

## 1.- LIST OF PEOPLE WHO MAKE UP THE RESEARCH TEAM.

The group **Phytopathology of Sustainable Agricultural Systems**, is a multidisciplinary research group belonging to Institute for Sustainable Agriculture, Spanish Council for Scientific Research (CSIC). The candidate will be tutored by PhD Juan Emilio Palomares Rius (scientist) PhD Antonio Archidona Yuste (Ramon y Cajal researcher) inside a research line (Improving soil nematode biodiversity in agroecosystems to control plant-parasitic nematodes using sustainable agricultura management measures) of the **Nematology Group at Institute for Sustainable Agriculture (IAS-CSIC)**, a consolidate research group composed by the following researchers: **Scientific Team:** i) **PhD. Pablo Castillo** (research scientist, team leader), ii) **PhD Juan Emilio Palomares Rius** (scientist), iii) **PhD Antonio Archidona Yuste**, **Working Team:** iv) **Mrs. Carolina Cantalapiedra Navarrete** (scientific technician), v) **Mrs. Ilenia Clavero Camacho** (PhD student), v) **Mr. Jorgen Martín Barbarroja** (technician), and **Mr. Guillermo León Roperó** (computer technician).

In particular, **the candidate will be included in the project led by PhD Juan Emilio Palomares Rius (PI) and PhD Antonio Archidona-Yuste (PI)** and focused on “NEW TOOLS TO IMPROVE THE EFFICACY AND RESILIENCE OF BIOCONTROL AGENTS IN AGRICULTURAL ECOSYSTEMS”. **Juan Emilio Palomares-Rius** holds a PhD in Agricultural Engineering from the University of Cordoba (Spain) and is Tenure Scientist at the IAS-CSIC. The outstanding quality of the scientific career is described in positive evaluation of 2 “sexenios” research periods, postdoctoral competitive stays in The James Hutton Institute in Dundee (U.K.) and in the Forestry and Forest Products Research Institute (Japan), Ramon y Cajal postdoctoral position (1st position in Agriculture), principal investigator of 4 competitive research projects and 9 projects as participant, principal investigator for 9 contracts with publics and private companies, 4 PhD supervised (3 in course), 1 Master of Science supervised. In brief, the scientific achievements are documented in more than 140 scientific publications (SCI-JCR), 9 book chapters, 1 book monography and a high number of no indexed publications, and more than 65 participations in national and international congresses being in 3 as invited speaker. Overall, the **h index is 32** with more than 5000 citations. **Antonio Archidona-Yuste** holds a PhD in Agricultural Engineering from the University of Cordoba and is a contracted Ramon and Cajal (2021) at the Institute for Sustainable Agriculture (IAS, CSIC). Notably, there are several points that describe the outstanding quality of the scientific career of him in terms of scientific knowledge transfer and international competitiveness: competitive grants such as Professional Training of Researchers (FPI), Humboldt Research Fellowship of Postdoctoral Researchers, competition contract such as the Selection of Doctoral Research Staff (PAIDI 2020) obtaining the first position in the IFAPA, and Ramon and

Cajal Programme 2021, scientific awards such as the Extraordinary Doctoral Thesis Prize of University of Cordoba (UCO) and the First Prize for the Best Poster in the XV International Congress of the Mediterranean Phytopathological Union, involvement in a total of 14 competitive international and national research projects being IP in one of them and responsible for some WPS, participation in research projects with private agricultural company being IP of one of them. He also made three research stays in international recognized centers, two stays in the pre-doctoral stage including the UC-Davis (EEUU) and UFZ (Germany) for 3 months each one, and a competitive international postdoctoral stay at the UFZ and iDiv in Germany for 24 months. In brief, the scientific achievements are documented in more than 60 scientific publications (SCI-JCR), 1 book chapter, high number of no indexed publications, and more than 30 participations in national and international congresses being in 3 as invited speaker (one in plenary session). Overall, the **h index is 16** with a total of citations of 850. Another member of the research team, **Pablo Castillo** holds a PhD in Biology Sciences in 1988 from the University of Granada (Spain) and is Research Scientist at IAS-CSIC, being leader of the Nematology group. The outstanding quality of the scientific career is described in positive evaluation of 6 “sexenios” and 6 “quinquenios” research periods, principal investigator of 14 competitive research projects and 23 projects a participant, principal investigator for 19 contracts with publics and private companies, 4 PhD supervised (1 in course), 4 Master of Science supervised, and scientific and international awards, such as, “A. Cicarone-award” (Mediterranean Phytopathological Union, 1990) and “F. Lamberti-award” (Mediterranean Phytopathological Union, 2006). In brief, the scientific achievements are documented in more than 255 scientific publications (SCI-JCR), 3 book monographies, and 51 book chapters, high number of no indexed publications, and more than 125 participations in national and international congresses, being 11 as invited speaker. Overall, the **h index is 44** with a total of citations around 5800.

