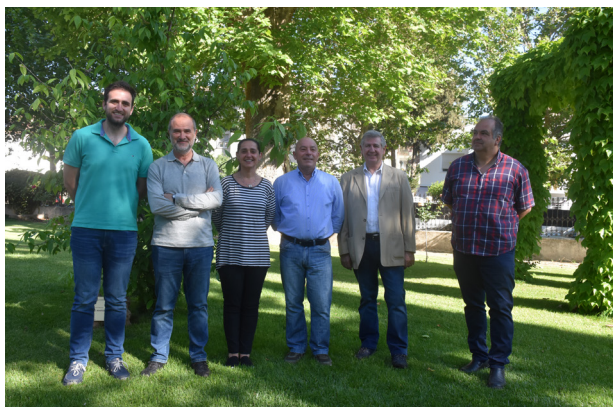
ROS and Nitric Oxide-Signaling and Peroxisomal
Dynamics in Plants

EEZ
Estación Experimental del Zaidín



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

Postdoctoral Researchers

Marta Rodríguez Ruiz

Predoctoral Researchers

M^a de los Ángeles Muñoz Vargas

Hired Researchers

Salvador González Gordo

Staff Technicians

M^a Jesús Campos Ramos

Carmelo Ruiz Torres

Hired Technicians

José Manuel Rubí Villegas

OVERVIEW

The Group investigates, at the cell and molecular levels, 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 which allow a better exploitation of the nutritional and potential features of these crops. Thus, our Group applies high throughput approaches (transcriptomics, proteomics, peptidomics and metabolomics), and collaborates with leading companies in the food and biotechnology sector, including Syngenta Seeds Ltd., Sakata, United Caro Research and Development, S.L.U., Lactalis-Puleva, S.L.U., Deoleo Inc., Agrosol, and MEDINA Foundation. Furthermore, *Arabidopsis* and pea are used as model plants, to generate knowledge to be further used in the applied objectives of the Group's activity.

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 Sulphur Species (ROS, RNS and RSS, respectively) in plants 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 basically investigated in pepper, tomato and olive, through the analysis of enzymatic and non-enzymatic antioxidants. The influence of NO, and the reactive oxygen, nitrogen and sulphur species (ROS, RNS and RSS, respectively) in the quality parameters of the selected products is analysed through transcriptomic, proteomic and metabolomic approaches.

2. Role of NO and RNS in germination, development and abiotic stress in higher plants. The biochemical and molecular characterization of the endogenous cell targets (proteins, lipids and nucleic acids) involved in post-translational modifications promoted by ROS, RNS and RSS species is investigated, as well as the analysis of their participation in cell signaling processes during germination and development, and in abiotic stresses.

3. Search for natural bioactive compounds coming from vegetables with nutritional and biotechnological applications. This objective is addressed to the nutritional and biotechnological sectors. New bioactive compounds (capsaicin, proteins and/or peptides, flavonoids, etc.) and antioxidants, applied either through biomedical therapies or as dermatological products, are investigated in connection with the productive sector.

5 MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

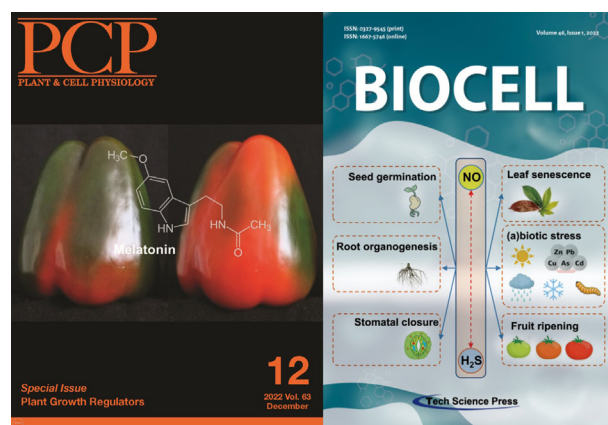
Corpas, F.J.; González-Gordo, S.; Palma, J.M. 2022. NO source in higher plants: present and future of an unresolved question. *Trends in Plant Science*, 27: 116-119.

Corpas, F.J.; Rodríguez-Ruiz, M.; Muñoz-Vargas, M.A.; González-Gordo, S.; Reiter, R.J.; Palma, J.M. 2022. Interactions of melatonin, reactive oxygen species, and nitric oxide during fruit ripening: an update and prospective view. *Journal of Experimental Botany*, 73: 5947-5960.

López-Huertas, E.; Lozano-Sánchez, J.; Segura-Carretero, A. 2021. Olive oil varieties and ripening stages containing the antioxidants hydroxytyrosol and derivatives in compliance with EFSA health claim. *Food Chemistry*, 342: 128291.

López-Huertas, E.; Palma, J.M. 2020. Changes in glutathione, ascorbate, and antioxidant enzymes during olive fruit ripening. *Journal of Agricultural and Food Chemistry*, 68: 12221-12228.

Palma, J.M.; Mateos, R.M.; López-Jaramillo, J.; Rodríguez-Ruiz, M.; González-Gordo, S.; Lechuga-Sancho, A.M.; Corpas, F.J. 2020. Plant catalases as NO and H₂S targets. *Redox Biology*, 34: 101525.



Covers of the journal *Plant and Cell Physiology* related to the article: Aghdam et al. (2022) (*Plant and Cell Physiology*, 63: 1764-1786), and of the journal *BioCell*, related to the article Corpas, F.J. et al. (2022) (*BioCell*, 46: 1-5)

PLANT REPRODUCTIVE BIOLOGY AND ADVANCED MICROSCOPY LABORATORY (PReBAIL)

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 M^a Berral Hens

M^a Elena Lima Cabello

Staff Technicians

Diana Fuensanta Nicolás Llorach

Hired Technicians

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, encompass-

ing 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. Identification, characterization and functional analysis of gene products involved in the development of plant reproductive tissues. Signaling mechanisms involved in orientation and focused growing of the pollen tube.
2. Characterization of proteins of interest in the olive seed, and in new by-products resulting from the alternative processing of the olive fruits and other species of agronomical interest. Identification of biomolecules in olive oils and applications to alimentary and pharmaceutical uses.
3. Pollen and food allergy. Molecular allergology: isolation and characterization of allergenic proteins. Characterization of genetic and functional variability of allergens. Development of molecular techniques for allergy diagnosis and therapy.
4. Proximal characterization of new foods derived from plant reproductive tissues and assessment of their nutritional value and their potential nutraceutical benefits or toxicity in animal models (mouse and zebrafish), and in healthy and pathological humans through *in vivo* nutritional interventions and *in vitro* and *ex vivo* assays.

5 FIVE MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

Alché, J.D. 2019. A concise appraisal of lipid oxidation and lipoxidation in higher plants. *Redox Biology*, 23: 101136.

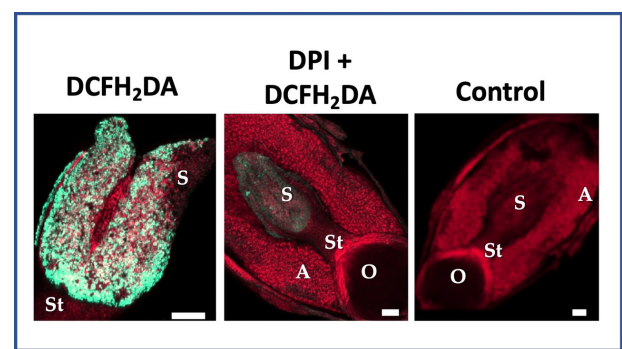
Castro, A.J.; Lima-Cabello, E.; Alché, J.D. 2020. Identification of seed storage proteins as the major protein constituents of the extra virgin olive oil (EVOO). *Food Chemistry*, X: 100099.

Hernández, M.L.; Lima-Cabello, E.; Alché, J.D.; Martínez-Rivas, J.M.; Castro, A.J. 2020. Lipid composition and associated gene expression patterns during pollen germination and pollen tube

growth in olive (*Olea europaea* L.). *Plant and Cell Physiology*, 61: 1348-1364.

Lima-Cabello, E.; Alché, J.D.; Morales-Santana, S.; Clemente, A.; Jiménez-López, J.C. 2020. Narrow-leaved lupin (*Lupinus angustifolius* L.) seeds gamma-conglutinin is an anti-inflammatory protein promoting insulin resistance improvement and oxidative stress amelioration in PANC-1 pancreatic cell-line. *Antioxidants*, 9: 12.

Zafra, A.; M'rani-Alaoui, M.; Lima, E.; Jiménez-López, J.C.; Alché, J.D. 2018. Histological features of the olive seed and presence of 7S-type seed storage proteins as hallmarks of the olive fruit development. *Frontiers in Plant Science*, 9: 1481.



Localization of ROS produced by Rboh in young olive flowers using the fluorochrome DCFH₂-DA and the specific Rboh inhibitor DPI. Bars = 250 μm; A: anthers; O: ovary; S: stigma; St: style. Modified from Jiménez-Quesada et al. (2022) *Oxygen*, 2: 79-90

MOLECULAR PHYSIOLOGY OF ION TRANSPORT IN PLANTS UNDER ADVERSE ENVIRONMENTAL CONDITIONS

MEMBERS



Senior Researchers

Andrés Belver Cano, *Group Leader*

M^a Pilar Rodríguez Rosales

Cornelis Venema

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M^a de las Nieves Aranda Sicilia

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M^a Elena Sánchez Romero

Hired Technicians

Jaime Mañas Galindo

OVERVIEW

We use an integrated approach to study the molecular mechanisms of ion homeostasis in plants in order to develop biotechnological applications to improve salt tolerance, mineral nutrition and water use efficiency in crop plants. We make special emphasis on the functional characterization of ion transporters in economically important crops, as tomato and citrus, and model organisms, such as *Arabidopsis* and yeasts, with two separate research lines. 1. Genetic and molecular approach focusing on quantitative traits (QTL) of agronomical interest functionally supported by Na⁺ and Cl⁻ transporters by combining QTL mapping, candidate gene analysis, transcriptomic and reverse genetics (RNAi, CRISPR/Cas), what may facilitate their monitoring in genetic improvement programs in order to obtain tolerant plants to abiotic stress or their use as rootstocks of commercial varieties. 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 functional characterization of the tomato KEA1,2 homologue using transgenic plants in which these genes are disrupted by CRISPR/Cas. Inhibition of photosynthesis contributes substantially to the negative effects of abiotic stresses like salinity, drought or K⁺ deficiency on crop productivity

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⁻, Ca²⁺) across chloroplast membranes of glycophytic and halophytic species and their relevance for chloroplast function and photosynthesis under normal and stress conditions.

5 FIVE MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

Aranda-Sicilia, M.N.; Sánchez Romero, M.E.; Rodríguez-Rosales, M.P.; Venema, K. 2022. Plastidial transporters KEA1 and KEA2 at the inner envelope membrane adjust stromal pH in the dark. *New Phytologist*, 229: 2080-2090.

Asins, M.J.; Romero-Aranda, M.R.; Espinosa, J.; González-Fernández, P.; Jaime-Fernández, E.; Traverso, J.A.; Carbonell, E.A.; Belver, A. 2022. HKT1;1 and HKT1;2 Na⁺ Transporters from *Solanum galapagense* play different roles in the plant Na⁺ distribution under salinity. *International Journal of Molecular Sciences*, 23: 5130.

Baghour, M.; Gálvez, F.J.; Sánchez, M.E.; Aranda, M.N.; Venema, K.; Rodríguez-Rosales, M.P. 2019. Overexpression of LeNHX2 and SISOS₂ increases salt tolerance and fruit production in double transgenic tomato plants. *Plant Physiology and Biochemistry*, 135: 77-86.

Cagnac, O.; Baghour, M.; Jaime-Pérez, N.; Aranda-Sicilia, M.N.; Sánchez-Romero, M.E.; Rodríguez-Rosales, M.P.; Venema, K. 2020. Deletion of the N-terminal domain of the yeast vacuolar (Na⁺;K⁺)/H⁺ antiporter Vnx1p improves salt tolerance in yeast and transgenic *Arabidopsis*. *Yeast*, 37: 173-185.

Romero-Aranda, M.R.; González Fernández, P.; Pérez-Tienda, J.R.; López Díaz, M.R.; Espinosa, J.; Granum, E.; Traverso, J.A.; Pineda, B.; García Sogo, B.; Moreno, V.; Asins, M.J.; Belver, A. 2020. Na⁺ transporter HKT1;2 reduces flower Na⁺ content and considerably mitigates the decline in tomato fruit yields under saline conditions. *Plant Physiology and Biochemistry*, 154: 341-352.



Overview of a reciprocal rootstock/scion combinations assay with SgHKT1;1- and SgHKT1;2-RNAi-silenced lines grown under control and saline conditions under commercial greenhouse conditions (Asins et al. 2022)

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

M^a 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 investigate the redox regulation carried out by the thioredoxins (TRXs) *f* and *m* in photosynthesis and carbon metabolism. Our research interest is focused on how plants integrate redox and sugar signalling in chloroplasts to efficiently adapt their development to the changing environment.

tal conditions. In this regard, we also investigate emerging non-classical TRX-like proteins as key players in plant adaptation and survival.

2. Plant phenotyping is mostly based on computer vision: thermography, chlorophyll fluorescence (Chl-F), multicolour fluorescence (MCFI) and hyperspectral reflectance imaging devices. We investigate plant biotic and abiotic stress induced by pathogen infections (viruses, bacteria and fungi), parasitic plants or by challenging environmental cues (high temperatures and CO₂, drought, etc.). For data handling and analysis, we use artificial intelligence tools as machine learning classifiers.

