NIAB

Breeding for IPM in fruit crops

Felicidad Fernandez

Talk overview

- General points about breeding for sustainable production
- NIAB fruit breeding
- Which pests?
- Illustration of pest-resistance breeding in our research
- Final thoughts

Breeding for pest and disease resistance

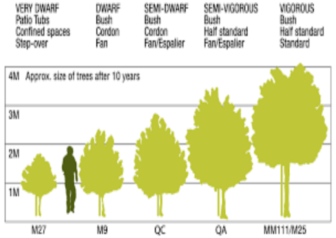
- IPM as an arms race
  - Pest evolution against plant resistance and pesticides
- Resistance breeding is an additional layer of protection
  - Targeted use of pesticide protects the durability of resistance and use of resistant genotypes protect the effectiveness of the pesticide
- Plant response
  - Susceptible (range of attractiveness and responses to infestation)
  - Tolerance
  - Resistance:
    - Gene-for-gene (large raspberry aphid)
    - Quantitative
    - Pyramiding

- Part of the NIAB group since 2016
- East Malling site focused on fruit research since 1913
- Recent developments on the EM site: upgraded facilities, exp winery and control environment growth rooms

NIAB Fruit Breeding

Stone Fruit

Pip Fruit



Berries

Which pests?

- Sources of resistance available
- Reliable/reproducible phenotyping
- Inheritable trait
- Importance of the pest (in it self or as a vector)
- Priority within breeding objectives (cost-benefit)
- [Marker-assisted breeding]

Which pests?

Spotted Wing Drosophila (*Drosophila suzukii*)


Female SWD

SWD- Key pest in soft and stone fruit
Mitigation and crop loss due to damage is estimated at £20 - £30 million p.a. in UK


Male SWD

Screening for 'resistance' to Spotted Wing Drosophila (*Drosophila suzukii*) in strawberry and raspberry accessions
Project number 10025468

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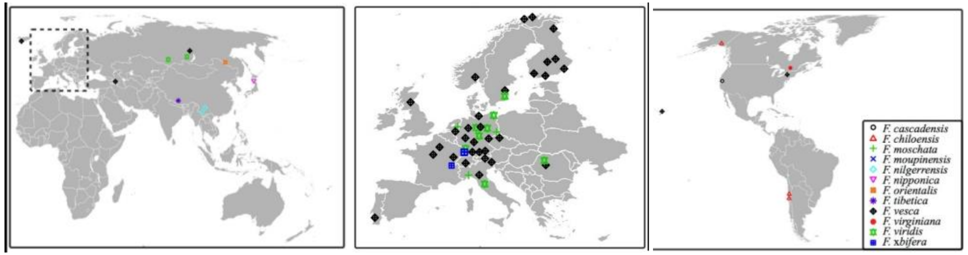
The Project

Background

- Known variation in ‘resistance’ in some *Fragaria* species



frontiers in Plant Science

ORIGINAL RESEARCH
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Strawberry Accessions with Reduced *Drosophila suzukii* Emergence From Fruits

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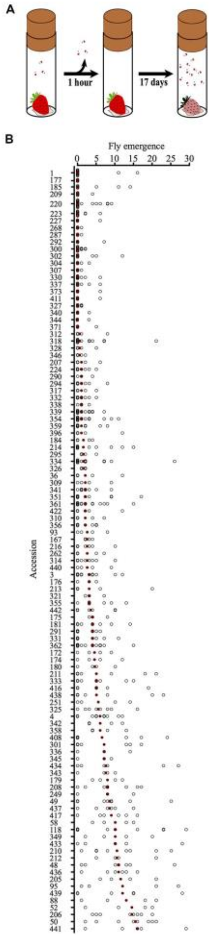
Drosophila suzukii is threatening soft fruit production worldwide due to the females' ability to pierce through the intact skin of ripe fruits and lay eggs inside. Larval consumption and the associated microbial infection cause rapid fruit degradation, thus drastic yield and economic loss. Cultivars that limit the proliferation of flies may be ideal to counter this pest; however, they have not yet been developed or identified. To search for potential breeding material, we investigated the rate of adult *D. suzukii* emergence from individual fruits (fly emergence) of 107 accessions of *Fragaria* species that had been exposed to egg-laying *D. suzukii* females. We found significant variation in fly emergence across strawberries, which correlated with accession and fruit diameter, and to a lesser extent with the strawberry species background. We identified accessions with significantly reduced fly emergence, not explained by their fruit diameter. These accessions constitute valuable breeding material for strawberry cultivars that limit *D. suzukii* spread.