**The nematology group** is a world-leading research team in basic and applied Nematology and with a main research line focused in **questions-driven research in finding and improving sustainable control strategies for plant-parasitic nematodes, mainly based in the study of nematodes and soil biodiversity, biocontrol agents and agroecosystem management**. Within the research group, **each member works with different and flexible but complementary research lines, always working and aligning in the same coordinated and unified research direction (a sustainable and economically feasible management of plant-parasitic nematodes)**. i) PhD. Pablo Castillo is specialized in taxonomy and phylogeny of plant-parasitic nematodes; ii) Juan Emilio Palomares Rius is specialized in molecular analysis, biocontrol agents and agronomic crop management; iii) PhD. Antonio Archidona Yuste is specialized in ecological

modelling, mainly in plant-parasitic nematodes and ecological environmental data; iv) Mrs. Carolina Cantalapiedra is specialized in molecular techniques, data gathering and experiment planning; v) Mrs. Ilenia Clavero Camacho has an important knowledge in management and isolation of biocontrol agents; vi) Mr. Jorge Martín Barbarroja is in charge of experiments and field sampling; and vii) Mr. Guillermo León Roperero is specialized in programming language and sampling design. In addition, members of the research group are closely related in other and external research lines and are collaborating in many research projects. **In summary, the research group is composed of a multidisciplinary team, with researchers specialized in different research areas and complementary to each other, where the good and friendly relationship between members and their complementarity is key to the success of the main research line.**

## **2.-TRAINING CAPACITY**

### **2.1. Training program planned in the context of the requested project**

The research team is composed of researchers with experience in doctoral theses, master projects and training of pre- and postdoctoral researchers at the IAS-CSIC and UCO, all of them related to the subject of this project. The requested fellow student will make short stays in national or foreign research centers to train in new techniques or expand the management of bioinformatics programs or programming. Also in the CSIC continuous training plan he/she can have access to courses (2 per year). This project is a good framework to carry out a doctoral thesis, since it integrates the use of both classical and genomic tools in various aspects of crop protection, which will allow a good training for a doctoral student. Also, contact with agronomic and business aspects in training can be of great benefit to the doctoral student as a postdoctoral researcher in the future, either in the private or public field. The requested fellow student in the project (CPPF) will have the supervision and the orientation of all participants in the project, so that this research will contribute to a specialized training in Plant Pathology (specifically plant nematology) and bioinformatic techniques, as well as its relationship with an interdisciplinary group of researchers which will allow him/her to acquire expertise in this field in order to successfully expose and defend his/her PhD. Additionally, the doctoral student will be involved in: - Participation in weekly meetings with supervisors and other doctoral students, final projects or researchers who are passing through the laboratory; - Participation in the Master of Agronomy or the Master in Production, Protection and Plant Breeding of the University of Córdoba; -Performing at least 3 months of stays in other laboratories (national or international) with technical activities related to the project; -From the second year, participation in national congresses such as the SEF or ESN; -Participation in seminars are organized at IAS-CSIC for doctoral students and in conferences organized by foreign researchers. The applicant

group also has international experience in scientific training with foreign students who stay in the laboratory, with whom the doctoral student will interact and know different scientific perspectives.

