OECD RESEARCH FELLOWSHIPS 2018-19

Title Sustainable non-chemical control of Russian wheat aphid in cereal crops

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I consent this report being posted on the Co-operative Research Programme's website

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

Background

Worldwide, cereals are exposed to established and newly introduced aphid species which affect crops directly, or indirectly as carriers of viruses. Russian wheat aphid (*Diuraphis noxia*) is a new pest to Australia, first detected in cereal crops in South Australia in May 2016, and later found in Victoria and New South Wales. As a first reaction to this new pest, the industry has deployed a 4-step FITE strategy: FIND – look for aphids and characteristic plant symptoms; IDENTIFY the pest; THRESHOLD APPROACH using international thresholds for control, and ENACT an appropriate management strategy. This strategy relies strongly on chemical control and can be useful in the short term, but integrated approaches are required in the long term, including the screening and selection of cereal varieties with improved aphid resistance. With a focus on the cereal-aphid system from a new ecological perspective, our proposal contributes to long-term sustainability. This has implications for biosecurity in Australia and beyond, as we focus on the biological foundations of plant-insect relationships.

Objective

The objective of this project was to test experimentally the role of osmotic stress on cereal-aphid relationships.

2. Were the objectives of the fellowship achieved?

We established a comprehensive factorial experiment combining (a) two levels of CO_2 (400, 700 ppm), (b) two nitrogen levels (100%, 20% using Hoagland solution) and (c) two aphid species (*Sitobion avenae*, *Rhopalosiphum padi*). The behaviour and fitness of aphids on plants grown under contrasting conditions were assessed using fitness tests (Fig. 1) and electric penetration graphs (Fig. 2). Plant chemical analysis are currently being finalised to probe for correlations between plant composition and aphid responses.

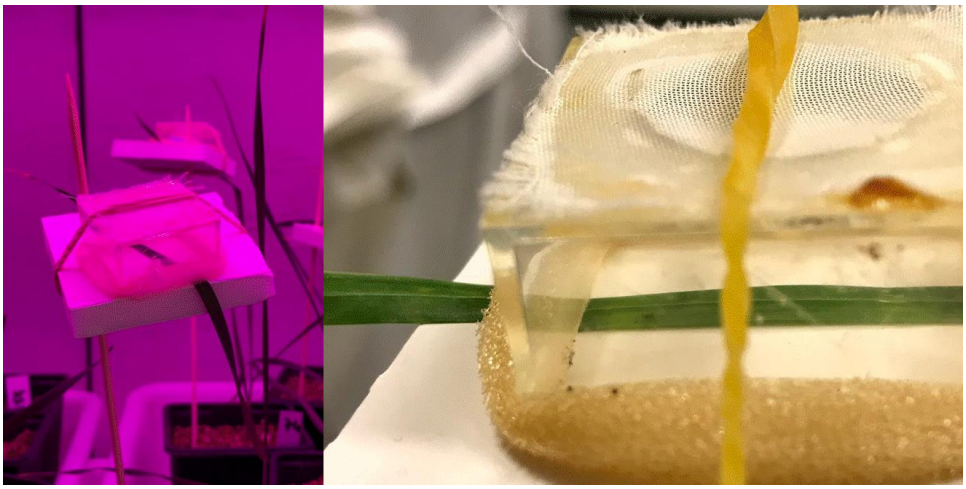

Figure 1. Fitness test. Single adult aphids of similar age and size are enclosed on clip-cages in wheat plants grown under contrasting CO_2 and nitrogen regimes. This test returns life-history parameters reflecting host-plant suitability.