Keywords: ***Drosophila suzukii*, *Fragaria*, plant-insect interactions, plant disease resistance, soft fruits, horticulture**

INTRODUCTION

The spotted wing fly, *Drosophila suzukii*, is one of the most serious pests in soft fruit production, attacking several fruits of agricultural importance such as strawberries, raspberries, blueberries, grapes, blackberries and cherries. A key feature of this species is the serrated ovipositor of *D. suzukii* females, which enables them to pierce ripening fruits and lay eggs inside the flesh (Atallah et al., 2014). In contrast, most closely related species deposit their eggs in decaying fruits. The infestation by *D. suzukii* typically leads to complete loss of the



Gong, et al. 2016

The Project and Team

Aim

To identify UK relevant strawberry and raspberry germplasm with natural resistance to SWD for future variety development.

- Offspring emerging
- Preference between accessions
- Identify any clear fruit characteristics which are associated with 'resistance'

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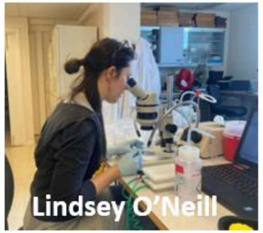

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Focus 2022 - Strawberries

76 accessions

Fragaria X *ananassa*

Diverse origin

Trait variation

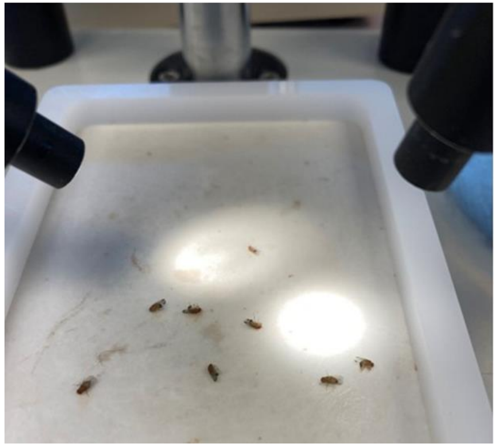
Process

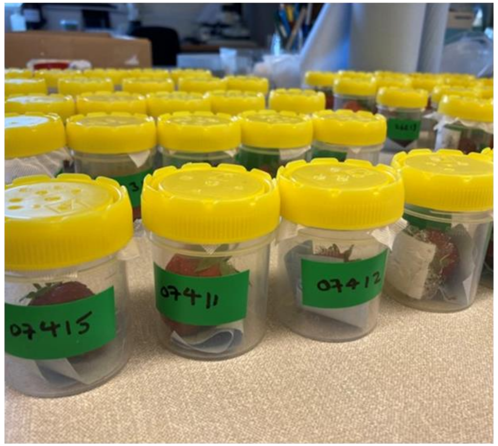


Fruit assessment, parameters measured:

- Berry size
- Skin colour
- Skin strength
- Flesh firmness
- Brix

Process



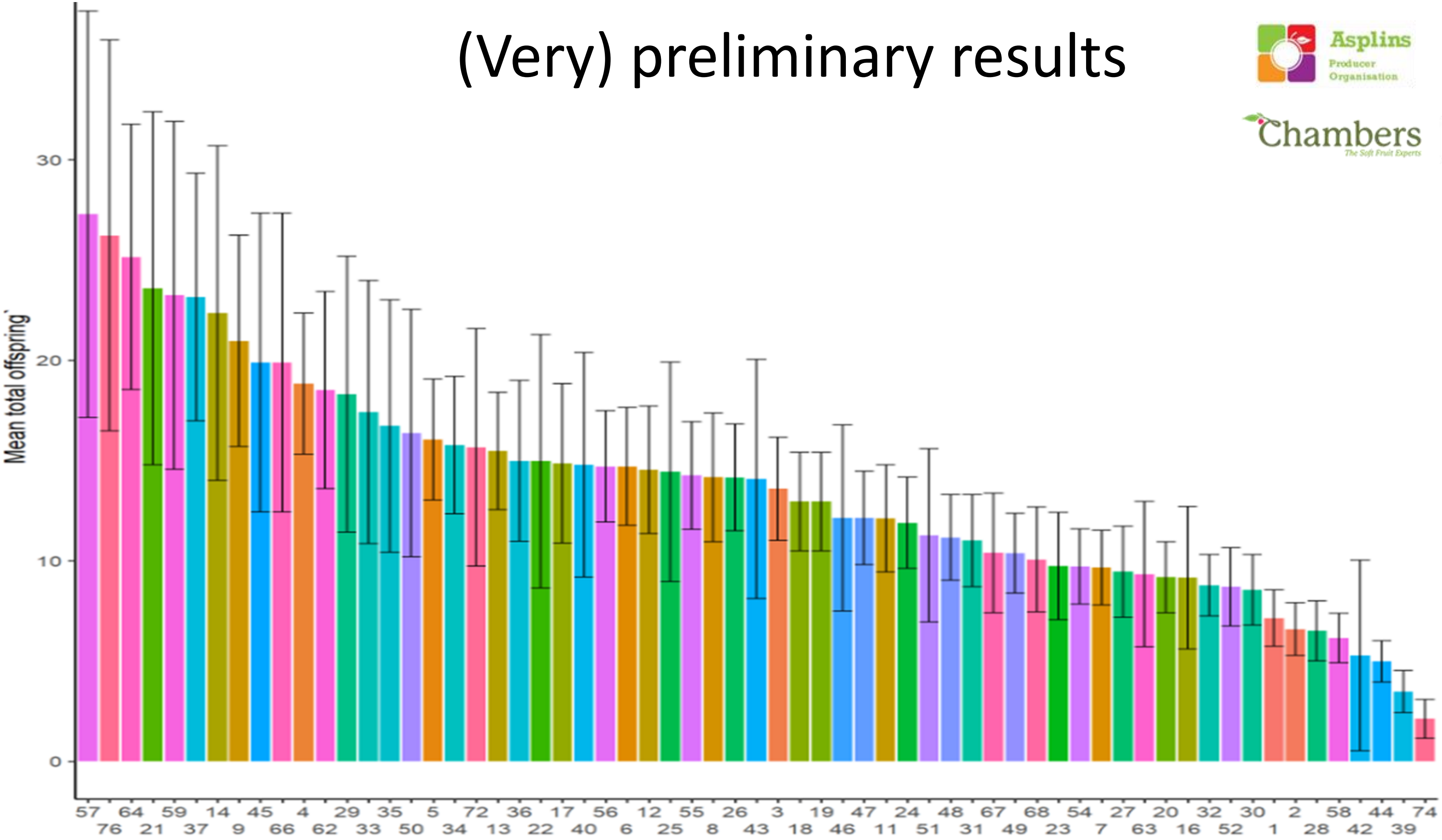


Fly assessments

Berry exposed to SWD for egg laying

Number of emerging offspring assessed after two weeks

(Very) preliminary results



Next steps

- Choice tests (strawberry pulp)
- Re-screening selected strawberry genotypes
- Preliminary screen of raspberry accessions
- 55-75 genotypes of raspberry including yellow, purple, black raspberry accessions & some species level material.

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Large raspberry aphid: *Amphorophora idaei*

- European large raspberry aphid (*Amphorophora idaei)*

- Vector of the raspberry mosaic disease (RMD) viral complex:
    - raspberry leaf spot virus (RLSV)
    - black raspberry necrosis virus (BRNV)
    - raspberry leaf mottle virus (RLMV)
    - *Rubus* yellow net virus (RYNV)

fruitdisease.co.uk

- Reduced vigour, longevity and yield
- Difficult chemical or biological control as transmission can occur ≤ 2 h
- Vector resistance has been a breeding objective in the UK for >50yrs