5 FIVE MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

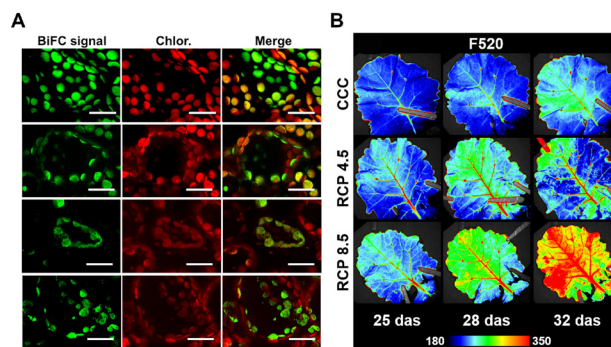
Pérez-Bueno, M.L.; Pineda, M.; Vida, C.; Fernández-Ortuño, D.; Tores, J.; de Vicente, A.; Cazorla, F.; Barón, M. 2019. Detection of white root rot in avocado trees by remote sensing. *Plant Disease*, 103: 1119-1125.

Serrato, A.J.; Rojas-González, J.A.; Torres-Romero, D.; Vargas, P.; Mérida, A.; Sahrawy, M. 2021. Thioredoxins *m* are major players in the multifaceted light-adaptive response in *Arabidopsis thaliana*. *The Plant Journal*, 108: 120-133.

Pérez-Bueno, M.L.; Pineda, M.; Barón, M. 2019. Phenotyping plant responses to biotic stress by chlorophyll fluorescence imaging. *Frontiers in Plant Science*, 10: 1135.

Pérez-Bueno, M.L.; Pineda, M.; Barón, M. 2021. Thermal imaging for plant stress detection and phenotyping. *Remote Sens*, 13: 68.

Sahrawy, M.; Fernández-Trijuque, J.; Vargas, P.; Serrato, A.J. 2022. Comprehensive expression analyses of plastidial thioredoxins of *Arabidopsis thaliana* indicate a main role of thioredoxin *m2* in roots. *Antioxidants (Basel)*, 11:1365.



A, Confocal images of the BiFC interaction of the TRX *m2* of *Arabidopsis* with chloroplast transporters and thylakoid-associated proteins (project PGC2018-096851-B-C21). B, Images of the green fluorescence (F520) of oilseed rape plants under current climate conditions (CCC) () and two scenarios of climate change (RCP 4.5 and RCP 8.5) (Pineda, M.; Barón, M. 2022. *Agronomy*, 12: 1845)

ROS AND NITRIC OXIDE-SIGNALING AND PEROXISOMAL DYNAMICS IN PLANTS

MEMBERS



Senior Researchers

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María C. Romero Puertas

Predoctoral Researchers

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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 and xenobiot-

ics) 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 are 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.

5 MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

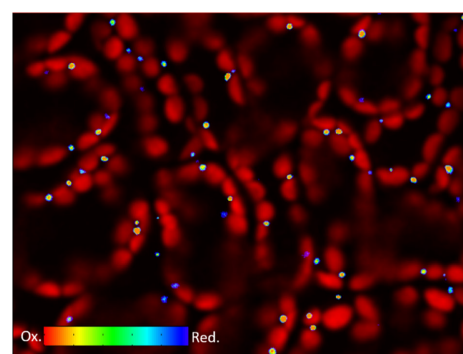
Calero-Muñoz, N.; Expósito-Rodríguez, M.; Collado-Arenal, A.M.; Rodríguez-Serrano, M.; Laureano-Marín, A.M.; Santamaría, M.E.; Gotor, C.; Díaz, I.; Mullineaux, P.M.; Romero-Puertas, M.C.; Olmedilla, A.; Sandalio, L.M. 2019. Cadmium induces reactive oxygen species-dependent peroxophagy in *Arabidopsis* leaves. *Plant, Cell and Environment*, 42: 2696-2714.

Hafsi, C.; Collado-Arenal, A.M.; Wang, H.; Sanz-Fernández, M.; Sahrawy, M.; Shabala, S.; Romero-Puertas, M.C.; Sandalio, L.M. 2022. The role of NADPH oxidases in regulating leaf gas exchange and ion homeostasis in *Arabidopsis* plants under cadmium stress. *Journal of Hazardous Materials*, 429: 128217.

Romero-Puertas, M.C.; Peláez-Vico, M.A.; Pazmiño, D.M.; Rodríguez-Serrano, M.; Terrón-Camero, L.; Bautista, R.; Gómez-Cárdenas, A.; Gonzalo Claros, M.; León, J.; Sandalio, L.M. 2022. Insights into ROS-dependent signalling underlying transcriptomic plant responses to the herbicide 2,4-D. *Plant, Cell and Environment*, 45: 572-590.

Sandalio, L.M.; Peláez-Vico, M.A.; Molina-Moya, E.; Romero-Puertas, M.C. 2021. Peroxisomes as redox-signaling nodes in intracellular communication and stress responses. *Plant Physiology*, 186: 22-35.

Terrón-Camero, L.C.; Rodríguez-Serrano, M.; Sandalio, L.M.; Romero-Puertas, M.C. 2020. Nitric oxide is essential for cadmium-induced peroxule formation and peroxisome proliferation. *Plant, Cell and Environment*, 43: 2492-2507



Imaging the oxidation state of peroxisomes in response to Cd in *Arabidopsis* leaf discs expressing the GRX1-roGFP2-per





REPORT | 2022 |

DEPARTMENT 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

eez
Estación Experimental del Zóndin

BIOFERTILIZATION AND BIODEGRADATION BY RHIZOSPHERIC FUNGI

MEMBERS



Senior Researchers

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Inmaculada García Romera

Postdoctoral Researchers

Tania Ho Plagaro

Predoctoral Researchers

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Martín Ramos-Alvelo Cancellieri

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Gloria Andrea Silva Castro
Jacob R. Pérez Tienda

Staff Technicians

Custodia Cano Romero
Nuria Molinero Rosales
M^a Isabel Tamayo Navarrete

Hired Technicians

Silvia Moreno Morillas

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 AM fungi through tailor-made inoculants.

LINES OF RESEARCH

1. Regulation of the formation and function of arbuscules in AM.
2. Role of the transcription factors of the GRAS family in arbuscule homeostasis and mycorrhizal autoregulation (AOM).
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.

5 MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

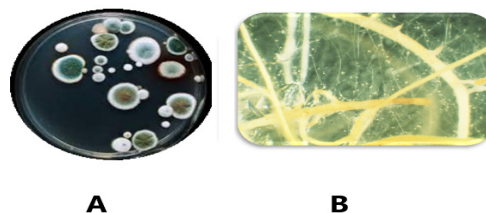
García-Sánchez, M.; Cajthaml, T.; Filipová, A.; Tlustos, P.; Száková, J.; García-Romera, I. 2019. Implications of mycoremediated dry olive residue application and arbuscular mycorrhizal fungi inoculation on the microbial community composition and functionality in a metal-polluted soil. *Journal of Environmental Management*, 247: 756-765.

Ho-Plágaro, T.; Morcillo, R.J.L.; Tamayo-Navarrete, M.I.; Huertas, R.; Molinero-Rosales, N.; López-Ráez, J.A.; Macho, A.P.; García-Garrido, J.M. 2021. DLK2 regulates arbuscule hyphal branching during arbuscular mycorrhizal symbiosis. *New Phytologist*, 229: 548-562.

Mestre, M.C.; Tamayo Navarrete, M.I.; García-Garrido, J.M. 2022. Exploring the yeast-mycorrhiza-plant interaction: *Saccharomyces eubayanus* negative effects on arbuscular mycorrhizal formation in tomato plants. *Plant and Soil*, 479: 529-542.

Reva, M.; Cano, C.; Herrera, M.A.; Bago, A. 2020. Arbuscular mycorrhizal inoculation enhances endurance to severe heat stress in three horticultural crops. *Hortscience*, 56: 396-406.

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.



Isolation of saprophytic fungi (A) and monoxenic culture of an AM fungus (B)

STRUCTURE, DYNAMICS AND FUNCTION OF RHIZOBACTERIAL GENOMES

MEMBERS



Senior Researchers

Nicolás Toro García, *Group Leader*

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José Ignacio Jiménez Zurdo

Francisco Martínez-Abarca Pastor

Jesús Mercado Blanco

Predoctoral Researchers

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Esperanza Sánchez Nieto

Hired Researchers

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Natalia Isabel García Tomsig

Sabina Kiara Guedes García

Vicenta Millán Casamayor

Ana Vicente Lasa

Staff Technicians

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Fernando Manuel García Rodríguez

Ascensión Martos Tejera

M^a Dolores Molina Sánchez

Pablo José Villadas Latorre

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.
2. Bacterial Reverse Transcriptases associated to Phage-Defense Systems.
3. Regulation by RNA in nitrogen-fixing symbiotic bacteria (RhizoRNA).

5 MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

Bubici, G.; Kaushal, M.; Prigigallo, M.I.; Gómez-Lama Cabanás, C.; Mercado-Blanco, J. 2019. Biological control agents against *Fusarium* wilt of banana. *Frontiers in Microbiology*, 10: 616.

Fernández-González, A.J.; Cardoni, M.; Gómez-Lama Cabanás, C.; Valverde-Corredor, A.; Villadas, P.J.; Fernández-López, M.; Mercado-Blanco, J. 2020. Linking belowground microbial network changes to different tolerance level towards *Verticillium* wilt of olive. *Microbiome*, 8:11.

García-Tomsig, N.I.; Robledo, M.; diCenzo, G.C.; Mengoni, A.; Millán, V.; Peregrina, A.; Uceta, A.; Jiménez-Zurdo, J.I. 2022. Pervasive RNA regulation of metabolism enhances the root colonization ability of nitrogen-fixing symbiotic α -rhizobia. *mBio*, 13: e03576.

González-Delgado, A.; Mestre, M.R.; Martínez-Abarca, F.; Toro, N. 2019. Spacer acquisition from RNA mediated by a natural reverse transcriptase-Cas1 fusion protein associated with a type III-D CRISPR-Cas system in *Vibrio vulnificus*. *Nucleic Acids Research*, 47:10202-10211.

Mestre, M.R.; González-Delgado, A.; Gutiérrez-Rus, L.I.; Martínez-Abarca, F.; Toro, N. 2020. Systematic prediction of genes functionally associated with bacterial retrons and classification of the encoded tripartite systems. *Nucleic Acids Research*, 48:12632-12647.



Centenary specimen of melojo oak (*Quercus pyrenaica*) in the Alpujarra of Granada

PLANT-BACTERIA INTERACTIONS

MEMBERS



Senior Researchers

Juan Sanjuán Pinilla, *Group Leader*

M^a Trinidad Gallegos Fernández

Daniel Pérez Mendoza

Predocctoral Researchers

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Laura Martínez Rodríguez

Staff Technicians

M^a José Lorite Ortega

Socorro Muñoz Rodríguez

Hired Technicians

Juan Antonio Marchante Sánchez

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.

5 MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

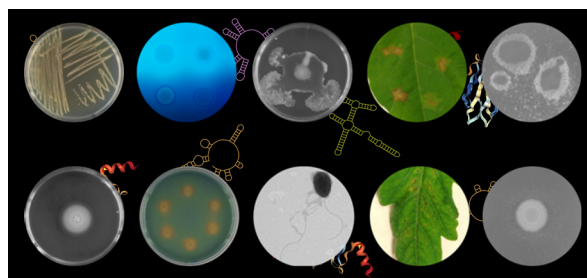
Ferreiro, M.D.; Behrmann, L.V.; Corral, A.; Nogales, J.; Gallegos, M.T. 2021. Exploring the expression and functionality of the *rsm* sRNAs in *Pseudomonas syringae* pv. tomato DC3000. *RNA Biology*, 18: 1818-1833.

Ferreiro, M.D.; Gallegos, M.T. 2021. Distinctive features of the Gac-rsm pathway in plant-associated *Pseudomonas*. *Environmental Microbiology*, 23: 5670-5689.

Lorite, M.J.; Estrella, M.J.; Escaray, F.; Sannazzaro, A.; Videira, I.; Monza, J.; León-Barrios, M.; Sanjuán, J. 2018. The Rhizobia-*Lotus* symbioses: deeply specific and widely diverse. *Frontiers in Microbiology*, 9: 2055.

Pérez-Mendoza, D.; Ferreiro, M.D.; Felipe, A.; Sanjuán, J.; Gallegos, M.T. 2019. AmrZ and FleQ co-regulate cellulose production in *Pseudomonas syringae* pv. tomato DC3000. *Frontiers in Microbiology*, 10: 746.

Pérez-Mendoza, D.; Romero-Jiménez, L.; Rodríguez-Carvajal, M.A.; Lorite, M.J.; Muñoz, S.; Olmedilla, A.; Sanjuan, J. 2022. The role of two linear β -glucans activated by c-di-GMP in *Rhizobium etli* CFN42. *Biology*, 11: 1364.



Within the framework of the PID2021-122418NB-I00 project, we use the phytopathogenic bacterium *Pseudomonas syringae* pv. tomato and its interaction with tomato plants (*Solanum lycopersicum*) to characterize its particularly complex Gac-Rsm pathway

NITROGEN METABOLISM

MEMBERS



Senior Researchers

Eulogio J. Bedmar Gómez, *Group Leader* until April 2022

M^a Jesús Delgado Igeño, *Group Leader* since May 2022

M^a Socorro Mesa Banqueri

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Hired Researchers

Juan José Cabrera Rodríguez

Andrea Jiménez Leiva

Staff Technicians

Alba Hidalgo García

Germán Tortosa Muñoz

Hired Technicians

Sofía Guzmán García

OVERVIEW

To gain knowledge about denitrification using the endosymbiotic bacterium *Bradyrhizobium diazoefficiens* as a model to study the process both in free living-conditions and in symbiosis with legumes. 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 that control their expression and activity, and to the characterization of the molecular mechanism of these regulators. Furthermore, the 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 endosymbiotic bacteria of leguminous plants. These latter serve as a basis for the development of solutions to reduce their emissions in 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, PGPB), and nitrogen fixation determination at both, gene expression, and nitrogenase activity.