## **2.2. Theses completed or in progress within the scope of the research team (last 10 years).**

- PhD name: María Córdoba Sánchezxxxx. Title: Plant breeding in pea for plant-parasitic nematodes resistance. University: Córdoba. Defense: 2027. Supervisors: Juan E. Palomares Rius & Diego Rubiales Olmedo.

- PhD name: Ilenia Clavero Camacho. Title: **Interacciones entre microorganismos en el suelo como una herramienta para la sostenibilidad de la resistencia de patrones de frutales frente a nematodos fitoparásitos.** University: Córdoba. Defence: 2024. Supervisors: Juan E. Palomares Rius & P. Castillo

- PhD name: Pedro Emilio Torres Asuaje. Title: **Optimización del sistema radical del banano (Musa AAA cv Grande Naine), mediante el manejo de la microbiota del suelo.** University: Doctorado en Ciencias Naturales para el Desarrollo, Universidad Nacional Costa Rica. Defense: 2023. Supervisor: Juan Emilio Palomares Rius.

- PhD name: Antonio Archidona Yuste. Title: **Climatic and agronomic factors determining the presence and geographic distribution of plant-parasitic nematodes in olive in Andalusia.** University: Universidad de Córdoba. Defense: 29/11/2018. Supervisor: Pablo Castillo & Juan Antonio Navas Cortés. Obtained qualification: Cum Laude (European doctorate).

## **2.3. Scientific or professional development of graduate doctors.**

PhD **Antonio Archidona (IP in this application)** has been a PhD student in the applicant group and one of the members of the research team has been his supervisor (PhD Pablo Castillo) (2018). Following the PhD, Antonio Archidona obtain a highly **competitive Humboldt Research Fellowship for Postdoctoral Researchers** (2019) in Helmholtz Centre for Environmental Research (UFZ) and German Centre for Integrative Biodiversity Research (iDiv) in Leipzig (Germany) for 24 months inside the team of Dr. Thorsten Wiegand and Prof. Nico Eisenhauer, which are world-leading in ecological modeling and interaction ecology. Later, he obtained a **competitive contract in the Selection of Doctoral Research Staff (PAIDI, Junta de Andalucía)** (1st position in IFAPA) (2021) at the Andalusian Institute of Agricultural and Fisheries Research and Training (IFAPA) inside the applied nematology team of PhD Miguel Talavera. Recently (2021), he obtained the **competitive contract Ramón y Cajal** from the Spanish Education and he is incorporated in the IAS-CSIC and his following the nematology lines in cooperation with Pablo Castillo and Juan Emilio Palomares-Rius.

Older PhD students, such as, PhD **Juan Emilio Palomares-Rius (IP in this application)** obtained his PhD inside the IAS-CSIC (supervisors Pablo Castillo & Manuel Tena Aldave) (2009), following postdoctoral competitive stays in The James Hutton Institute in Dundee (U.K.) and in the Forestry and Forest Products Research Institute (Japan). The researcher has got the **Ramon y Cajal postdoctoral position (1st position in agriculture) in 2019 in the IAS-CSIC**. Nowadays, he is a staff researcher in the IAS-CSIC from 2020. Other PhD was Carlos Gutiérrez Gutiérrez has also obtained his PhD inside the IAS-CSIC (supervisors Pablo Castillo & Juan Emilio Palomares Rius) (2012), after several competitive stays in different countries (Ecuador and Portugal) is now working in Nematology with competitive PhD contract (5 + 5 years) at the University of Évora, inside the MED/NemaLab.

*These examples showed that the graduate students have followed a successful scientific career with important lines of stabilization (researchers, Ramon y Cajal contract, or long PhD contracts) with the help of the supervisors and with complementary lines inside the Nematology team.*