Raspberry-aphid interactions

Series of single dominant conferring biotype-dependent resistance

R. idaei 'Baumforth A'	A_1	Knight et al 1959
R. strigosus 'Chief'	A_2-A_7	Knight et al 1960
R. strigosus L518	A_8-A_9	Keep & Knight 1965
R. occidentalis	A_{10}	Keep et al 1967
R. idaeus Klon4a	A_{k4a}	Keep et al 1970
R. coreanus L646	*Acor*	Keep & Knight 1970

Raspberry-aphid interactions

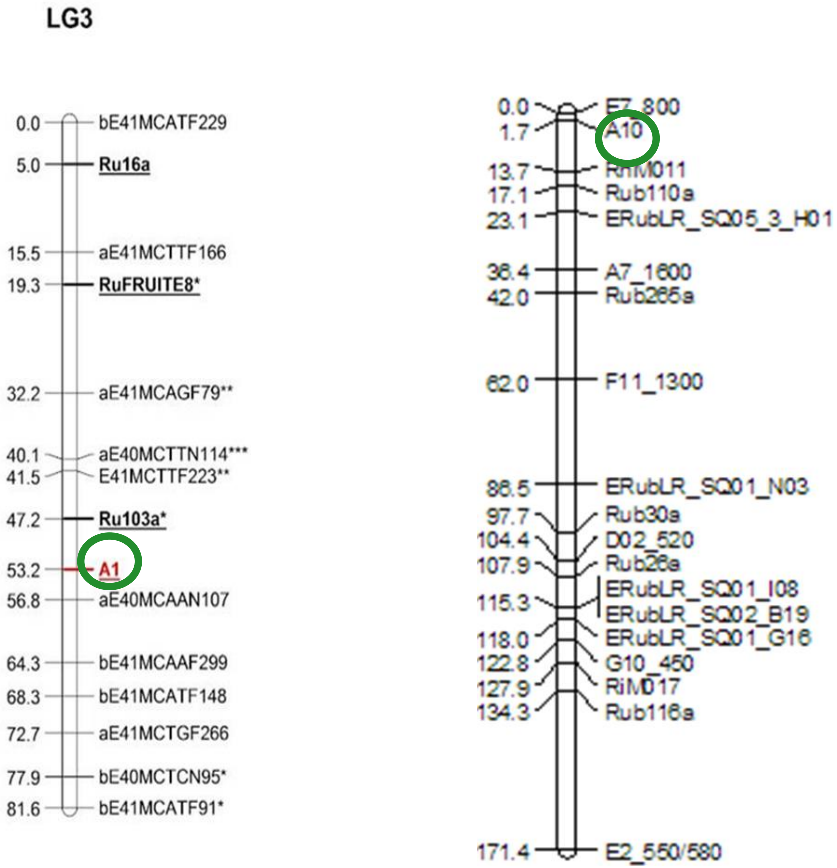
Gene	Aphid strain				
	1	2	3	4	X
A_1	R	S	R	S	?
A_2	S	R	S	S	?
A_1A_3	R	R	R	S	?
A_3A_4	S	R	S	S	?
A_5	R	S	S	S	?
A_6	R	S	S	S	?
A_7	R	S	S	S	
A_8, A_9 | A_{L518}	R	R	R	R	?
A_{10}	R	R	R	R	S
A_{k4a}	R	R	R	R	R?
A_{cor}	R	R	R	R	?

Classic resistance breeding

- Generate breeding families segregating for one or more of the resistance genes

- Phenotype seedlings
- Limitations:
  - Cost
  - Timeliness
  - Gene pyramiding
- Marker-Assisted Breeding

Mapping resistance genes vs markers for breeding



Sargent et al 2007

- More difficult for quantitative traits
- Marker validation across germplasm is essential
- Tracking haplotypes and marker inheritance through multiple generations
- Practical considerations such as marker types and detection modes (SSRs to SNPs), overall cost …

Applied Marker-Assisted Breeding

- Still rare in fruit crops for pests but increasing common for disease
  - Apple scab
  - Fire-blight (quantitative trait)

- Marker validation and change in ‘markers of choice’ require ongoing investment

- Cost-benefit analysis needed for each breeding programme

Breeding for IPM in fruit crops

Felicidad Fernandez