LINES OF RESEARCH

1. Study the environmental factors, genes, enzymes and redox processes 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-related processes during symbiosis.
3. Analyse the molecular ecology of nitrifying and denitrifying bacteria in soils, waters and sediments contaminated with nitrates. Effect of nitrogen fertilization.
4. Determine the environmental and regulatory factors involved in reducing the emission of the greenhouse gas nitrous oxide by endosymbiotic bacteria associated with legume crops.
5. Development of organic and biological fertilisers based on agricultural organic wastes composting.

5 MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

Cabrera, J.J.; Jiménez-Leiva, A.; Tomás-Gallardo, L.; Parejo, S.; Casado, S.; Torres, M.J.; Bedmar, E.J.; Delgado, M.J.; Mesa, S. 2021. Dis-

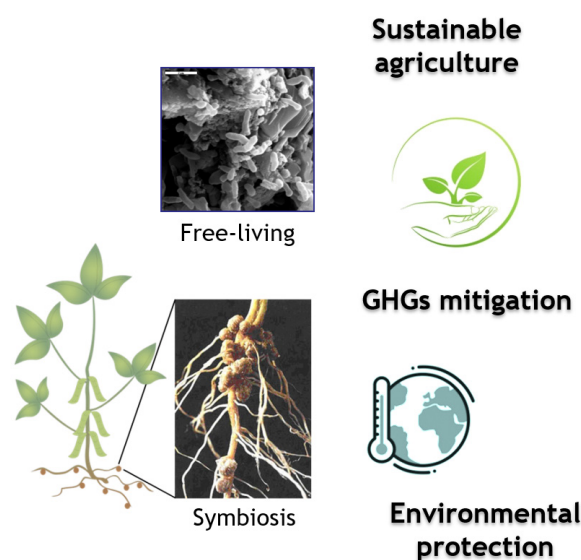
section of FixK₂ protein-DNA interaction unveils new insights into *Bradyrhizobium diazoefficiens* lifestyles control. *Environmental Microbiology*, 23: 6194-6209.

Hidalgo-García, A.; Torres, M.J.; Salas, A.; Bedmar, E.J.; Girard, L.; Delgado M.J. 2019. *Rhizobium etli* produces nitrous oxide by coupling the assimilatory and denitrification pathways. *Frontiers in Microbiology*, 10: 980.

Jiménez-Leiva, A.; Cabrera, J.J.; Bueno, E.; Torres, M.J.; Salazar, S.; Bedmar, E.J.; Delgado, M.J.; Mesa S. 2019. Expanding the regulon of the *Bradyrhizobium diazoefficiens* NnrR transcription factor: New insights into the denitrification pathway. *Frontiers in Microbiology*, 10: 1926.

Jindo, K.; Goron, T.L.; Pizarro-Tobías, P.; Sánchez-Monedero, M.A.; Audette, Y.; Deolu-Ajayi, A.O.; van der Werf, A.; Goitom Teklu, M.; Shenker, M.; Pombo Sudré, C.; Busato, J.G.; Ochoa-Hueso, R.; Nocentini, M.; Rippen, J.; Aroca, R.; Mesa, S.; Delgado, M.J.; Tortosa, G. 2022. Application of biostimulant products and biological control agents in sustainable viticulture: a review. *Frontiers in Plant Science*, 13: 932311.

Tortosa, G.; Pacheco P.J.; Hidalgo-García, A.; Granados, A.; Delgado, A.; Mesa, S.; Bedmar, E.J.; Delgado, M.J. 2020. Copper modulates nitrous oxide emissions from soybean root nodules. *Environmental and Experimental Botany*, 180:104262.



Nitrogen fixation and denitrification are two key processes in the nitrogen cycle. We applied a multidisciplinary approach to better understand the environmental and regulatory factors associated to these processes in legume-associated endosymbiotic bacteria. This knowledge is crucial for the development of an eco-friendly sustainable agriculture. GHG, greenhouse gases

MYCORRHIZA

MEMBERS



Senior Researchers

Concepción Azcón González de Aguilar, *Group leader*

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Nuria Ferrol González

José Luis Garrido Sánchez

Juan Antonio López Ráez

M^a José Pozo Jiménez

Juan Manuel Ruiz Lozano

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Olena Nesterenko

Hired Researchers

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Laura Dejana

Sandra Lendínez Contreras

Javier Lidoy Logroño

Antonio Jesús Perea Martos

Jorge Prieto Rubio

Beatriz Ramírez Serrano

Álvaro López García

Andrea Ramos Molina

Zhivko Minchev Ivanov

Staff Technicians

Juan Manuel García Ramírez

Sonia M^a Molina Arias

M^a Jesús Molina Luzón

Eulogio Javier Palenzuela Jiménez

M^a Carmen Perálvarez Gutiérrez

Hired Technicians

Estefanía Berrio Pozo

Luis España Luque

M^a Dolores Hidalgo Gálvez

Olga M^a 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 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, pests and parasitic weeds) and abiotic (nutrient deficiency, metal toxicity, salinity and drought) stresses, and to the mechanisms involved in these processes. The diversity of mycorrhizal 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 signaling in the rhizosphere during the early stages of mycorrhizal colonization. The final goal is the promotion of symbiosis establishment.
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. Aquaporins regulation 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.

5 MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

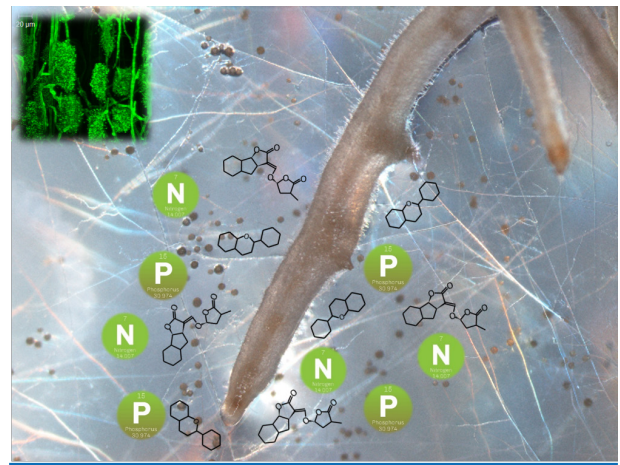
Alcántara, J.M.; Garrido, J.L.; Rey, P.J. 2019. Plant species abundance and phylogeny explain the structure of recruitment networks. *New Phytologist*, 223: 366-376.

Gómez-Gallego, T.; Valderas, A.; van Tuinen, D.; Ferrol, N. 2022. Impact of arbuscular mycorrhiza on maize P_{18} -ATPases gene expression and ionome in copper-contaminated soils. *Ecotoxicology and Environmental Safety*, 234: 113390.

Marro, N.; Lidoy, J.; Chico, M.A.; Rial, C.; García, J.; Varela, R.M.; Macías, F.A.; Pozo, M.J.; Janoušková, M.; López-Ráez, J.A. 2022. Strigolactones: new players in the nitrogen-phosphorus signalling interplay. *Plant, Cell & Environment*, 45: 512-527.

Quiroga, G.; Erice, G.; Ding, L.; Chaumont, F.; Aroca, R.; Ruiz-Lozano, J.M. 2019. The arbuscular mycorrhizal symbiosis regulates aquaporins activity and improves root cell water permeability in maize plants subjected to water stress. *Plant, Cell and Environment*, 42: 2274-2290.

Rivero, J.; Álvarez, D.; Flors, V.; Azcón-Aguilar, C.; Pozo, M.J. 2018. Root metabolic plasticity underlies functional diversity in mycorrhiza-enhanced stress tolerance in tomato. *New Phytologist*, 220: 1322-1336.



Plant communication in the rhizosphere: effect of nutrient fertilization in plant signalling and colonization by beneficial arbuscular mycorrhizal fungi



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Estación Experimental del Zaidín



REPORT | 2022 |

DEPARTMENT OF NUTRITION AND SUSTAINABLE ANIMAL PRODUCTION

Animal Nutrition

Gastrointestinal Health and Food Safety

Sustainable Production of Ruminants

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Estación Experimental del Zóndin



ANIMAL NUTRITION

MEMBERS



Senior Researchers

Rosa M^a Nieto Liñán, *Group Leader*

Ignacio Fernández-Fígares Ibáñez

Manuel Lachica López

Isabel Seiquer Gómez-Pavón

Postdoctoral Researcher

Consolación García Contreras

Predoctoral Researcher

Zaira Pardo Domínguez

Staff Technicians

Alfonso Bartolomé García Écija

Luis Lara Escribano

Hired Technicians

Ana M^a Haro García

Miguel Ángel Liñán Fernández

Jesús Nieto Chica

OVERVIEW

The activity of the Group is focused on the study of energy and nutrient utilization in non-ruminant, and on the identification of processes and specific compounds involved in the metabolic response to feed intake, including bioaccessibility 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.

5 MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

Fernández-Fígares, I.; Lachica, M.; Martínez-Pérez, M.; Ramsay, T.G. 2019. Conjugated linoleic acid and betaine affect lipolysis in pig adipose tissue explants. *Animal*, 13: 2840-2846.

Palma-Granados, P.; Lara, L.; Seiquer, I.; Lachica, M.; Fernández-Fígares, I.; Haro, A.; Nieto, R. 2021. Protein retention, growth performance and carcass traits of individually housed immunocastrated male- and female- and surgically castrated male Iberian pigs fed diets of increasing amino acid concentration. *Animal*, 15: 100187.

Palma-Granados, P.; Seiquer, I.; Benítez, R.; Ovilo, C.; Nieto, R. 2019. Effects of lysine deficiency on carcass composition and activity and gene expression of lipogenic enzymes in muscles and backfat adipose tissue of fatty and lean piglets. *Animal*, 13: 2406-2418.

Pardo, Z.; Seiquer, I.; Lachica, M.; Nieto, R.; Lara, L.; Fernández-Fígares, I. 2022. Exposure of growing Iberian pigs to heat stress and effects of dietary betaine and zinc on heat tolerance. *Journal of Thermal Biology*, 106: 103230.

Seiquer, I.; Palma-Granados, P.; Haro, A.; Lara, L.; Lachica, M.; Fernández-Fígares, I.; Nieto, R. 2019. Meat quality traits in *longissimus lumborum* and *gluteus medius* muscles from immunocastrated and surgically castrated Iberian pigs. *Meat Science*, 150: 77-84.



Exploring the outdoor space

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

M^a Carmen Marín Manzano

Staff Technicians

Antonia Felipe Reyes

Hired Technicians

María Padial de Jáudenes

Ana M^a Haro García

OVERVIEW

The research activity of the Group of 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. To study the nutritional use, biological effects and digestive behaviour of legume food proteins (peas, chickpeas, lentils, among others) and compounds with putative biological effects (e.g., protease inhibitors, oligosaccharides) involved in the prevention of inflammatory and carcinogenic processes within the gastrointestinal tract by using *ex vivo*, *in vivo* (rodents) and *in vitro* (cell models, faecal homogenates) approaches.

2. To develop *in vitro* digestion models designed to investigate the relationships between protein structure and functionality, digestibility and antigenicity as well as bioaccessibility of processing contaminants; and to design colonic fermentation models to determine carbohydrate fermentability, nutrient availability, and survival of prebiotic compounds and probiotic strains.

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

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

5. Develop mathematical models (R programming) capable of simulating intestinal bacterial growth.

5 MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

Brodkorb, A.; Egger, L.; Alminger, M.; Alvito, P.; Assucao, R.; Ballance, S.; Bohn, T.; Bourlieu-Lacanal, C.; Boutrou, R.; Carriere, F.; Clemente, A.; Corredig, M.; Dupont, D.; Dufour, C.; Edwards, C.; Golding, M.; Karakaya, S.; Kirkhus, B.; Le Feunteun, S.; Lesmes, U.; Macienzancka, A.; Mackie, A.; Matins, C.; Marza, S.; McClements, J.; Menard, O.; Minekus, M.; Portmann, R.; Santos, C.; Souchon, I.; Singh, R.P.; Vegarud, G.E.; Wickham, M.; Weitschies, W.; Recio, I. 2019. INFOGEST static *in vitro* simulation of gastrointestinal food digestion. *Nature protocols*, 14: 991-1014.

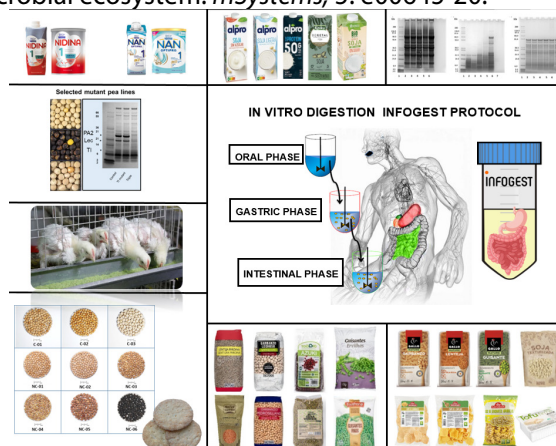
García-Casas, VE; Seiquer, I; Pardo, Z; Haro, A; Recio, I; Olías, R. 2022. Antioxidant potential of the sweet whey-based beverage colada after the digestive process and relationships with the lipid and protein fractions. *Antioxidants*, 11: 1827.

