UNIVERSITY OF LIVERPOOL

CAN ENDOSYMBIONTS INFLUENCE THE DEVELOPMENT, FITNESS, AND BEHAVIOUR OF CEREAL APHIDS?

Dr Daniel Leybourne
1851 Research Fellow

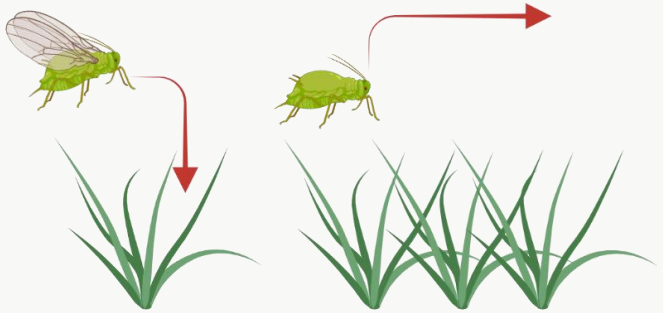
@danielleybourne



THE SYSTEM

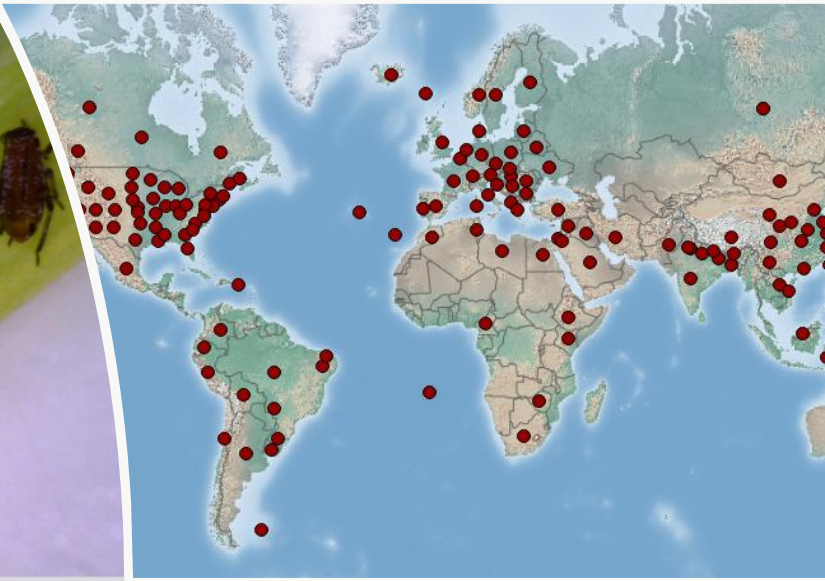
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- Cereal aphids are globally significant
- Can cause significant yield losses in wheat, barley, oats
- Barley Yellow Dwarf Virus transmission
- Management reliant on pesticide application
- Pesticide resistant populations











