

SUMMARY REPORT

Name: Alejandro Solla

Subject title: Disturbance and resilience of *Quercus ilex* and *Quercus suber* in response to individual and combined water stress and *Phytophthora cinnamomi* infection

Theme number of research fellowship: 2

Host institution: Department of Agricultural Sciences, University of Sassari

Host collaborator: Bruno Scanu

Dates of fellowship: July 1 2022 – September 30 2022

I declare that my report can be posted on the Co-operative Research Programme's website.

1. What were the objectives of the research project? Why is the research project important?

The objectives of the project were to bring results from a manipulative experiment, in particular (i) to evaluate the individual and combined effects of drought and *Phytophthora cinnamomi* (*Pc*) disturbance in *Quercus suber* and *Q. ilex*, two of the most abundant forest tree species in southern Europe, (ii) estimate by means of parameters commonly used in science the response variability of 12 populations from 5 Mediterranean countries to two *Pc* strains of different phenology and origin, and (iii) select drought- and *Pc*-tolerant plants (and to both stresses) to make them available to the nurseries.

In both *Quercus suber* (cork oak) and *Q. ilex* (holm oak) species it was intended to test the hypotheses that disturbance and resilience to 'drought stress' and '*Pc*' (1) alter ecosystems synergistically if both stresses act in combination, (2) are dependent on the *Pc* strain and (3) maintain a latitudinal and longitudinal geographic gradient.

The research project is important because it is a scientific reference on the effect of combined stress in trees, and provides real data into the uncertainty in modelling. From the practical point of view, the project identified trees (and populations) tolerant to *Pc*. The two oaks are highly prized for their edible acorns (by pigs and cattle) and ecosystem services. In a further step of this research, selected clones could be catalogued and delivered into forest nurseries to make trees available for the society.

2. Were the objectives of the fellowship achieved?

The first objective was not achieved. Due to failure in the cooling system of the greenhouse during one weekend, coinciding with an intense heat wave, 83% of the plants subjected to water stress became death. In consequence there were not enough plants for the 'drought' treatment. As an alternative plan, on plants from the 'regular watering' treatment (which were available in enough quantity) it was decided to test the effect of 'aerial infection' (stem inoculation) vs 'root infection' (soil infestation). Therefore, the first scientific objective of the stay was replaced by checking for interactions between aboveground and belowground *Pc*-infections. The following hypothesis was tested: aboveground and belowground *Pc* infections interact synergistically in *Q. suber* and *Q. ilex* plants, in a way that infections occurring together induce more plant mortality than the cumulative mortality induced when infections occur individually.

3. What were the major achievements of the fellowship? (up to three)

- For the first time on a biogeographical scale, significant differences between cork and holm oaks in response to *Pc* have been confirmed: (i) the holm oak is always more susceptible, (ii) Iberian holm oaks are more susceptible than those in Italy, and (iii) Iberian cork oaks are more tolerant than those of the Maghreb. Moreover, the populations of cork oak from Extremadura and of holm oak from Sardinia showed superiority in terms of tolerance to *Pc*, which makes them candidates as sources of germplasm for a breeding program.
- It is the first time that genetic characterization and tolerance assessment to *Pc* has been addressed simultaneously in holm oak and cork oak. According to the heritability estimates obtained, tolerance to *Pc* in oak and cork oak is under genetic control, and does not differ depending on the *Pc* isolate.
- Finally, simultaneous stem infections and root infections generate a synergistic effect on plant mortality.

4. Will there be any follow-up work?

During the stay, a short note was jointly published in *Plant Disease* journal, which is *Q1* and has an impact factor of 4,614 in the Plant Science area. The publication can be downloaded from: <https://doi.org/10.1094/PDIS-08-22-1795-PDN>

An additional publication entitled ‘Susceptibility of *Quercus suber* and *Q. ilex* to *Phytophthora cinnamomi* in the Mediterranean Basin’ and authored by Alejandro Solla, F. Javier Dorado, Tomás Gil-Zorita, Francisco Alcaide, Elena Cubera, M. Ángela Martín, Francisco J. Ruiz-Gómez, Younes Abbas, Tayeb Mahi, Juan A. Martín, Carmen Morales-Rodríguez, Andrea Vannini, Andrea Brandano, and Bruno Scanu is being prepared.

Moreover, the stay could lead to a stable collaboration through a *Life* project, currently being drafted.

5. How might the results of your research project be important for helping develop regional, national or international agro-food, fisheries or forestry policies and, or practices, or be beneficial for society?

The two oaks are highly prized for their edible acorns (by pigs and cattle) and ecosystem services. At the end of the experiment, a plant selection based on survival, absence of symptoms and plant height was made. Seven *Q. ilex* individuals and twelve *Q. suber* individuals tolerant to *Pc* were selected. The plants will be evaluated one more year, then catalogued and delivered into forest nurseries to make trees available for the society. Once the plant material is propagated or cloned, genotypes will be ready to be planted in *Pc*-diseased areas, and will generate a direct benefit to society in terms of ecosystem services and products (cork and acorn).

6. How was this research relevant to:

The project was directly related to ‘STRENGTHENING RESILIENCE IN THE FACE OF MULTIPLE RISKS IN A CONNECTED WORLD’ since directly assesses through experimentation the disturbance and resilience of tree populations to *Pc* stress. Because the plant material used included seedlings from two widespread tree species obtained from five different countries and the *Pc* strains originated from two geographically separate countries, the project directly fell into the scope of the CRP and the objectives of Theme 2.

7. Satisfaction

The fellowship conformed all my expectations and will increase my career opportunities. It will allow (1) two novel publications, (2) a post doc exchange, (3) sending isolates of *Phytophthora* to the University of Sassari for molecular analysis, (4) request funds to evaluate a second time the tolerance of the 'tolerant' plant material selected in the current project, under controlled conditions and in the field, (5) learning new techniques and skills, which will be transferred to my doctoral students, and (5) in the near future, try to catalogue the 'tolerant' plant material selected and enable its commercial distribution through nurseries. Apart from the technical problem indicated in epigraph 2, I did not encounter any practical problem.

8. Advertising the Co-operative Research Programme

- How did you learn about the Co-operative Research Programme? Through an e-mail from *Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria – INIA*.
- What would you suggest to make it more “visible”? Promotion *via* ResearchGate
- Are there any issues you would like to record? No, just to say **thanks**.