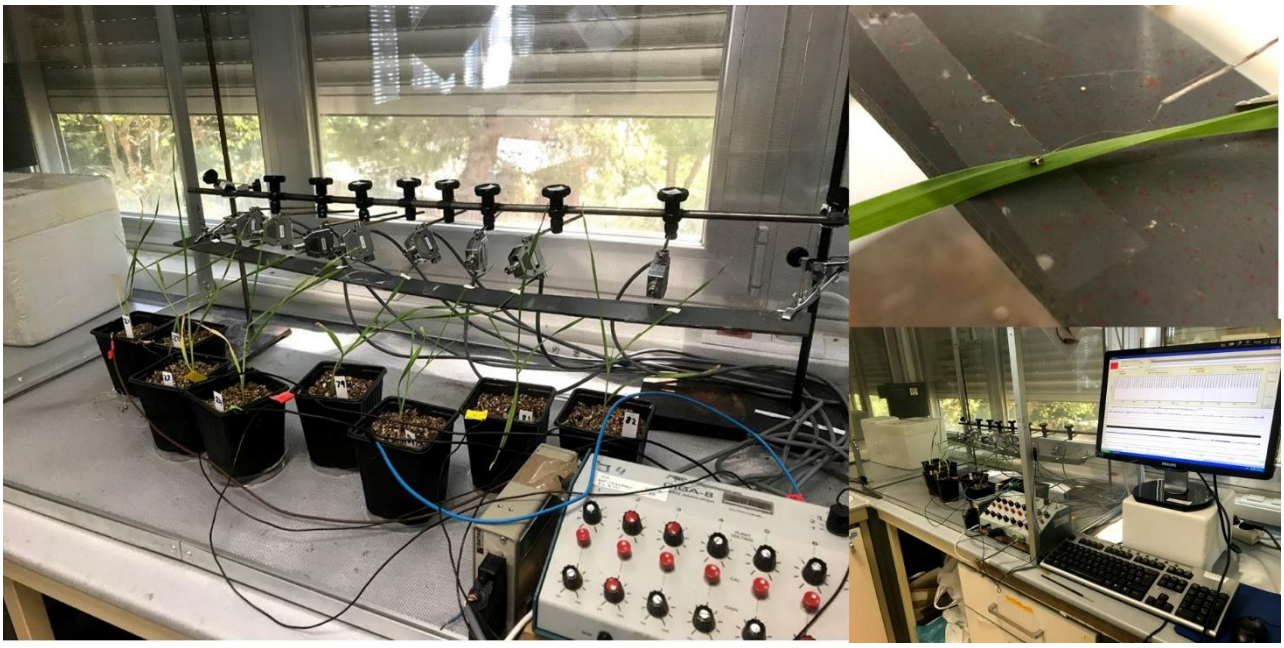

Figure 2. Electrical penetration graphs to quantify aphid behaviour on a range of host plant phenotypes.

3. What were the major achievements of the fellowship?

A new concept is developed at the interface between crop science and entomology, relating osmotic potential in cereals and resistance to aphids. We have favoured hypothesis-driven innovation in a pervasive culture of data-driven efforts.

4. Will there be any follow-up work?

We envisage to publish two scientific articles in peer-reviewed journals to be submitted in the first and third quarters of 2020. We will explore funding opportunities to support ongoing collaboration between home and host institutions. This research is unlikely to result in protected intellectual property.

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?

We will explore novel traits for improved cereal adaptation to aphids. This means that practical outcomes have to be mediated by plant breeding, and these are bound to be medium to long-term (> 5 years). If the experiments support the hypothesis that high concentration of labile carbohydrates enhances cereal resistance to aphids, phenotyping tools and genetic markers could be developed to improve cereal resistance to key species, particularly those carrying viruses. To achieve these longer term outcomes, we propose a two-step strategy. First, we will tap on the existing infrastructure of two programs to complement the results from this OECD project, including (a) a regional research program on the biology and management of Russian wheat aphid, and (b) the national Oat Breeding Program concerned with aphid-transmitted viruses. The South Australian R&D Institute leads both these projects, and Sadras has initiated collaborations with the entomologist and breeder responsible for these projects. Second, we will seek to leverage CRP investment towards larger projects to continue the collaborations between Spain and Australia.

6. How was this research relevant to CRP

This project addressed CRP Theme II. MANAGING RISKS IN A CONNECTED WORLD; it informs biosecurity science seeking to secure social, environmental and economic wellbeing by reducing both: (a) the risk of yield losses in cereals caused by aphids (Hemiptera: Aphididae), and (b) the reliance on insecticides for pest control.

7. Satisfaction

Did your fellowship conform to your expectations?
Yes, fully.

Will the OECD Co-operative Research Programme fellowship increase directly or indirectly your career opportunities?
This project can potentially open new lines of research in our institute and more broadly at the interface between crop science and entomology.

Did you encounter any practical problems?
No.

Please suggest any improvements in the Fellowship Programme.

With a relatively modest investment, the Programme is very useful to initiate collaborations, proof-of-concept projects and leverage larger initiatives. The reporting requirements are proportional to the investment. Overall the programme achieves a good balance between magnitude of investment and objectives.

8. Advertising the Co-operative Research Programme

I learnt about the Co-operative Research Programme through brochures and emails. Based on my excellent experience with the Programme, I encourage my early and mid-career colleagues to check on the CRP's website and look for possible partnerships with fellow colleagues in OECD countries. I do not find any issues to record.