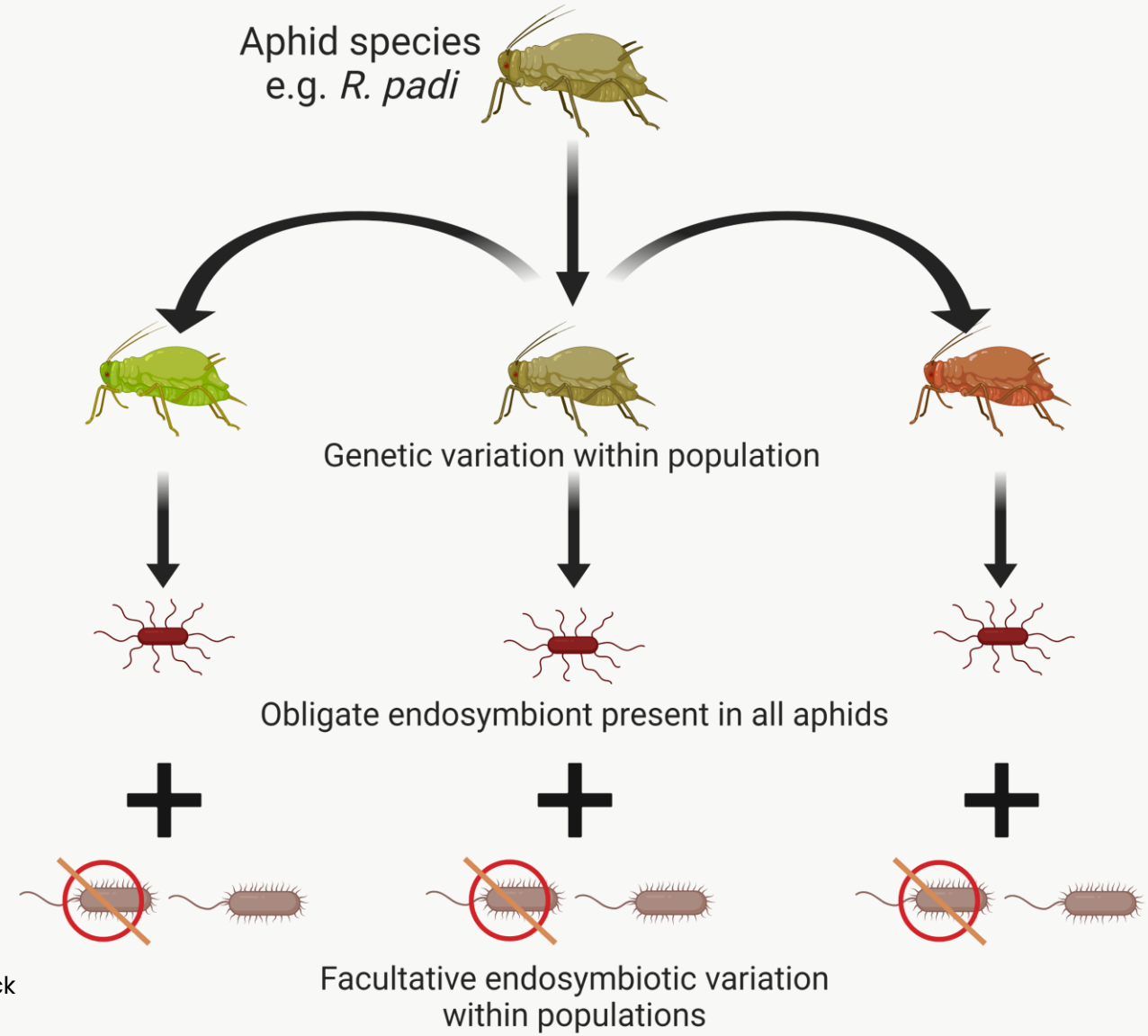


APHID DIVERSITY – WHY IS IT IMPORTANT?

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Main aphid endosymbionts:

- *Hamiltonella defensa*
- *Regiella insecticola*
- *Serratia symbiotica*
- *Fukatsia symbiotica*
- *Aresnophonus spp.*
- *Rickettsia spp.*
- *Ricketsiella spp.*
- *Spiroplasma spp.*



ENDOSYMBIONT

INFECTION IS VARIABLE

R. padi:

- *Hamiltonella defensa*: 10-38% (China/Europe, UK, Germany)
- *Fukatsia symbiotica:* 28% (Germany)
- *Regiella insecticola*: 40% (China/Europe)
- *Rickettsia spp.:* 60% (China/Europe)
- *Spiroplasma spp.:* 26% (China/Europe)
- Other endosymbionts: Low prevalence or not reported



S. avenae:

- *Regiella insecticola*: 50-75% (Germany, Morocco)
- *Fukatsia symbiotica:* 8-12% (Germany)
- Other endosymbionts: Low prevalence or not reported



Metopolophium dirhodum

- Low prevalence or rarely reported
- *Regiella insecticola, Hamiltonella defensa* (Germany)

CAN ENDOSYMBIONTS INFLUENCE PHENOTYPE?