### **3.-SCIENTIFIC-TECHNICAL ACHIEVEMENTS AND CONTRIBUTIONS TO SOCIETY**

The scientific achievements of the research Nematology group have focused in the field of **Plant Protection**, with special focus on **Agricultural Nematology**, both in the diagnosis and control of **plant diseases caused by plant-parasitic nematodes (PPNs) in diverse crops of relevance in Spanish Agriculture** and on how these organisms interact with plants and other soil microorganisms to design an **effective integrated and sustainable management in agricultural systems**. In addition, and of special interest are the research lines developed in the field of Soil Ecology and Conservation of Soil Biodiversity. All this constitutes **the main research line carried out, leading the line focused in question driven research in finding and improving sustainable control strategies for plant-parasitic nematodes, mainly based in the study of nematodes and soil biodiversity, biocontrol agents and agroecosystem management**. This requires addressing a series of issues that have formed part of the following lines that the Nematology research group have led: **i) Study of plant-nematode interactions including the characterization of resistance and its stability; ii) Integrative diagnosis of plant-parasitic nematodes (including description of new species); iii) Molecular diversity and genome sequencing of plant-parasitic nematodes and endosymbionts; iv) Genetic structure of populations and molecular diversity of nematodes and plant viruses transmitted by nematodes; v) Sequencing of mitochondrial genomes and their analysis; vi) Deterministic processes driving the diversity of plant-parasitic nematodes in agricultural systems; vii) Spatio-temporal, community assembly patterns and climate**

change effect on the diversity of soil nematodes; and **viii**) Variation of nematode diversity as driving agents of ecosystem multifunctionality in agroecosystems. **This extensive and complementarity lines of research have allowed to achieve a deep experience and an extensive scientific production, as well as a satisfactory contribution to society, making Spanish Agricultural Research more competitive within the area of Agricultural Sciences.** In brief, and **for the last 5 years (2018-2022)**, the scientific achievements are documented in a total of **78 scientific publications in SCI-JCR journals (about 50% in Q1 and around 90% of the papers in Q1-Q2), 5 book chapters and 1 book**, more than **15 non-referenced and scientific-technical publications**, and more than **40 participations in national and international congresses being in 8 as invited speakers**. A list of the most relevant scientific publications (SCI-JCR) documented during the last five years is detailed below. It is important to point out the **high degree of publications in open access, which denotes the interest of this research group to expand the research and to be closer to society.**

In addition, and within the background of the scientific-technical achievements of this research group, there are other aspects that highlight the profound and significant contribution to society and science. For example, it is important to point out the integrative description of more than 40 new species of plant-parasitic nematodes (including molecular markers for the unequivocal identification). In this line, it is important to mention the publication of the first official species-list of plant-parasitic nematodes associated with olive trees in Andalusia, Spain, which was published in an open access and was disseminated in the media. The high number of molecular markers of nematode species deposited in open databases (for example, more than **3342 DNA sequences in open databases NCBI**) is another aspect to highlight, which denotes the contribution that this research group promotes to society, for example by making tools available to farmers for the accurate diagnosis and identification of nematodes of agricultural interest. And finally, contacts with the real nematological problems for the farmers is showed with the more than **700 annual external services actions in nematological analysis of samples, establishing an external diagnostic service for nematodes of agricultural interest at IAS-CSIC in a wide range of crops**. This interaction with the real agricultural problems has led to the participation with private companies, mainly in the testing of new molecules, fertilizers or biocontrol agents against plant parasitic nematodes or in the testing of new cultivars or rootstocks for many crops and in field test. This is an important financial line for the group and a highly demanded service in the group. The group has participated in the last 5 years in more than 6 projects financed with **212.571,46 euros** with several companies (Cambrico Biotech, UPL Iberica, and Fercampo). Additionally, members of the group have participated in the international and national meeting organization (SECH, XV

International Congress of the Mediterranean Phytopathological Union, among others) and in the different diffusion activities (Noche de los investigadores, Tradecorp meeting with farmers, ...). Members of the group participates in several Masters (Máster en Olivicultura y Elaiotecnia (Universidad de Córdoba), “Los nematodos de la Vid” Grado de Enología y Viticultura (Universidad de Córdoba), Master in Plant Health (Universidad de Sevilla), Máster Universitario en Sanidad y Producción Vegetal (Universidad Politécnica de Valencia)), technical courses (Curso Superior en Poda de Respeto protección y longevidad del viñedo, Universidad Rovira i Virgili; Curso Webminar "Horticultura Ecológica", modulo "Control de Enfermedades", Sociedad Española de Agricultura Ecológica; Online Advanced Course Monitoring and Surveillance of olive pathogens, International Olive Council; Nematodos en cultivos leñosos, Curso de gestión integrada de plagas, enfermedades y malas hierbas en cultivos mediterráneos, Especialización en cultivos leñosos, Cátedra Bayer CropScience, Universidad Politécnica de Valencia) and conferences (“Problemática de los nematodos fitoparásitos en el cultivo de la vid”, Instituto de las Ciencias de la Vid y el Vino-CSIC;...).