Mesías, M.; Delgado-Andrade, C.; Morales, F.J. 2022. An updated view of acrylamide in cereal prod-

ucts. *Current Opinion in Food Science*, 46: 100847.

Olías, R.; Becerra, C.; Soliz, J.; Moreno, F.J.; Delgado-Andrade, C.; Clemente, A. 2019. Glycation affects differently the main soybean Bowman-Birk inhibitors, IBB1 and IBB2, altering their anti-proliferative properties against HT29 colon cancer cells. *Food & Function*, 10: 6193-6202.

Wang, S.; Rubio, L.A.; Duncan, S.H.; Holtrop, G.; Donachie, G.; Kettle, H.; Louis, P.; Walker, A.W.; Flint, H.J. 2020. A pivotal role for lactate and lactate-utilizing bacteria in the stability of the human colonic microbial ecosystem. *mSystems*, 5: e00645-20.



- ✓ **Nutritional profile**
- ✓ **Evaluation of thermal damage during food processing**
- ✓ **Protein digestibility**
- ✓ **Essential aminoacid bioavailability**
- ✓ **Bioaccessibility of bioactive compounds and food processing contaminants**
- ✓ **Health related activity**
- ✓ **Microbiota effects**

Combined approaches to evaluate nutrient bioavailability and functionality of legume-based foods (PY20_00242/CA17182) and infant formula enriched with human milk oligosaccharides (PID2021-126101OB-I00)



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SUSTAINABLE PRODUCTION OF RUMINANTS

MEMBERS



Senior Researchers

Eduarda Molina Alcaide, *Group Leader* until August 2022

David R. Yáñez Ruiz, *Group Leader* since September 2022

A. Ignacio Martín García

Predoctoral Researchers

Mahmoud Hassan Abdelnabi Moham Hassan

Juan Manuel Palma Hidalgo

Pedro Jesús Romero Márquez

Eva M^a Romero Recio

Hired Researchers

Aharón Gómez Mesonero

Elisabeth Jiménez Jiménez

Eva Ramos Morales

Manuel Romero Huelva

Staff Technicians

Isabel M^a Jiménez Romero

Hired Technicians

Noemí Pino López

OVERVIEW

The research Group works 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 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. Enteric methane mitigation.
3. Animal welfare.

5 MOST RELEVANT PUBLICATIONS IN THE LAST 5 YEARS

Arndt, C.; Hristov, A.N.; Price, W.J.; McClelland, S.C.; Peláez, A.M.; Cueva, S.F.; Oh, J.; Dijkstra, J.; Bannink, A.; Bayat, A.R.; Crompton, L.A.; Eugéne, M.A.; Enahoro, D.; Kebreab, E.; Kreuzer, M.; McGee, M.; Martin, C.; Newbold, C.J.; Reynolds, C.K.; Schwarm, A.; Shingfield, K.J.; Veneman, J.B.; Yáñez-Ruiz, D.R.; Yu, Z. 2022. Full adoption of the most effective strategies to mitigate methane emissions by ruminants can help meet the 1.5 °C target by 2030 but not 2050. *Proceedings of the National Academy of Sciences of the United States of America*, 119: e2111294119.

Belanche, A.; Palma-Hidalgo, J.M.; Nejjam, I.; Jiménez, E.; Martín-García, A.I.; Yáñez-Ruiz, D.R. 2020. Inoculation with rumen fluid in early life as a strategy to optimize the weaning process in intensive dairy goat systems. *Journal of Dairy Science*, 103: 5047-5060.

Belanche, A.; Palma-Hidalgo, J.M.; Nejjam, I.; Serrano, R.; Jiménez, E.; Martín-García, I.; Yáñez-Ruiz, D.R. 2019. *In vitro* assessment of the factors that determine the activity of the rumen microbiota for further applications as inoculum. *Journal of the Science of Food and Agriculture*, 99: 163-172.

Cabeza-Luna, I.; Carro, M.D.; Fernández-Yepes, J.; Molina-Alcaide, E. 2018. Effects of modifications to retain protozoa in continuous-culture fermenters on ruminal fermentation, microbial populations, and microbial biomass assessed by two different methods. *Animal Feed Science and Technology*, 240: 117-127.

Marcos, C.N.; Carro, M.D.; Fernández-Yepes, J.E.; Haro, A.; Romero-Huelva, M.; Molina-Alcaide, E. 2020. Effects of agroindustrial by-product supplementation on dairy goat milk characteristics, nutrient utilization, ruminal fermentation, and methane production. *Journal of Dairy Science*, 103: 1472-1483.



Study of resilience in extensive livestock systems

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R&D&I ASSOCIATED UNITS

Cell Signaling and Metabolic Integration. 2014-2023. 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: M^a 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. 2020-2023. 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.



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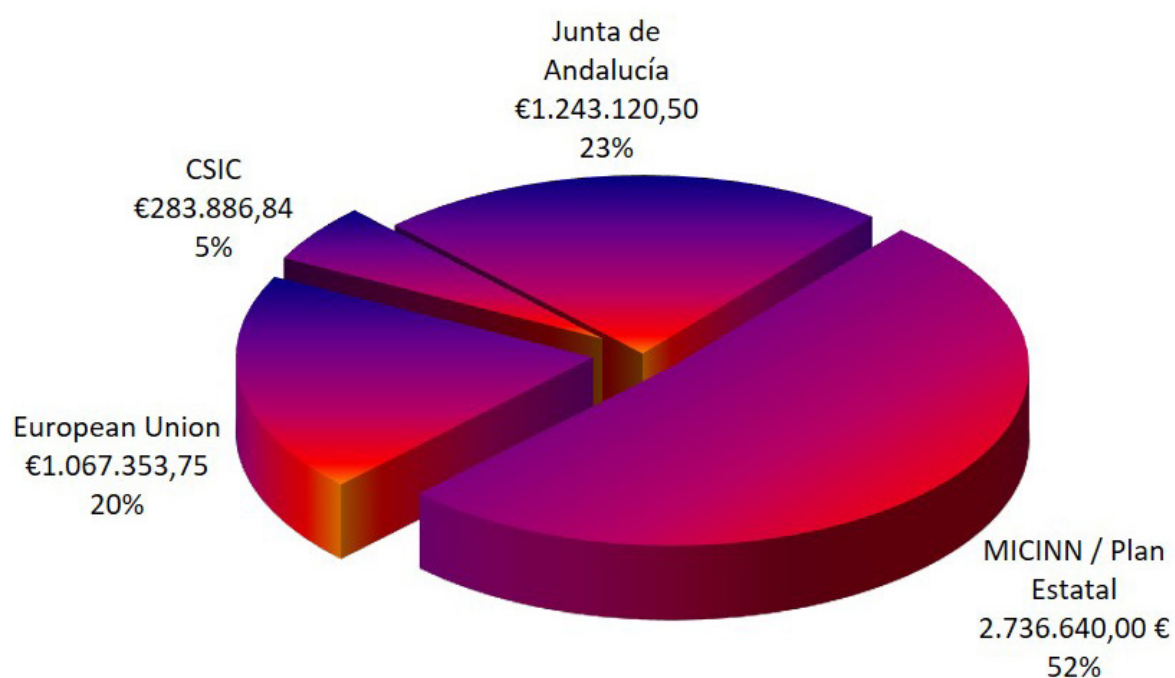
FUNDING 2022

TOTAL INCOME 2022

8.094.948,18€

Administrative Budget	1.161.971,42 €
Services Revenues	56.042,28 €
Investments & Special Actions (Buildings, constructions, etc.)	663.522,48 €
Competitive Calls Incomes	5.718.280,43 €
Contracts & Agreements Incomes	495.131,57 €

FUNDING AGENCIES OF COMPETITIVE CALLS



(Sources: PCO2022 and Sorolla)

ONGOING RESEARCH PROJECTS

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.

Acrylamide exposure and bioaccessibility in foodservices and traditional cooking. Retos de la Sociedad (RTI2018-094402-B-I00). PIs: Cristina Delgado Andrade, Marta Mesías García (IC-TAN-CSIC). 2019-2022.

Arbuscular mycorrhizal fungi as biotechnological tools to increase plant resilience to climate change. Retos de la Sociedad (RTI2018-098756-B-I00). PIs: Nuria Ferrol González, Concepción Azcón González de Aguilar. 2019-2022.

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 del Conocimiento (PID2019-109372GB-I00). PIs: Manuel Espinosa Urgel, M^a 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: upsca-

ling 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: M^a 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.

Cross-regulation insights of nitrogen fixation and denitrification in the soybean endosymbiont and model organism *Bradyrhizobium diazoefficiens*. Generación del Conocimiento (PID2020-114330GB-I00). PI: M^a 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: M^a 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). PI: Jesús Mercado Blanco, Antonio di Pietro (UCO). 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 cross-talk and in the peroxisome-dependent signalling mechanisms. Generación del Conocimiento (PID2021-122280NB-I00). PIs: María C. Romero Puertas, Luisa M^a 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.

Heat stress in lactating Iberian sows: physiological and productive effects and nutritional mitigation strategies. Generación del Conocimiento (PID2021-125059OB-I00). PIs: Rosa M^a 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: M^a 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.

Marine microbiome against cancer. Retos Colaboración (RTC-2017-6405-1). PI: Silvia Marqués Martín. 2018-2022.

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

Microbial conversion of lignocellulosic wastes into value-added products. Retos de la Sociedad (RTI2018-094370-B-I00). PIs: Juan Luis Ramos Martín, Estrella Duque Martín de Oliva. 2019-2022.

Mycorrhiza induced resistance: Bridging the gap between basic knowledge and application.

Retos de la Sociedad (RTI2018-094350-B-C31). PIs: M^a José Pozo Jiménez, Juan Antonio López Ráez. 2019-2022.

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 and functional properties of Bowman-Birk inhibitors from pea (*Pisum sativum* L.). Retos de la Sociedad (AGL2017-83772-R). PIs: Alfonso Clemente Gimeno, Luis A Rubio San Millán. 2018-2022.

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.

Peroxisome-dependent signalling under stress: role of peroxules and peroxisomal homeostasis. Generación del Conocimiento (PGC2018-098372-B-I00). PIs: Luisa M^a Sandalio González, María C. Romero Puertas. 2019-2022.

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.

Phenotyping plant-pathogen interactions under different scenarios of climate change. Retos de la Sociedad (RTI2018-094652-B-I00). PI: Matilde Barón Ayala. 2019-2022.

Restoration of soils contaminated by heavy metals: A strategy based on waste recycling and bioremediation by symbiotic and saprobic microorganisms. Retos de la Sociedad (RTI2018-094327-B-I00). PI: Inmaculada García Romera. 2019-2022.

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.

Signalling mechanisms and regulation of photosynthesis and carbon metabolism in chloroplasts. Generación del Conocimiento (PGC2018-096851-B-C21). PIs: Mariam Sahrawy Barragán, Antonio Jesús Serrato Recio. 2019-2022.

Study of proton linked ion transport at the chloroplast envelope. Generación del Conocimiento (PID2019-105260GB-I00). PIs: Kees Venema, M^a 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.

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: M^a Isabel Ramos González. 2022-2025.

Ayudas del Sistema Nacional de Garantía Juvenil en la Junta de Andalucía 2021 (EI-GARJUV-AND21-0164): Luis España Luque. PI: Juan Antonio López Ráez. 2022-2023.

Ayudas del Sistema Nacional de Garantía Juvenil en la Junta de Andalucía 2021 (EI-GARJUV-AND21-0168): Jesús Nieto Chico. PI: Rosa M^a Nieto Liñán. 2022-2023.

Ayudas del Sistema Nacional de Garantía Juvenil en la Junta de Andalucía 2021 (EI-GARJUV-AND21-0175): Sofía Guzmán García. PI: M^a Socorro Mesa Banqueri. 2022-2023.

Ayudas del Sistema Nacional de Garantía Juvenil en la Junta de Andalucía 2021 (EI-GARJUV-AND21-0171): Diego Becerra Mora. PI: María C. Romero Puertas. 2022-2023.

Ayudas del Sistema Nacional de Garantía Juvenil en la Junta de Andalucía 2021 (EI-GARJUV-AND21-0169): Andrea García Alcaide. PI: Mariam Sahrawy Barragán. 2022-2023.

Ayudas del Sistema Nacional de Garantía Juvenil en la Junta de Andalucía 2021 (EI-GARJUV-AND21-0165): Jaime Mañas Galindo. PI: M^a Pilar Rodríguez Rosales. 2022-2023.

Ayudas del Sistema Nacional de Garantía Juvenil en la Junta de Andalucía 2021 (EI-GARJUV-AND21-0173): Esther Rodríguez de Haro. PI: José Carlos Jiménez López. 2022-2023.

Ayudas del Sistema Nacional de Garantía Juvenil en la Junta de Andalucía 2021 (EI-GARJUV-AND21-0163): José Manuel Rubí Villegas. PI: Eduardo López-Huertas León. 2022-2023.

Ayudas del Sistema Nacional de Garantía Juvenil en la Junta de Andalucía 2021 (EI-GARJUV-AND21-0167): Cristina Lomas Martínez. PI: Miguel A. Matilla Vázquez. 2022-2023.

Ayudas del Sistema Nacional de Garantía Juvenil en la Junta de Andalucía 2021 (EI-GARJUV-AND21-0160): María Padial de Jádenes. PI: Alfonso Clemente Gimeno. 2022-2023.

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.

Biotechnological potential of *Novosphingobium* sp. HR1a for the synthesis of fuels from plant polymers. Proyectos de Generación de Conocimiento Frontera (PY20_0061/CA17211). PI: Ana Segura Carnicero. 2021-2022.

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.