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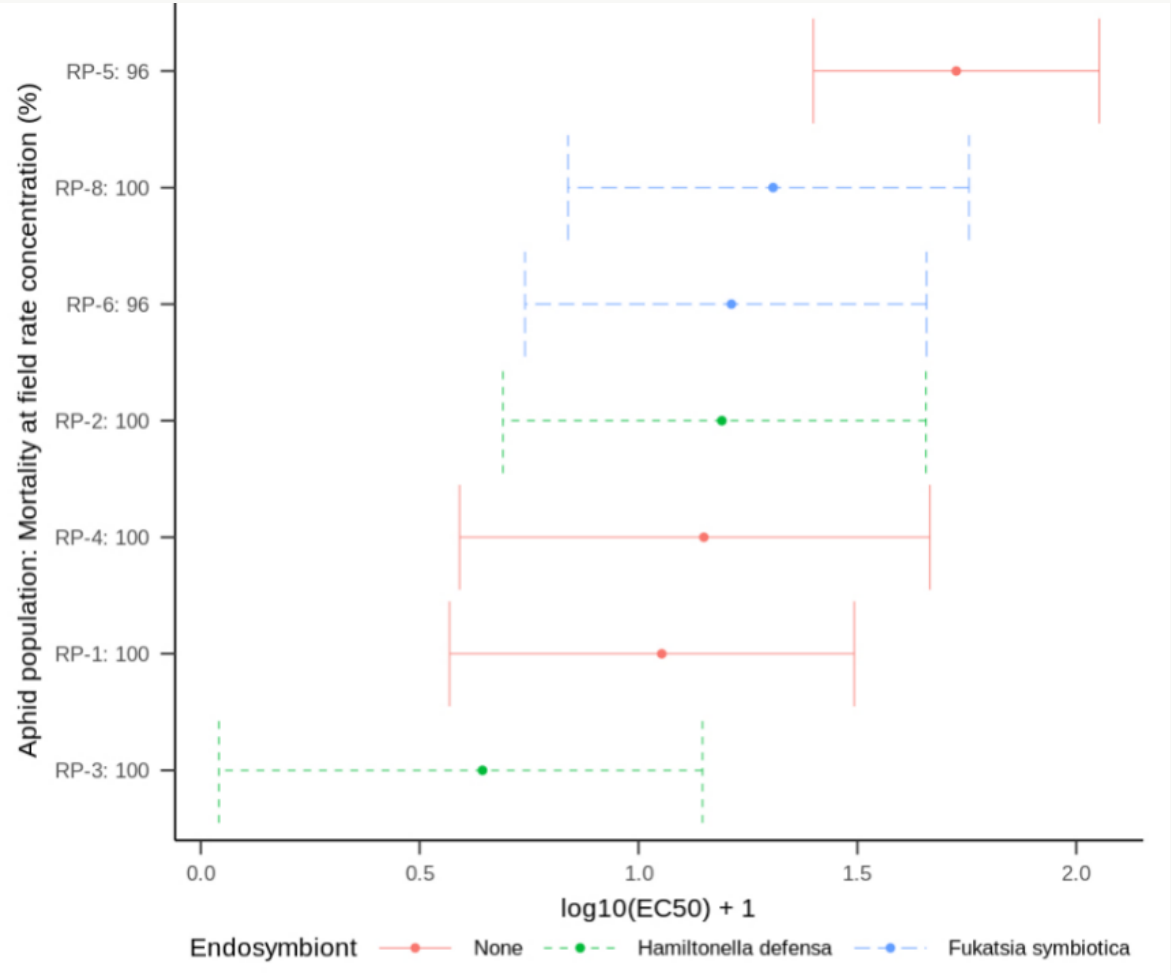
Rhopalosiphum padi

- Four populations (Dundee)
  - Two endosymbiont levels
    - No facultative endosymbiont
    - *Hamiltonella defensa*
- Eight populations (Hannover)
  - Three endosymbiont levels
    - No facultative endosymbiont
    - *Fukatsia symbiotica*
    - *Hamiltonella defensa*



