University of Hertfordshire UH

School of Life and Medical Sciences

Comparative genomics and modelling of insect pests and their host plant selections in the UK

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Background

- **Cabbage stem flea beetle (CSFB)** *Psylliodes chrysocephala*
  - Is an increasing winter oilseed rape crop pest throughout the UK and northern to central Europe.
  - Due to CSFB and a decrease of OSR planted area, English oilseed rape production for harvest 2020 is at a 21-year low, down 39% from 2019 (Defra, 2020) (Figure.1).

- **Spotted wing drosophila (SWD)** *Drosophila suzukii*
  - First detected in 2008 in North America, and has emerged as a major problem for UK agriculture since 2012.
  - Can infest more than sixty kinds of commercial fruits (e.g., small fruits including strawberries, cherries) (Stewart et al., 2014).

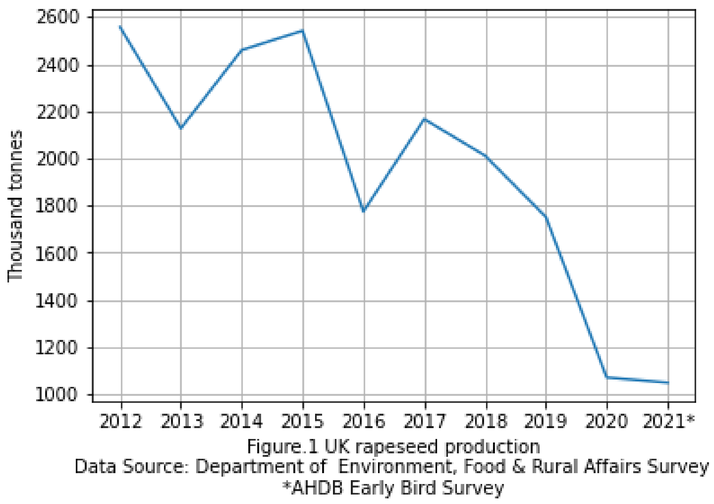

Figure.1 UK rapeseed production
Data Source: Department of Environment, Food & Rural Affairs Survey
*AHDB Early Bird Survey

Figure. 2 Cabbage stem flea beetle, *Psylliodes chrysocephala* (L.) (Coleoptera: *Chrysomelidae*)
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Figure.3 Spotted wing drosophila (SWD) *Drosophila suzukii* (L) (Diptera: *Drosophilidae*), named after the male's dark spots near his wing tips
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Climate change will impact agroecosystems and pest epidemics (Stern 2007) and with the recent ban on neonicotinoid insecticides, new IPM (Integrated Pest Management) solutions should be developed to rely less on chemical products.

Focusing on SWD and CSFB, we now have an opportunity to link biological knowledge, phenological data, and trait information of the pest/host for qualitative and empirical model development and future climate-based predictions.

Objectives

1. Use comparative genomics to identify herbivore-specific traits and differentiate specialist from generalist herbivores (Table 1).

2. Herbivory-related pathway analysis, including the detoxification of phytochemicals and olfaction.

3. Informed IPM through modelling of SWD and CSFB pest dynamics to estimate which period of the year is critical for the crop (host) and the optimal time to apply pesticides and IPM strategies (e.g., pheromone traps).

Methodology

- Use of Venn diagrams to find specialised genes through species comparisons (Objectives 1 & 2) to reveal unique genes involved in novel species-specific functions.
- leveraging machine learning techniques like SVM (support vector machine) and pattern recognition approaches (Objectives 1 & 2)

Table 1. Specialist vs. generalist pests

	Diptera (Flies)	**Coleoptera (Beetles)**	**Lepidoptera (Moth etc.)**
Specialist	*Scaptomyza flava*	*Psylliodes chrysocephala (CSFB); & Phyllotreta striolata*	*Plutella xylostella*
Generalist	*Drosophila suzukii*	*Trilobium castaneum*	*Spodoptera exigua*

- Development of predictive models (e.g., Growing Degree Day) for pest management and production of forecasting pest risks maps (Objective 3), based on the pest geographical distribution correlated with the crops in the UK (Figure. 4).
- Simulations of different climate change scenarios to produce similar maps to investigate potential pest behavior changes. (Objective 3)

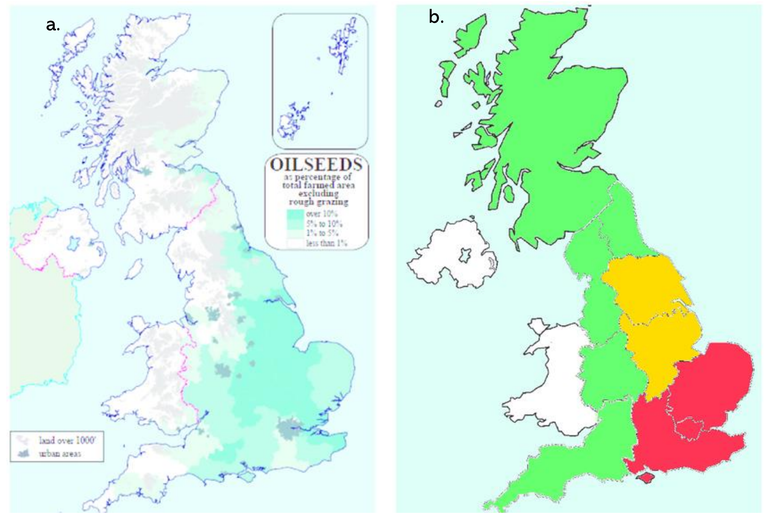

Figure.4 Cropping Intensity (a) and insect damage (b) severity of adult cabbage stem flea beetle in winter oilseed rape in the UK in 2015. Red = Highest Loss and Risk. (Sekulic and Rempel, 2016)

Implications and contributions to knowledge

- Better understanding of:
  - Dynamics of pest involved;
  - Herbivory-related pathways, e.g. detoxification of phytochemicals and olfaction.
  - Functional characterisation of key genes that are important for host selection by insects, and benefit future research in these areas.

- Delivery of practical outcomes to breeders and growers in the UK.

- Presentation at national and international conferences and UK arable events like Cereals.

- Publication in relevant high-impact journals.

References

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