Contribution of the non-coding transcriptome to symbiotic diversity of rhizobia nodulating agronomically relevant legumes. Proyecto FED-ER-University of Seville (US-1250546). PIs: José M^a Vinardell González (US), José I. Jiménez Zurdo. 2020-2022.

Development of bio-mechanical-chemical systems for environmental CO₂. Proyectos de Investigación orientados a los Retos de la Sociedad Andaluza (PY20-00328/CA17183). PI: Silvia Marqués Martín. 2021-2022.

Effects of the Rhizobium volatilome on plants: growth, stress resistance and the associated microbiome. Proyectos de Generación de Conocimiento Frontera (PY20_00225/CA17213). PI: M^a 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. 2020-2022.

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. 2020-2022.

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: M^a Jesús Delgado Igeño, M^a 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 M^a Sandalio González. 2021-2022.

Molecular characterization and evolution of acid phosphatases for industrial applications. Proyectos de Investigación orientados a los Retos de la Sociedad Andaluza (PY20_0049/CA17180). PI: Juan Luis Ramos Martín. 2021-2022.

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. 2021-2022.

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. 2021-2022.

Redox molecular basis for sugar production and stress tolerance in plants. Proyectos de Generación de Conocimiento Frontera (PY20_00401/CA17215). PI: Mariam Sahrawy Barragán. 2021-2022.

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.

Signaling mechanisms in *Pseudomonas aeruginosa*: New strategies to combat this human pathogen. Proyectos de Generación de Conocimiento Frontera (P18-FR-1621/CA11199). PIs: Tino Krell, M^a Antonia Llamas Lorente. 2020-2022.

Subvención para la financiación del Programa Investigo en el marco del (PRTR) - Next Generation EU en Andalucía 2022 (OTR09454): Alberto Carrera Henke. PI: Ignacio Fernández-Figares Ibáñez. 2022-2024.

Subvención para la financiación del Programa Investigo en el marco del (PRTR) - Next Generation EU en Andalucía 2022 (OTR09453): Miriam Lucas Fernández. PI: Andrés Belver Cano. 2022-2024.

CSIC

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.

Emission of nitric oxide and nitrous oxide by legume crops: processes involved, their control and mitigation strategies. Ayudas Extraordinarias para Preparación de Proyectos 2021. (2021AEP083, Project AGL2017-85676-R). PI: M^a Jesús Delgado Igeño. 2022.

Impact of dietary protein intake on mineral metabolism in a porcine model. Proyecto Intramural (202040E006). PI: Rosa M^a Nieto Liñán. 2020-2022.

Impact of oligogalacturonides on tomato defense responses and the study of their role in mycorrhiza induced resistance. Proyecto Intramural CSIC (201840E130). PI: M^a José Pozo Jiménez. 2018-2022.

Lipidic volatiles produced by *Sinorhizobium (Ensifer) meliloti*: Functional analyses, mechanism of action and biosynthetic pathways. Ayudas Extraordinarias para Preparación de Proyectos 2021 (2021AEP085, Project PGC2018-096477-B-I00). PI: M^a José Soto Misffut. 2022.

Microbial conversion of lignocellulosic residues into added-value products. Ayudas Extraordinarias para Preparación de Proyectos 2021. (2021AEP084, Project RTI2018-094370-B-I00). PI: Juan Luis Ramos Martín, Estrella Duque Martín de Oliva. 2022.

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

Nutritional and functional properties of Bowman-Birk inhibitors from pea (*Pisum sativum* L.). Ayudas Extraordinarias para Preparación de Proyectos 2021 (2021AEP087, Project AGL2017-83772-R). PIs: Alfonso Clemente Gimeno, Luis A. Rubio San Millán. 2022.

Pastoralism and environment. Proyecto Intramural (202140E014). PI: Ana Belén Robles Cruz. 2021-2023.

Peroxisome-dependent signalling under stress: role of peroxules and peroxisomal ho-

meostasis. Ayudas Extraordinarias para Preparación de Proyectos 2021 (2021AEP086, Project PGC2018-098372-B100). PIs: Luisa M^a Sandalio González, María C. Romero Puertas. 2022.

Physiological response of plants of agronomic interest to *Piriformospora indica*. Proyecto Intramural (201640E057). PI: Nuria Ferrol González. 2016-2022.

Regulation by cyclic diguanylate and role of extracellular proteins and polysaccharides in bacteria-plant interactions. Ayudas Extraordinarias para Preparación de Proyectos 2021 (2021AEP136, Project BIO2017-83533-P). PI: Juan Sanjuán Pinilla. 2022.

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.

Study of methane production in sheep and goats fed with new nutritional alternatives. Proyecto Intramural (202140E003). PI: David R. Yáñez Ruiz. 2021-2022.

Study of the nutritional composition and antioxidant properties of whey and their relationship with mineral bioavailability. Proyecto Intramural (202140E009). PI: Isabel Seiquer Gómez-Pavón. 2021-2022.

OTHER NATIONAL PROJECTS

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

NATIONAL EXTERNAL PROJECTS

Comprehensive study of plant-induced defenses through exogenous application of fluorescent derivatives of MSB, Vitamin K3 and sodium bisulfite. Agencia Canaria de Investigación, Innovación y Sociedad de la Información (ProID2020010082). PI: Antonio Jesús Herrera González. Participants of the EEZ: Luisa M^a Sandalio González. 2020-2022.

Differential markers of organic extra virgin olive oils: physicochemical and sensometric characterization of oils from the main Andalusian varieties. Junta de Andalucía/Universidad de Sevilla (US-1380836). Universidad de Sevilla (20221509), PI: Raquel María Callejón Fernández.

Participants of the EEZ: Eduardo López-Huertas León. 2022-2023.

Evaluation in a microcosm model of the efficacy of probiotic strain implantation and phytobiotic treatments on the intestinal microbiota in species of agricultural interest. Plan Estatal, Retos de la Sociedad (B-BIO-604-UGR20). PI: Manuel Martínez Bueno, University of Granada. Participant of the EEZ: Luis A. Rubio San Millán. 2021-2022.

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. Plan Estatal, 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.

Integrated strategies for improving the quality, safety and functionality of food: towards a healthy diet. Comunidad de Madrid (P2018/BAA-4393). PI: M^a Luisa Marina Alegre, University of Alcalá de Henares. Participant of the EEZ: Cristina Delgado Andrade. 2019-2022.

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: M^a Trinidad Gállegos Fernández. 2021-2022.

Novel sustainable protein sources meeting human health. CSIC, ILINKA (ILINKA 20292). PI: Isidra Recio Sánchez, CIAT-CSIC. Participants of the EEZ: Alfonso Clemente Gimeno, Raquel Olías Sánchez. 2020-2021.

Recovery of the high mountains vegetation after wildfire of year 2019 at Teide National Park. Proyectos de I+D por organismos de investigación y empresas en las áreas prioritarias de la Estrategia de Especialización Inteligente de Canarias RIS-3 (ProID2020010103). PI: Milagros Alicia León Barrios, University of La Laguna, Tenerife. Participants of the EEZ: Manuel Fernández López, Pablo J. Villadas Latorre. 2020-2022.

Redes de reemplazamiento en bosques: variación ecogeográfica e influencia de las comunidades de hongos de la filosfera y de las interacciones planta-suelo. Plan Estatal, Generación de Conocimiento (PGC2018-100966-B-I00). PI: Julio M. Alcántara, University of Jaén. Participant of the EEZ: José Luis Garrido Sánchez. 2019-2021.

INTERNATIONAL PROJECTS

CSIC BILATERAL PROJECTS

Application of silicon as a stimulator of rice response to abiotic and biotic stresses. Programa CSIC de Cooperación Científica 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.

Integrated study of factors modulating polyhydroxybutyrate balance in *Bradyrhizobium diazoefficiens* for its use as both a more competitive soybean inoculant and a bioplastics producer. Programa CSIC de Cooperación Científica para el Desarrollo I-COOP+ 2020 (COOPB20505). PI: M^a Socorro Mesa. 2021-2022.

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

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

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

EUROPEAN & INTERNATIONAL PROJECTS

Biostimulant Academy. ERASMUS+ 2019 (2020-1-FR01-KA202-080329). PI: Ricardo Aroca Álvarez. 2020-2022.

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: M^a Jesús Delgado Igeño. 2019-2023.

Facilitating Innovations for Resilient Livestock Farming Systems (Re-Livestock). European Project (HORIZON-CL6-2021-CLIMATE-01). Coordina-

tor: David R. Yáñez Ruiz. Pls: David R. Yáñez Ruiz, Rosa Mª Nieto Liñán. 2022-2027.

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/MICINN 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-MS-CA-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.

Scenarios for providing multiple ecosystem services and biodiversity in viticultural landscapes. Acciones de Programación Conjunta Internacional/EraNet H2020/BiodivScen 2017 (PCI2018-092938). PI: Emilio Benítez León. 2019-2022.

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). Pls: 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.

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.

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

Feed and Nutrition Network of the Livestock Research Group (GRA). Participant of the EEZ: David Yáñez-Ruiz. 2011-2022.

Livestock Research Group of the Global Research Alliance on Agricultural Greenhouse Gases. Participant of the EEZ: David R. Yáñez Ruiz. 2008-2022.

National Research Network “Learning from nature: multitrophic interactions for crop and forest protection”. Acciones de Dinamización-Redes de Investigación (RED2018-102407-T). PI: Isabel Díaz Rodríguez, Centro de Biotecnología y Genómica de Plantas. Participants of the EEZ: M^a José Pozo Jiménez, Juan Antonio Lopez Ráez. 2020-2022

Redox signaling and post-translational regulation in plant development and stress response.

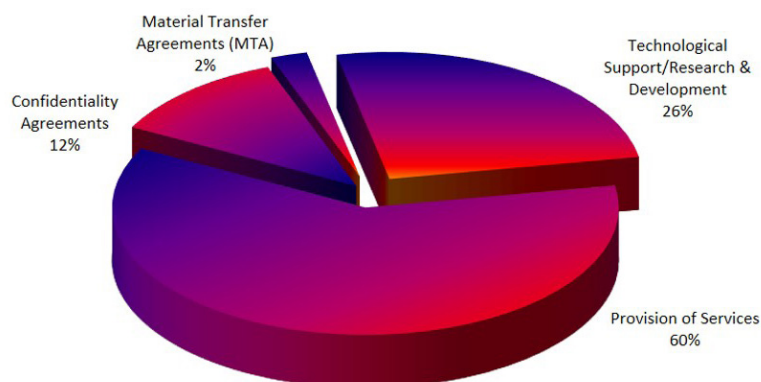
Acciones de Dinamización-Redes de Investigación (RED2018-102397-T). PI: Luisa M^a Sandalio González. 2020-2022.

Soil network. Acciones de Dinamización-Redes de Investigación (RED2018-102624-T). PI: Ana Segura Carnicero. 2020-2022.

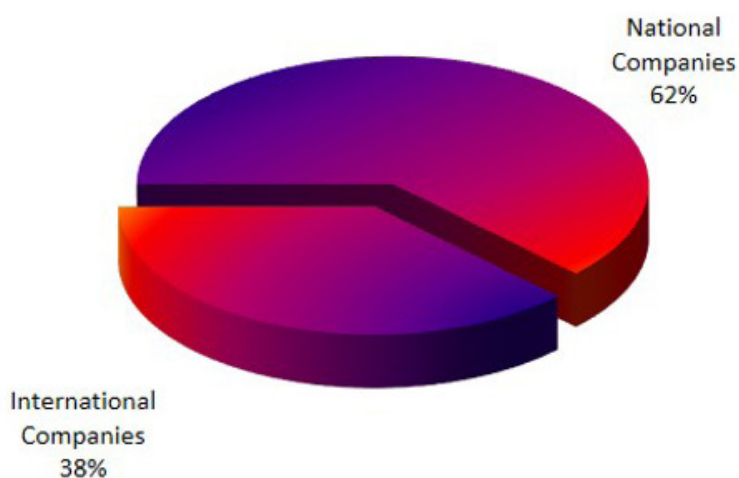


RESEARCH, DEVELOPMENT & INNOVATION CONTRACTS AND COLLABORATION AGREEMENTS WITH COMPANIES

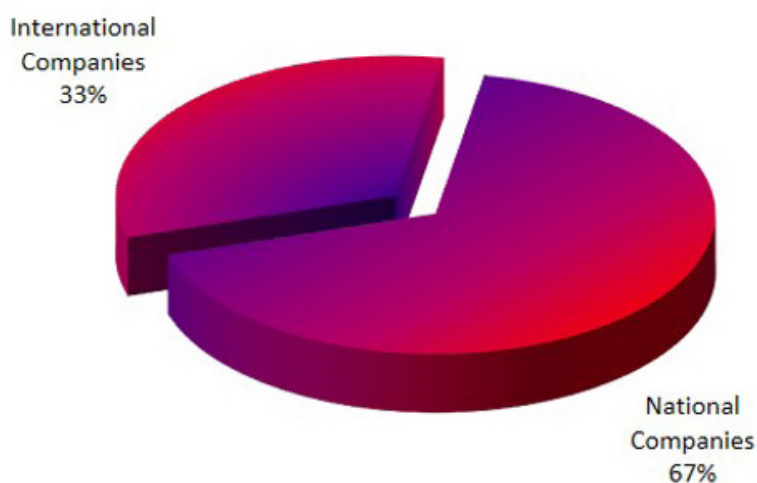
During 2022, 43 new contracts were signed, for a total amount of 640.045 €. This is the distribution according to the type of contract and the national/international scope:



SCOPE OF CONTRACTS - FUNDING



SCOPE OF CONTRACTS - NUMBER



ONGOING CONTRACTS / COLLABORATION AGREEMENTS

Analytical determinations of the Project Ref. US-1380836 at Estación Experimental del Zaidín. Universidad de Sevilla (20221509), PI: Eduardo López-Huertas León. 2022-2023.