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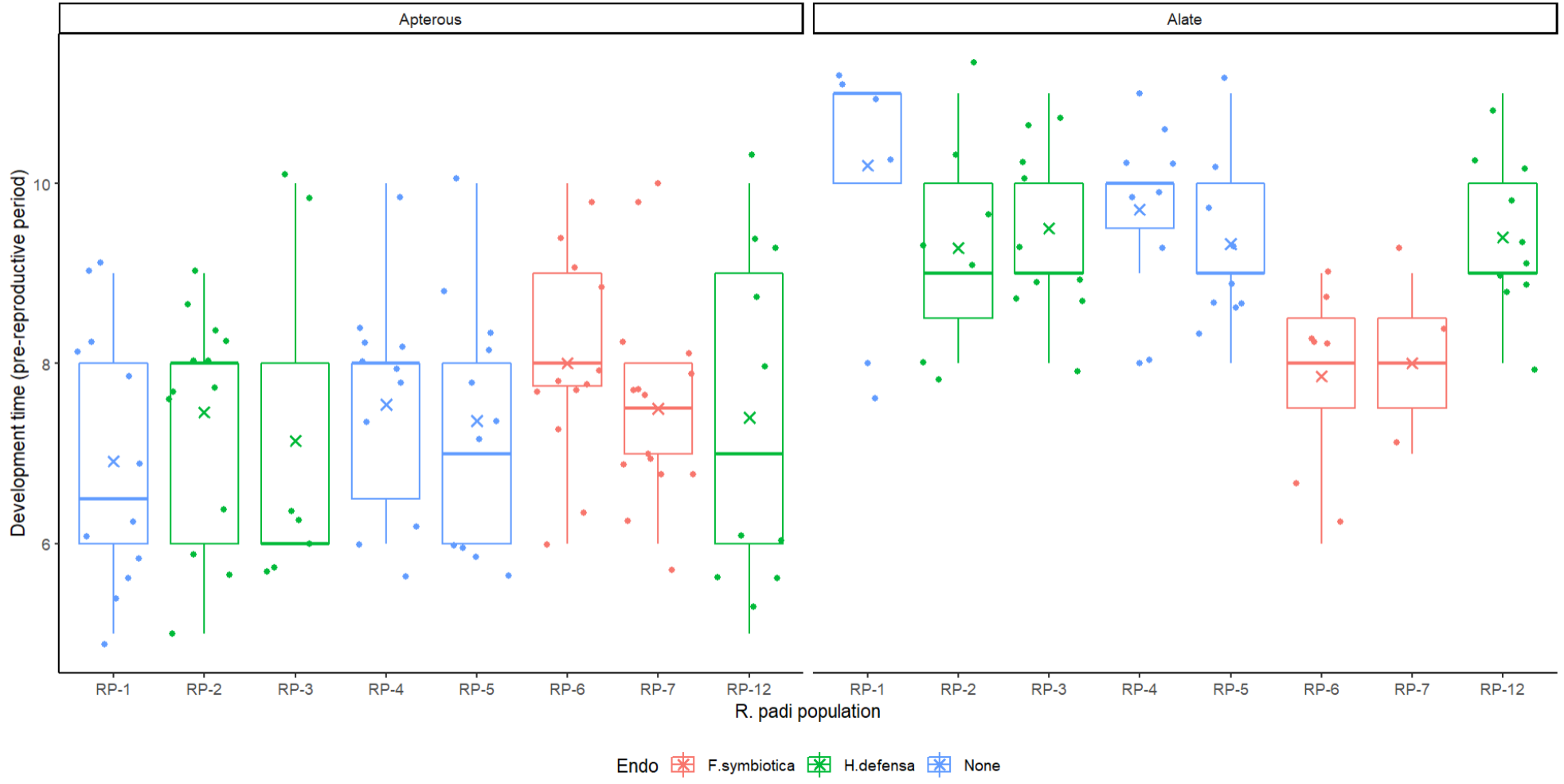
ANOVA (Endosymbiont): F = 0.65; p = 0.569