#### **4.-SCIENTIFIC-TECHNICAL ACHIEVEMENTS AND CONTRIBUTIONS TO SOCIETY.**

**List of most relevant scientific publications (selected from 78 scientific publications in SCIJCR journals, about 50% in Q1 and around 90% of the papers in Q1-Q2). 2018-2023.**

##### **SELECTED PAPERS:**

- Clavero-Camacho, I., Cantalapiedra-Navarrete, C., Archidona-Yuste, A., Castillo, P., Palomares-Rius, J.E. (2022). Distribution, ecological factors, molecular diversity, and specific PCR for major species of pin nematodes (*Paratylenchus* spp.) in Prunus plantations in Spain. **PLANT DISEASE** 106, 2711-2721. Q1
- Campos-Herrera, R.\*, Palomares-Rius, J.E.\*, Blanco-Pérez, R., Rodríguez-Martín, J.A., Landa, B.B., Castillo, P. (2022). Irrigation modulates entomopathogenic nematode community and its soil food web in olive groves under different agricultural managements. **AGRICULTURE ECOSYSTEM ENVIRONMENT** 337, 108070. \*: equal contribution. Q1.
- Archidona-Yuste, A., Wiegand, T., Eisenhauer, N., Cantalapiedra-Navarrete, C., Palomares-Rius, J.E., Castillo, P. (2021). Agriculture causes homogenization of soil nematode communities at the regional scale. **JOURNAL OF APPLIED ECOLOGY** 58, 2881-2891. Q1
- Clavero-Camacho, I., Cantalapiedra-Navarrete, C., Archidona-Yuste, A., Castillo, P., Palomares-Rius, J.E. (2021). Remarkable cryptic diversity of *Paratylenchus* spp. (Nematoda: Tylenchulidae) in Spain. **ANIMALS** 11, 1161, 1-57 pp. Q1

- Palomares-Rius, J.E., Archidona-Yuste, A., Cantalapiedra-Navarrete, C., Azpilicueta, A.S., Saborido, A., Tzortzakakis, E.A., Cai, R., Castillo, P. (2021). New distribution and molecular diversity of the reniform nematode *Rotylenchulus macrosoma* Dasgupta, Raski and Sher, 1968 (Nematoda: Rotylenchulinae) in Europe. **PHYTOPATHOLOGY** 111, 720-730. Q1
- Palomares-Rius, J.E., Clavero-Camacho, I., Archidona-Yuste, A., Cantalapiedra-Navarrete, C., León-Ropero, G., Braun Miyara, S., Karssen, G., & Castillo, P. (2021). Global distribution of the reniform nematode genus *Rotylenchulus* with the synonymy of *R. macrosoma* with *R. borealis*. **PLANTS** 9, 1649. Q1
- Palomares-Rius, J.E., Gutiérrez-Gutiérrez, C., Mota, M., Bert, W., Claeys, M., Yushin, V.V., Suzina, N.E., Ariskina, E.V., Evtushenko, L.I., Subbotin, S.A., Castillo, P. (2021). 'Candidatus Xiphinematocola pachtaicus gen. nov., sp. nov.', an endosymbiotic bacterium associated with nematode species of the genus *Xiphinema* (Nematoda, Longidoridae). **INTERNATIONAL JOURNAL OF SYSTEMATIC AND EVOLUTIONARY MICROBIOLOGY** 77, 004888. Q2
- Archidona-Yuste, A., Cai, R., Cantalapiedra-Navarrete, C., Carreira de la Fuente, J.A., Rey, A., Viñegla, B., Liebanas, G., Palomares-Rius, J.E., Castillo, P. (2020). Morphostatic speciation within the dagger nematode *Xiphinema hispanum*-complex species (Nematoda: Longidoridae). **PLANTS** 9, 1649. Q1
- Cai, R., Archidona-Yuste, A., Cantalapiedra-Navarrete, C., Palomares-Rius, J.E., Castillo, P. (2020). New evidence of cryptic speciation in the family Longidoridae (Nematoda: Dorylaimida). **JOURNAL OF ZOOLOGICAL SYSTEMATICS AND EVOLUTIONARY RESEARCH** 58, 869-899. Q1
- Van den Hoogen, J., ...Palomares-Rius, J. E.,...Crowter, T.W. (2019). Soil nematode abundance and functional group composition at a global scale. **SCIENTIFIC DATA** 572, 194-198.
- Archidona-Yuste, A., Wiegand, T., Castillo, P., & Navas-Cortés, J.A. (2020). Spatial structure and soil properties shape local community structure of plant-parasitic nematodes in cultivated olive trees in southern Spain. **AGRICULTURE ECOSYSTEMS AND ENVIRONMENTS** 287, 106688. Q1
- Palomares-Rius, J.E., Belaj, A., León, L., de la Rosa, R., Rappoport, H.F., Castillo, P. (2019). Evaluation of the phytopathological reaction of wild and cultivated olives as a mean of finding promising new sources of genetic diversity for resistance to root- knot nematodes. **PLANT DISEASE** 103, 2559-2568. Q1
- Van den Hoogen, J., ...Palomares-Rius, J. E.,...Crowter, T. W. (2019). Soil nematode abundance and functional group composition at a global scale. **NATURE** 572, 194-198. Q1