Bioavailability and antioxidant effects of supplemental magnesium in broiler nutrition. K+S KALI GmbH, Alemania (20221077), PI: Luis A. Rubio San Millán. 2022-2023.

Bioavailability and antioxidant effects of supplemental magnesium in broiler nutrition. K+S Minerals and Agriculture GmbH (090201220007). PIs: Luis Rubio San Millán, Isabel Seiquer Gómez-Pavón. 2022-2024.

Biochemical and nutritional study of the maturation of meat products prepared with natural and artificial casings. United Caro Research and Development, S.L.U. (20216532). PI: Eduardo López-Huertas León. 2021-2022.

Effect of Anco Fit additive on rumen fermentation parameters *in vitro*. ADM International Sàrl, Switzerland (20225442), PI: David R. Yáñez Ruiz. 2022.

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

Effect of the diet type on methane production in lambs. S.C.A. Ganadera del Valle de Los Pedroches (20226171), PI: David R. Yáñez Ruiz. 2022.

Evaluation of mycorrhizal inoculants. Agro-genia Biotech, S.L. (20202563), PI: Juan Antonio López Ráez. 2020-2022.

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

***In vitro* study of the effect of essential oil-based additives to reduce methane emissions in ruminants.** Innofarm, S.L. (20212896), PI: A. Ignacio Martín García. 2021-2022.

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

Isolation and identification of plant growth promoting bacteria (PGPR) and analysis of their viability in liquid media using molasses as the main component. Establecimiento HEFE, S.L. (20210359), PI: Eulogio Bedmar Gómez. 2021-2022.

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 M^a Nieto Liñán. 2021-2024.

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

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

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

Optimisation of the TOGO-Big Hanna composting system for the treatment of biowaste from selective collection. Berca Brand, S.L. (20213831), PI: Germán Tortosa Muñoz. 2021-2022.

Preparation of meals and focused feeding of animal models with components isolated from the olive tree. Elayotecnia, S.L. (20201357), PIs: Juan de Dios Alché Ramírez, José Carlos Jiménez López. 2020-2022.

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

Reduction of the use of antibiotics in organic animal production. Asociación Valor Ecológico, CAAE (20186638), PI: David R. Yáñez Ruiz. 2018-2022.

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 IC-CARE project: Indigenous and Community Conserved Area for social-ecological REsilien-

ce. Aix-Marseille University, France (20225183). PI: Ana Belén Robles Cruz. 2022-2024.

Study of the amino acid composition of ingredients for animal feeding. NUTEGA, S.L. (20214648). PI: Rosa M^a Nieto Liñán. 2021-2022.

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. (20201507), PI: A. Ignacio Martín García. 2020-2022.

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PATENTS

Antihypertensive peptides from olive oil

Granted EP Patent

European Patent Office (EP15380049)

Authors: Eduardo López-Huertas León, Juan M. Alcaide-Hidalgo

Entity: CSIC

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Arbuscular mycorrhiza-forming fungi and its use to stimulate plant growth

Authors: Alberto Bago Pastor, Custodia P. Cano Romero

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EEZ
Estación Experimental del Zaidín

PUBLICATIONS

SCI PUBLICATIONS

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Hydrogen Sulfide and Reactive Oxygen Species, Antioxidant Defense, Abiotic Stress Tolerance Mechanisms in Plants. 2022. Editors: Corpas, F.J. Multidisciplinary Digital Publishing Institute (MDPI AG). 240 pages. ISBN: 978-3-0365-5376-4.

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BOOK CHAPTERS

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Yáñez-Ruiz, D.R.; González Recio, O. 2022. Alimentación y mejora genética de vacuno lechero: eficiencia y sostenibilidad. In: *El sector lácteo en España*. Cajamar Publicaciones, pp.: 22-28. ISBN: 978-84-95531-63-6.

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WORKSHOPS AND MEETINGS

XVI National Meeting of Nitrogen Metabolism

Member of the Scientific Committee: M^a Jesús Delgado Igeño
Córdoba, 2-4 February 2022

II Research Congress of the PTS Granada

Member of the Scientific Committee: Alfonso Clemente Gimeno
Member of Experts Committee: Matilde Barón Ayala
Granada, 9-11 February 2022

11th Conference of the Association of Women Researchers and Technologists (AMIT)

Members of the Organizing Committee: Matilde Barón Ayala, Eduarda Molina Alcaide
Granada, 4th March 2022



7th International Conference on Food Digestion

Member of the Scientific Committee: Alfonso Clemente Gimeno
Cork, Ireland, 3-5 May 2022

Desgranando Ciencia: including Desgranando Cómics, and DegranaMEMES

Member of the Organizing Committee: Germán Tortosa Muñoz
Granada, 27-28 May 2022

Exhibition "Territories of life on the edge. Pastoral communities of the Mediterranean mountains in the XXII century"

Estación Experimental del Zaidín-CSIC, May-November 2022

Organizing entities: Aix-Marseille Université, Geode-CNRS, Institut Méditerranéen de Biodiversité et d'Écologie, SERPAM EEZ-CSIC

Members of the Organizing Committee: Ana Belén Robles Cruz, M^a Eugenia Ramos Font, Mauro Tognetti Barbieri, Antonio Jesús Pérez Luque (SERPAM EEZ-CSIC)



Visit to the exhibition of the researchers of the ICCA-RE project (University of Aix-Marseille)

XIII Workshop of the Spanish Society of Microbiota, Probiotics and Prebiotics

Member of the Scientific Committee: Alfonso Clemente Gimeno
Valencia, 7-9 June 2022



II Symposium Predoctoral and Postdoctoral Researchers of the Soil Network

Member of the Organizing Committee:
Ana Segura Carnicero

28th June 2022 (Online)



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XIII Meeting of the Specialized Group on Molecular Microbiology, of the SEM (Spanish Society of Microbiology)

25th Anniversary of the creation of the Molecular Microbiology Group

Members of the Organizing Committee:
M^a Trinidad Gallegos, Silvia Marqués, José Ignacio Jiménez Zurdo, Juan Luis Ramos

Members of the Scientific Committee: M^a Trinidad Gallegos, Silvia Marqués, José Ignacio Jiménez Zurdo, M^a Antonia Llamas, Juan Luis Ramos

Granada, 7-9 September 2022



7th EAAP International Symposium on Energy and Protein Metabolism and Nutrition (ISEP 2022)

Member of the International Scientific Committee: Ignacio Fernández-Fígares

Members of the Local Organizing Committee:
Ignacio Fernández-Fígares, Manuel Lachica, Rosa Nieto

Members of the Supporting Committee:
Zaira Pardo, Luis Lara, Ana Esteban, Consolación García Contreras

Granada, 12-15 September, 2022



25th European Nitrogen Cycle Meeting

Members of the Scientific Committee: M^a Jesús Delgado Igeño
Rome, Italy, 28-30 September 2022

I Spanish-Portuguese Congress on Beneficial Plant-Microbe Interactions (BeMiPlant) and XVIII National Meeting of the Spanish Society of Nitrogen Fixation (XVIII SEFIN)

Members of the Organizing Committee: Juan Sanjuán Pinilla (Vicepresident), José Ignacio Jiménez Zurdo

Members of the Scientific Committee: M^a Jesús Delgado Igeño, Nuria Ferrol González
Oeiras, Portugal, 17-19 October 2022



Kick-off Meeting Re-livestock

David Yáñez's European Project Facilitating Innovations for Resilient Livestock Farming Systems (Re-Livestock), which involves 37 partners from 14 European countries and Australia

Granada, EEZ-CSIC, 16th November 2022



Boosting Green Education 4th LTT

ERASMUS+ Meeting

Granada, EEZ-CSIC, 18-20 November 2022

Organizer: Manuel Espinosa Urgel



I Olive oil PDOs and distinctive characterization approaches in Spain and Tunisia

Member of the Organizing Committee:

Juan de Dios Alché

Tunis, Tunisia, 31st October 2022

I Conference of Young Researchers of the EEZ

Organizing Committee: M^a Isabel Recio Muñoz, Eva M^a Romera Recio, Jesús Espinosa Rodríguez, Ariana Casas Román, José Manuel Palm

Granada, EEZ-CSIC, 30th November 2022



Meeting of the National Network "Redox Signaling and Post-translational Regulation in Plant Development and Stress Response" (POST-REDOX, RED2018-102397-T)

Network Coordinator: Luisa M^a Sandalio

Salobreña (Granada), 25-27 May 2022, and last meeting of the Network in Granada, 23-25 November 2022



EEZ
Estación Experimental del Zaidín

AWARDS

16 active researchers from the EEZ are among the most influential worldwide in their areas of knowledge, according to the latest edition of the ranking published by Stanford University (Ranking of the World Scientists: World's Top 2% Scientists), which analyzes the production and impact of scientific publications as well as the number of times their work has been cited in other publications. October 2022.

Javier Corpas Aguirre, is one of the 15 CSIC researchers on the Highly Cited Researchers (HCR) list prepared by the analysis platform Web of Science Group, of Clarivate Analytics. November 2022.

www.eez.csic.es/16-investigadores-de-la-eez-entre-los-mas-influyentes-nivel-mundial

Archimedes Award from the Ministry of Universities, to **Inés Castillo Rodríguez**, student at the University of Granada, currently at the EEZ with Silvia Marqués. November 2022.

www.lavozdealmeria.com/noticia/

EEZ
Estación Experimental del Zaidín



TEACHING ACTIVITIES

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, Adela Olmedilla Arnal, M^a Jesús Delgado Igeño

Committee for Internal Quality members: Nuria Ferrol González, Juan Manuel Palma Hidalgo

<https://doctorados.ugr.es/biologiafundamentalysistemas/>

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/>

MASTER PROGRAMMES

Participation in Committees 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: M^a Socorro Mesa Banqueri

Committee for Internal Quality member: M^a Socorro Mesa Banqueri

<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/>

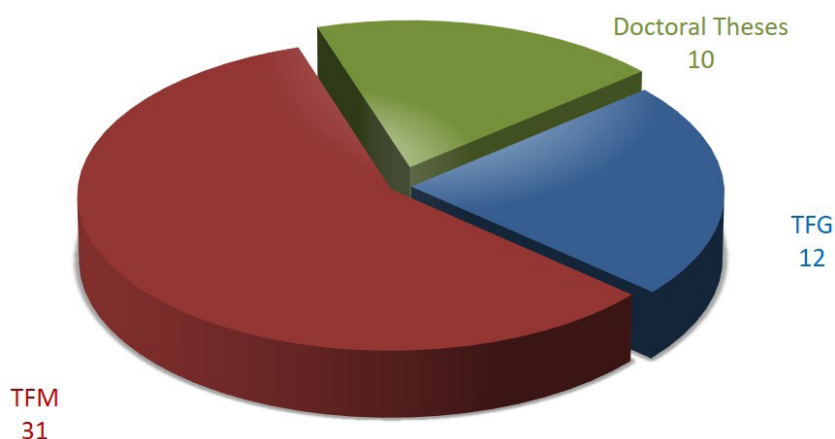
Master in Agroecology, Food Sovereignty, Urban Ecology and Cooperation in Rural Development. University of La Laguna (ULL), Institute of Ecological and Sustainable Agriculture Foundation and Agricultural Research Institute of Canarias (ICIA)
<https://www.ull.es/titulospropios/master-propio-agroecologia-soberania-alimentaria/>

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>

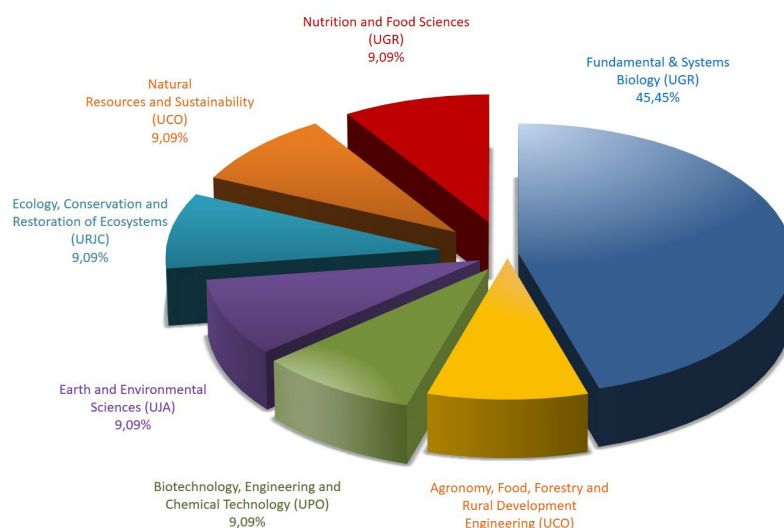
Master in Molecular Biology Applied to Biotechnology Companies (BioEnterprise). University of Granada
<https://masteres.ugr.es/bioenterprise/>

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

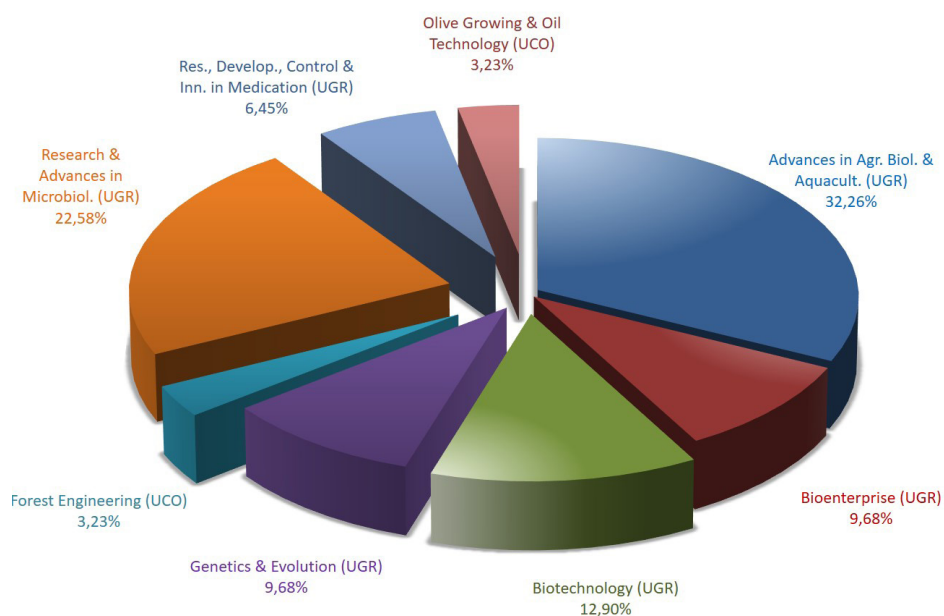
DOCTORAL THESES, MASTER ´S THESES (TFM) & FINAL DEGREE PROJECTS (TFG)



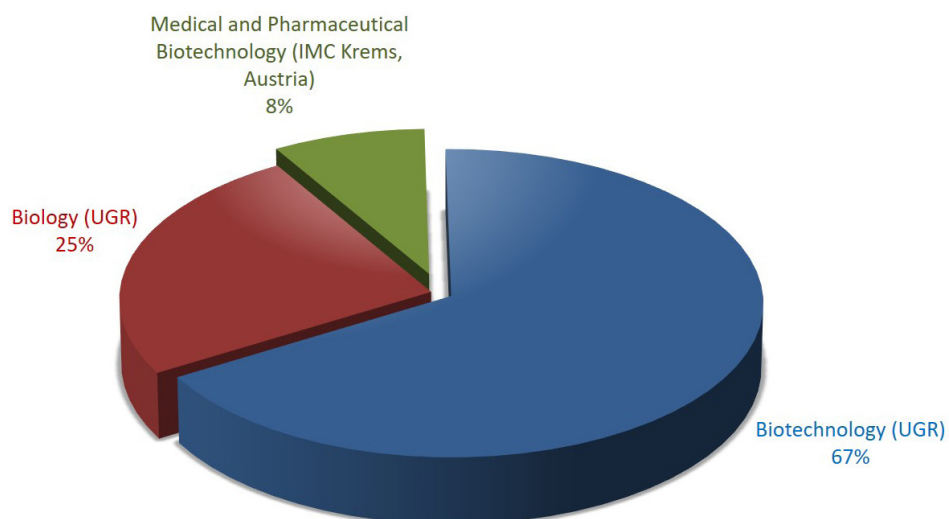
Number of Doctoral Theses, Master's Theses (TFM) & Final Degree Projects (TFG) defended at EEZ during 2022



PhD Theses distribution in different Doctoral Programmes



TFM distribution in different Master Programmes



TFG distribution in different UGR Degree Programmes

DOCTORAL THESES

RNA regulation of metabolism in the legume symbiont *Sinorhizobium* (Ensifer) *meliloti*

Author: Natalia Isabel García Tomsig

Supervisors: Marta Robledo Garrido, José Ignacio Jiménez Zurdo

University of Granada, 31st May 2022

Fatty acid metabolism and biofuel synthesis in *Pseudomonas putida*

Author: Lorena Jiménez Díaz

Supervisors: Ana Segura Carnicero, Antonio Caba-llero Reyes

University Pablo de Olavide (UNPO), 26th September 2022

Involvement of *Pseudomonas simiae* PICF7 genes in endophytic lifestyle, biological control and plant growth promotion

Author: Nuria M^a Montes Osuna

Supervisors: Jesús Mercado Blanco, Carmen Gómez Lama Cabanas

University of Cordoba, 2nd March 2022

Nutritional interventions in early life to optimize the function of rumen microbial activity, digestive health and productivity

Author: Juan Manuel Palma Hidalgo

Supervisors: David R. Yáñez Ruiz, Alejandro Belanche Gracia

University of Granada, 11th March 2022

Physiological and productive effects of heat stress on growing Iberian pigs and potential nutritional mitigation strategies

Author: Zaira Pardo Domínguez

Supervisors: Ignacio Fernández-Fígares Ibáñez, Isabel Seiquer Gómez-Pavón

University of Granada, 15th November 2022

Regulation and molecular mechanism of FixK₂, a key transcriptional factor for *Bradyrhizobium diazoefficiens*-soybean symbiosis

Author: Sergio Parejo Treviño

Supervisor: Socorro Mesa Banqueri

University of Granada, 22nd December 2022

Specificity of adult-juvenile interactions during recruitment of woody plants: complementarity of functional characters and plant-antagonist interactions

Author: Antonio Jesús Perea Martos

Supervisors: Julio M. Alcántara Gámez, José Luis Garrido Sánchez

University of Jaén, 25th March 2022

Study of plant-mycorrhizal fungi interaction networks and their involvement in the mechanisms that regulate recruitment between plants

Author: Jorge Prieto Rubio

Supervisors: Ana María Rincón Herranz (ICA-CSIC), Concepción Azcón González de Aguilar, Álvaro López García

University Rey Juan Carlos, Madrid, 27th July 2022

Study of the agricultural efficacy of a new generation ultrapure mycorrhizal inoculum gel

Author: Maxym Reva

Supervisors: Alberto Bago Pastor, Miguel Ángel Herrera Machuca (UCO)

University of Cordoba, 28th June 2022

Interactions of soil microbiome, plant defenses and domestication in tomato

Author: Lisanne Smulders

Supervisors: Emilio Benítez León, M^a José Pozo Jiménez

University of Granada, 12th September 2022

MASTER'S THESES

El silicio como potencial herramienta biotecnológica frente al estrés salino en plantas de arroz (*Oryza sativa* L.)

Author: Grecia Isabel Alfonzo García

Supervisor(s): José M. Palma Martínez, Marta Rodríguez Ruiz

University of Granada

Caracterización bioinformática, bioquímica y funcional de las proteínas 2S ricas en azufre de la semilla del olivo

Author: Ángel Almagro López

Supervisors: José Carlos Jiménez López, Juan de Dios Alché Ramírez

University of Granada

Identificación y análisis de las proteínas de almacenamiento 2S y del factor de elongación 1-alfa como proteínas con potencial nutracéutico en la semilla del olivo

Author: Ihsane Benslimane

Supervisors: Juan de Dios Alché Ramírez, Adoración Zafra Álvarez

University of Córdoba

Genes bacterianos que participan en el mecanismo de acción del infoquímico volátil 2-tridecanona

Author: Paula Brito Santana

Supervisor(s): M^a José Soto Misffut

University of Granada

Análisis de un nuevo sistema de defensa bacteriano frente a fagos asociado a reverso transcriptasas: UG17

Author: Daniel Cabrerizo Aguado

Supervisor: Francisco Martínez-Abarca Pastor

University of Granada

Caracterización de sistemas isoenzimáticos antioxidantes de tenca (*Tinca tinca*) alimentada con dietas basadas en harinas de insecto

Author: Gloria Corpas Guerrero

Supervisor(s): José M. Palma Martínez, María del Carmen Hidalgo Jiménez (UGR)

University of Granada

Interacción entre óxido nítrico, sulfuro de hidrógeno y sistemas antioxidantes en *Arabidopsis thaliana*

Author: Jorge de la O Sánchez

Supervisor(s): Francisco J. Corpas Aguirre, José M. Palma Martínez

University of Granada

Biorremediación del alpeorrujo por hongos saprobios y evaluación de su actividad fitoestimulante

Author: Irene Díaz Bolívar

Supervisors: Inmaculada García Romera, Gloria Andrea Silva Castro

University of Granada

Factores condicionantes del estilo de vida y la formación de biofilms en *Pseudomonas stutzeri* MJL19

Author: Agustina Fernández Álvarez

Supervisor: Manuel Espinosa Urgel

University of Granada

Caracterización bioinformática, bioquímica y funcional de las proteínas 2S (albúminas) en la

semilla del olivo (*Olea europaea* L.)

Author: Juan Miguel Guirao Torrente

Supervisors: Juan de Dios Alché Ramírez, José Carlos Jiménez López

University of Granada

Análisis de la composición de aceites derivados del procesamiento alternativo de la aceituna y sus efectos nutricionales en el pez cebra

Author: Beatriz Guzmán Rojas

Supervisors: Antonio Jesús Castro López, Juan de Dios Alché Ramírez

University of Granada

Estudios de expresión de los genes implicados en el metabolismo del óxido nítrico en *Bradyrhizobium diazoefficiens*

Author: Raquel A. Juárez Martos

Supervisors: M^a Socorro Mesa Banqueri, M^a Jesús Delgado

University of Granada

Programación del ecosistema microbiano ruminal en ganado caprino a través de intervenciones nutricionales con probióticos y prebióticos en edades tempranas

Author: M^a del Carmen Lara Fernández

Supervisor: A. Ignacio Martín García

University of Granada

Análisis predictivo y experimental de la nitración de tirosinas en el polen del olivo (*Olea europaea* L.)

Author: David López Becerra

Supervisors: Antonio Jesús Castro López, Juan de Dios Alché Ramírez

University of Granada

Identificación de la función de quimiorreceptores de *Pseudomonas aeruginosa*

Author: Andrea Lozano Montoya

Supervisor: Tino Krell

University of Granada

Producción de polisacáridos bacterianos regulada por c-di-GMP en *Paraburkholderia phymatum* STM815

Author: Juan Antonio Marchante Sánchez

Supervisors: Daniel Pérez Mendoza, Juan Sanjuán Pinilla

University of Granada

Evaluation of the effect of pyric herbivory on a gorse (*Genista scorpius*) and esparto (*Macchloa tenacissima*) plant community in the Sierra de los Filabres (Alcántar, Almería).

Author: Clara Montoya Román

Supervisor: Ana Belén Robles Cruz, M^a Eugenia Ramos Font
University of Granada

Efecto de la inoculación de *Rhizobium tropici* y *Rhizobium etli* en dos variedades de *Phaseolus vulgaris* L. (Contender y Borlotto) en condiciones de sequía

Author: María Muñoz Carrasco
Supervisor: Ricardo Aroca Álvarez
University of Granada

Regulación de la producción de la auxina ácido indolacético en el agente de biocontrol rizosférico *Serratia plymuthica*

Author: Salvador Muñoz Mira
Supervisor: Miguel Ángel Matilla Vázquez
University of Granada

Estudio del papel de la S-nitración de proteínas del polen en la reproducción del olivo (*Olea europaea* L.)

Author: Juan Manuel Ocaña Gálvez
Supervisors: Juan de Dios Alché Ramírez, Antonio Jesús Castro López
University of Granada

Estudio preliminar de la digestibilidad proteica de bebidas de soja comerciales

Author: María Padial de Jáudenes
Supervisors: Alfonso Clemente Gimeno, Raquel Olías Sánchez
University of Granada

Manejo de acuaporinas y fitohormonas para la mejora del transporte de agua en la raíz por microorganismos beneficiosos del suelo en un escenario de sequía y cambio climático

Author: Noelia Pérez Hernández
Supervisor: Juan Manuel Ruiz Lozano
University of Granada

Papel de las auxinas en la protección de plantas de tomate inoculadas con hongos beneficiosos contra estrés biótico

Author: Andrea Ramos Molina
Supervisors: M^a José Pozo Jiménez, Juan Antonio López Ráez
University of Granada

Relación entre la composición nutricional y las características sensoriales en la carne de cerdo Ibérico

Author: Mayte Rocinau Carrasco
Supervisors: Isabel Seiquer Gómez-Pavón, Rosa M^a Nieto Liñán
University of Granada

Estudio de la actividad antihipertensiva del alperujo, principal subproducto de obtención del aceite de oliva

Author: Javier Rodríguez Arenas
Supervisor: Eduardo López-Huertas León
University of Granada

Análisis molecular comparativo de proteínas alergénicas de semillas de soja (*Glycine max*) y otras legumbres extensamente usadas en la alimentación humana

Author: Andrea Román Mateo
Supervisor: José Carlos Jiménez López
University of Granada

Papel de las micorrizas arbusculares y las acuaporinas en la tolerancia de plantas de tomate frente al estrés salino. Posible implicación de los brasinoesteroides

Author: Raquel Sánchez Martínez
Supervisor: Ricardo Aroca Álvarez
University of Granada

Caracterización del factor de transcripción DA-G1en líneas mutantes de *Arabidopsis thaliana*

Author: Xela Laura Sobrino Iglesias
Supervisor: Mariam Sahrawy Barragán
University of Granada

Implicación de las poliaminas en el desarrollo post-germinativo de *Arabidopsis thaliana*

Author: Almudena Triguero Cueva
Supervisor(s): Francisco J. Corpas Aguirre, José M. Palma Martínez
University of Granada

Papel de los ARN reguladores Rsm de *Pseudomonas syringae* pv. tomato DC3001

Author: Adriana Vásquez Rodríguez
Supervisor: M^a Trinidad Gallegos Fernández
University of Granada

Use of information and communication technologies to assess the effect of grazing on vegetation in pasture-firebreak areas of Andalusia

Author: Lidia Velasco Peña
Supervisor: Pilar Fernández Rebollo (UCO), Antonio Jesús Pérez Luque
University of Córdoba