- Nguyen, V.C., Villate, L., Gutierrez-Gutierrez, C., Castillo, P., Plantard, O., Esmenjaud, D. (2019). Phylogeography of the soil-borne vector nematode *Xiphinema index* highly suggests Eastern origin and dissemination with domesticated grapevine. **SCIENTIFIC REPORTS** 9, 7313. Q1
- Archidona-Yuste, A., Cantalapiedra-Navarrete, C., Liebanas, G., Rapoport, H.F., Castillo, P., Palomares-Rius, J.E. (2018). Diversity of root-knot nematodes of the genus *Meloidogyne* Göeldi, 1892 (Nematoda: Meloidogynidae) associated with olive plants and environmental cues regarding their distribution in southern Spain. **PLoS ONE** 13, e0198236. Q1

## **5.-NATIONAL RESEARCH PROJECTS.**

The Nematology research group has led or participated in a total of **5 competitive NATIONAL research projects in the last FIVE YEARS (2018-2023).**

- P12-AGR1486. Biodiversidad y ecología de nematodos fitoparásitos de olivar en Andalucía, sus implicaciones en la Verticilosis y su control integrado (NEMABIOLI). Junta de Andalucía, Spain. **PI: P. Castillo** (IAS-CSIC, Spain). 2014-2018. 182.407,00 €.
- RTI2018-095925-A-I00CSIC-ID. Interacciones entre microorganismos en el suelo como una herramienta para la sostenibilidad de la resistencia de patrones de frutales frente a nematodos fitoparasitos (NEMARES). Ministerio de Ciencia, Innovación y Universidades. **PI: Juan E. Palomares-Rius** (IAS-CSIC, Spain). 2019-2022. 157.300,00 €.
- i-COOP+2020. COOPB20557. Molecular tools, barcoding and integrative taxonomy in soil pathogen identification for the improvement of crop yields in Egypt. CSIC. **PI: Juan E. Palomares-Rius** (IAS-CSIC, Spain). 2021-2022. 22.050,00 €
- ComMadVid. Biodiversidad y factores determinantes en la distribución de los nematodos fitoparásitos en viñedos en la región central. Comunidad de Madrid. PI: Sergio Álvarez (King Juan Carlos University, Spain). 2022-2024. 45,248.06 €.
- ProyExcel\_00327. Biological bases towards the integrated management of almond decline in Andalusia. PAIDI. Junta de Andalucía. PI: Carlos Agustí (UCO, Spain). 2023-2025. 180.000,00 €.