FINAL DEGREE PROJECTS

Mecanismo de acción del infoquímico 2-tridecanona en *Sinorhizobium meliloti*

Author: Cristina Carvia Hermoso
Supervisor(s): M^a José Soto Misffut
University of Granada

Producción del gas invernadero óxido nitroso (N₂O) por bacterias endosimbióticas de leguminosas

Author: Manuel Jesús Gilabert Ruiz
Supervisors: Germán Tortosa Muñoz, M^a Jesús Delgado Igeño
University of Granada

Regulación transcripcional de transportadores de metales y de potasio en mutantes de acil-CoA oxidasa (*acx1-2*) de *Arabidopsis*

Author: Rosa López García
Supervisor: Luisa M^a Sandalio
University of Granada

Evaluación del impacto de tratamientos de origen microbiológico sobre las características edafológicas, la micro y macrobio suelo en viticultura

Author: Ana M^a Ramírez Martín
Supervisor: Inmaculada García Romera
University of Granada

Señalización dependiente de H₂O₂ peroxisomal en *Arabidopsis*

Author: Juan José Rodríguez Fuentes
Supervisor: María C. Romero Puertas
University of Granada

Análisis predictivo de la S-nitrosilación en tejidos reproductivos del olivo y validación funcional preliminar

Author: Manuel Rueda Martínez
Supervisor: Juan de Dios Alché Ramírez
University of Granada

Optimización de la producción de biopolímeros bacterianos

Author: Lucía Ruiz Sáez
Supervisors: Daniel Pérez Mendoza, M^a Vanesa Martos Núñez (UGR)
University of Granada

Análisis de la expresión de los genes pertenecientes al regulón luxR287 en *Novosphingobium* sp. HR1a

Author: María Soler Núñez
Supervisor: Ana Segura Carnicero
University of Granada

Función de la melatonina en plantas superiores

Author: Jorge Taboada de la Rosa
Supervisor(s): Francisco J. Corpas Aguirre, José M. Palma Martínez
University of Granada

Aproximación bioinformática y experimental para la identificación de las secuencias de reconocimiento de ADN de la proteína NnrR de *Bradyrhizobium diazoefficiens*

Author: Raquel Terriente Hidalgo
Supervisors: M^a Socorro Mesa Banqueri, Coral del Val Muñoz (UGR)
University of Granada

Analysis of the role of a *Pseudomonas putida* signal transducer in sociomicrobiology

Author: Maite Wachter Galindo
Supervisor: M^a Isabel Ramos González
University of Applied Sciences, Krems, Austria

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JAE-INTRO STUDENTS

Germán Orlando Gómez Fernández

Supervisor: M^a José Pozo Jiménez

Raquel Adriana Juárez Martos

Supervisor: M^a Jesús Delgado Igeño

Salvador Muñoz Mira

Supervisor: Miguel Ángel Matilla Vázquez

Oriana Carolina Ortigoza Dempster

Supervisor: María C. Romero Puertas

Salvador Priego Poyato

Supervisor: Juan de Dios Alché Ramírez

Esther Rodríguez de Haro

Supervisor: José Carlos Jiménez López

ERASMUS PLUS STUDENTS

Anna Balduzzi, University of Padua, Italy

Supervisor: Cristina Delgado Andrade

Danilo di Francesco, University of Bologna, Italy

Supervisor: Nuria Ferrol González

Alexandra Cristina Dumitriu, Czech University of Life Sciences, Praga, Czech Republic

Supervisor: Inmaculada García Romera

Giorgio Gervasio, INIA-CSIC/UPM/University of Torino, Italy

Supervisor: Ana Belén Robles Cruz

Alessandra Lepore, University of Salerno, Italy

Supervisor: Nuria Ferrol González

IN-HOUSE COURSES

LVIII SOIL FERTILITY AND PLANT BIOLOGY INTERNATIONAL COURSE

On 7th February started the LVIII 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 58 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 as-

pects 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, twenty-two in this edition, from Spain and Italy.

STUDENTS

Araña Padilla, Abraham
Atero Calvo, Santiago
Cano Romero, Custodia
Carmona Yáñez, M^a Dolores
Castillo Rodríguez, Inés
Díaz Bolívar, Irene
Fernández Álvarez, Agustina
Fernández González, M^a del Rocío
García Franco, Ana Ángeles
Genova, Roberta
Godoy Alba, Patricia

López Becerra, David
Martín Rodríguez, Francisco Javier
Martín Wentzien, Nuria
Martirani Von Abercron, Sophie
Molina Luzón, M^a Jesús
Muñoz Vargas, M^a Ángeles
Pérez Hernández, Noelia
Pérez Padilla, Verónica
Prieto Poyato, Salvador
Rodríguez de Haro, Esther
Rusillo Rodríguez, María

In this edition, Dr. Enrique Iáñez Pareja, from the Dept. of Microbiology of the University of Granada, gave a new lecture on "Ethics and society in the debate on transgenic plants", to which all the personnel of the EEZ was invited.

The closing ceremony was held on 19th July. It was presided by the Rector of the University of Granada, Dr. Pilar Aranda Ramírez, and the Director of the EEZ, Dr. Alfonso Clemente Gimeno. The "last

lesson" of the Course, entitled "Modulation of the rumen microbiome for sustainable livestock production", was given by Dr. David Yáñez Ruiz, from the Group of Sustainable Production of Ruminants, EEZ-CSIC.

(More information at: <https://www.eez.csic.es/curso-de-fertilidad-de-suelos-y-biologia-vegetal>)

CSIC SPECIALISATION COURSES

Biosafety Training for Transgenic Plant and Plant Pathogen Facilities

Organization: CSIC Training Office, Deputy General Secretary for Human Resources, in collaboration with the National Centre for Biotechnology-CSIC Granada, 21-25 November, 2022

Teachers: Fernando J. Usera Mena (CNB-CSIC), Jorge Pérez Bruzón, Lab Safety Consulting

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, 3-7 October, 2022

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, 28 March-1 April, 2022

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, 21-29 November, 2022

Teachers: Juan de Dios Alché Ramírez, Antonio Jesús Castro López, Adoración Zafra Álvarez, José Carlos Jiménez López, M^a Elena Lima Cabello

OTHER COLLABORATIONS IN TRAINING & SCIENTIFIC EDUCATION

Agricultural Sciences Online in Secondary School (CAOS) Programme, organized by EEZ-CSIC. Funding: Acción Marie Skłodowska-Curie, Researchers' Night, Grant Agreement 1101061307; WP3: Researchers at School). Collaboration with:

IES Francisco Ayala (Granada), IES Mariana Pineda (Granada), IES Zaidín Vergeles (Granada), IES Padre Suárez (Granada), IES Joanot Martorell (Valencia), IES Jándula, Andújar (Jaén). Teachers/Researchers: Alché, J.D.; Berral, J.M.; Campos, M.J.; Espinosa, M.;

Lima Cabello, E.; López Ráez, J.A.; Martínez-Abarca, F.; Molina Henares, M.E.; Palma, J.M.; Ramos, M.E.; Ruiz, C.; Salas, M.; Tortosa, G.

Beneficial Microorganisms for Agriculture, organized by the Faculty of Agricultural Engineering, Technical University of Manabí, Ecuador. Teacher: Sanjuán, J.

Boosting Green Education at School, coordinated by Euphoria, Italy. Funding: Erasmus + Programme. Collaboration with Fundación Descubre. EEZ Teachers/Researchers: Tortosa, G.; Espinosa, M.

Composting as a source of organic material, amendments and biostimulants, in Composting Techniques Course, organized by Zaragoza Dinámica, Formación para el Empleo. EEZ Teacher: Germán Tortosa Muñoz.

Controlling and improving food quality and safety, organized by University of Alcalá de Henares, Madrid. EEZ Teacher: Cristina Delgado Andrade.

Expertise Training in Composting, IV Edition, organized by: Composta en Red. EEZ Teacher: Germán Tortosa Muñoz.

Infogest Technical Meeting on in Vitro Protein Digestibility, organized by the Research Institute of Food Science (CIAL, CSIC-UAM). EEZ Teacher: Raquel Olías.

New insights of plant-bacteria interactions unveiled during the study of *Sinorhizobium meliloti* life on surfaces, IHSM-CSIC Seminar Series 2022. EEZ Teacher: M^a José Soto Misffut.

Plant Illnesses, organized by Pre-CEEBI (State Congress of Biosciences Students). EEZ Teacher: M^a Trinidad Gallegos Fernández.

The Science of Small-Scale Composting, in the Training Course on Domestic and Community Composting, organized by de Monachil Townhall (Granada). EEZ Teacher: Germán Tortosa Muñoz.

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SEMINARS

Scientific and informative seminars are organized annually at the EEZ. During 2022 the coordinators of these cycles were Drs. David R. Yáñez Ruiz and Emilio Benítez León until June, when Drs. Daniel Pérez Mendoza and Isabel Seiquer Gómez-Pavón took over. 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.

- **Fernando Reyes Benítez.** MEDINA Foundation. "Discovery of new bioactive natural products from microbial cultures". 11/03/2022.
- **Rafael Hueso Ibáñez and Germán Tortosa Muñoz.** Carbon and Nitrogen Analysis Service and Department of Soil and Plant Microbiology, EEZ-CSIC, respectively. "Waste management". 24/03/2022.
- **Petar Podlesniy.** Bio-Rad Laboratories, Barcelona. Bio-Rad ddPCR applications-EEZ. 19/05/2022. (Organized by María C. Romero Puertas).
- **Jorge Monza.** Faculty of Agronomy, University of the Republic, Uruguay. "Identification of efficient rhizobia and forage legumes parasites in Uruguay: strategy for inoculants development". 01/07/2022.
- **Eduardo López-Huertas León.** Department of Stress, Development and Signaling in Plants, EEZ-CSIC. "Breast milk probiotics. A health source for the baby". 06/10/2022. (Probióticos de leche materna).
- **Tania Ho Plágaro.** Department of Soil and Plant Microbiology, EEZ-CSIC. "Molecular regulation of mycorrhizal symbiosis: from arbuscular mycorrhizae to ectomycorrhizae, from the plant to the fungus". 27/10/2022.
- **José Borrero de Acuña.** Department of Microbiology, University of Seville. "Interactomic approaches for the elucidation of highly organized protein complexes". 03/11/2022.
- **Jesús Fierro Risco.** Department of Agroforestry Sciences, University of Huelva. "Day-to-day Biotechnology". 17/11/2022.
- **Delisa García.** Arivis, a ZEISS Company, Rostock, Germany. "Approaches to microscopy image analysis". (Online) 01/12/2022.
- **Fernando Maestre Gil,** Dryland Ecology and Global Change Lab, University of Alicante. "How to achieve healthy research laboratories in a hyper-competitive world". 15/12/2022.



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VISITING SCIENTISTS

Wided Ben Slima. Centre of Biotechnology Borj-Cedria (CBBC), Tunisia. Group of Reactive Oxygen and Nitrogen Species Signaling under Stress Conditions in Plants.

Valeria Castro Pérez. Autonomous University of Baja California (UABC). Group of Biofertilization and Biodegradation by Rhizospheric Fungi.

Rocío Díaz Peña. University of Buenos Aires, Argentina. Group of Nitrogen Metabolism.

Souad Ettlili. National Agronomic Institute of Tunisia. Group of Mycorrhiza.

Mahdi Fendri. Institution of Agricultural Research and Higher Education, Tunis, Tunisia. Group of Plant Reproductive Biology and Advanced Microscopy Laboratory (PReBAIL).

Hanna Fuchs. Institute of Dendrology, Polish Academy of Sciences, Kórnik, Poland. Group of Redox Regulation, Sugar Signaling and Phenotyping using Imaging Techniques to detect Plant Stress.

Luz Cecilia García Cruzatty. Technical University of Manabí, Portoviejo, Ecuador. Group of Plant-Bacteria Interactions.

Lucía González Mulero. Institute of Food Science, Technology and Nutrition (ICTAN-CSIC), Madrid. Group of Gastrointestinal Health and Food Safety.

Martina Janouskova. Institute of Botany AS CR in Pířhonice, Czech Republic. Group of Mycorrhiza.

Victoria Miranda. Regional Research Center for Scientific Investigation and Technology Transfer of La Rioja (CRILAR), Argentina. Group of Biofertilization and Biodegradation by Rhizospheric Fungi.

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

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

Mohammed M'rani-Alaoui. Université Abdelmalek Essaâdi Tétouan, Morocco. Group of Plant Reproductive Biology and Advanced Microscopy Laboratory (PReBAIL).

Davide Panzeri. Universidad de Milano-Bicocca, Italia. Group of Gastrointestinal Health and Food Safety.

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).

María Verónica Pérez Chaca. Universidad Nacional de San Luis, Argentina. Group of Reactive Oxygen and Nitrogen Species Signaling under Stress Conditions in Plants.

Janto Pieters. Institute of Experimental Botany, Prague, Czech Republic. Group of Plant Reproductive Biology and Advanced Microscopy Laboratory (PReBAIL).

Ernestina Solórzano Álvarez. University of La Habana - Higher Institute of Technologies and Applied Sciences (InSTEC), La Habana, Cuba. Group of Antioxidants, Free Radicals and Nitric Oxide in Biotechnology, Food and Agriculture.

Aleksandra Staszak. University of Białystok, Poland. Group of Redox Regulation, Sugar Signaling and Phenotyping using Imaging Techniques to detect Plant Stress.

Gilberto Varas Catoira. Juan Misael Saracho Autonomous University, Tarija, Bolivia. Group of Plant-Bacteria Interactions.

Nicolás E. Zuber. National University of the Littoral / National University of La Plata, Argentina. Group of Plant-Bacteria Interactions.

LOCATION AND CONTACT



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