Leybourne et al., 2023*; Ag. For. Ento*

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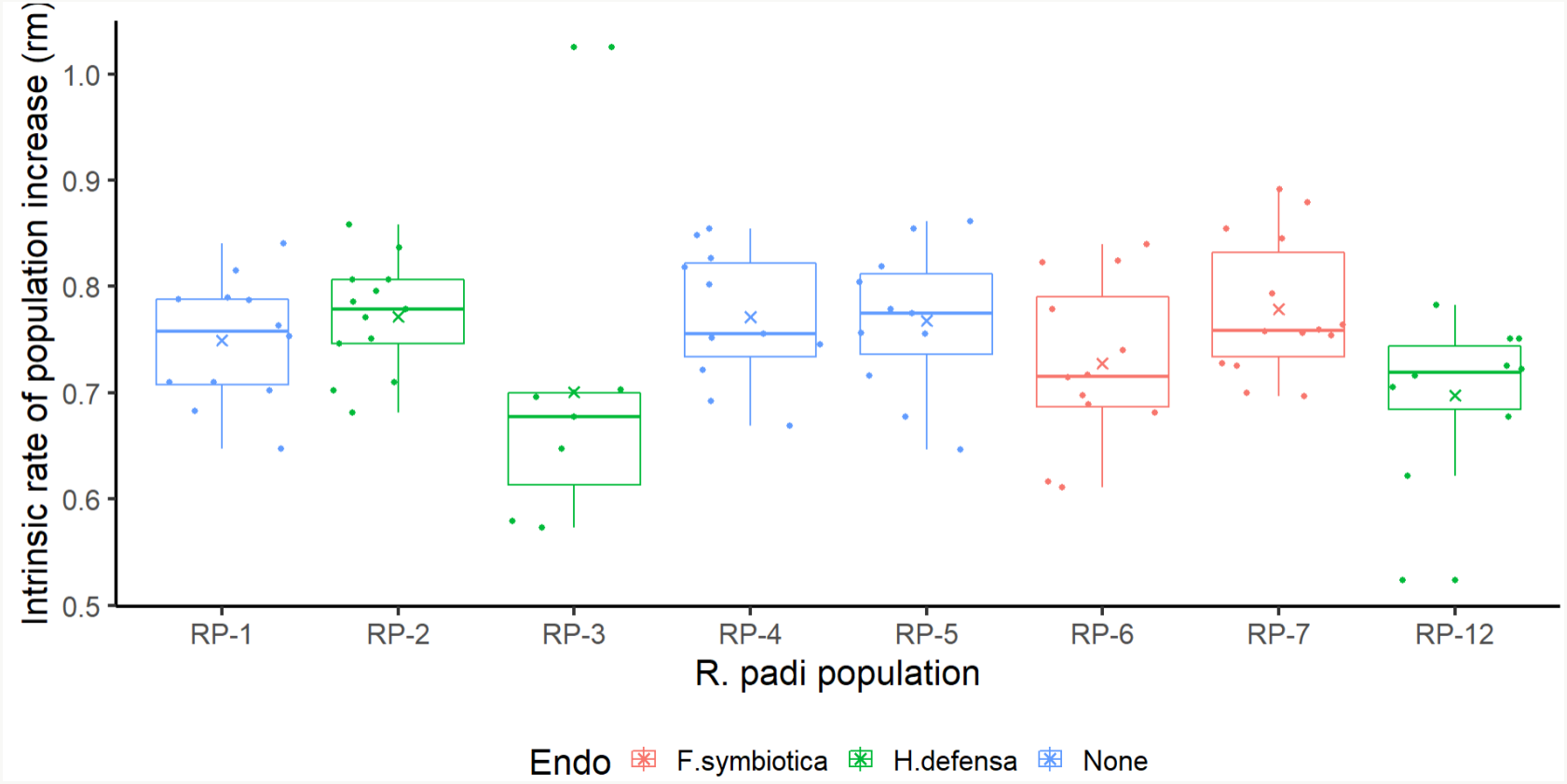
LMM (Population:Winged): $X^2 = 14.42$; $p = 0.044$

Leybourne et al., *In Prep*

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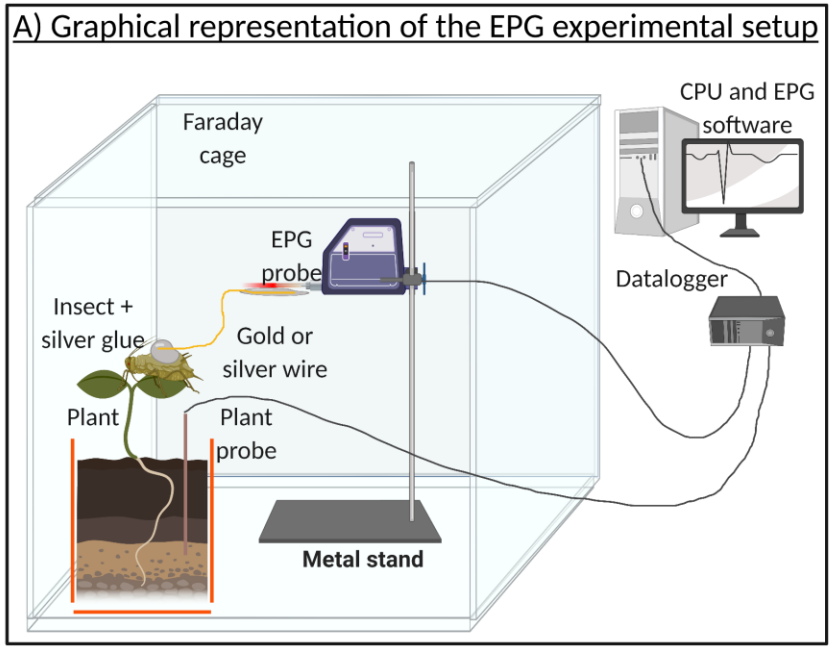


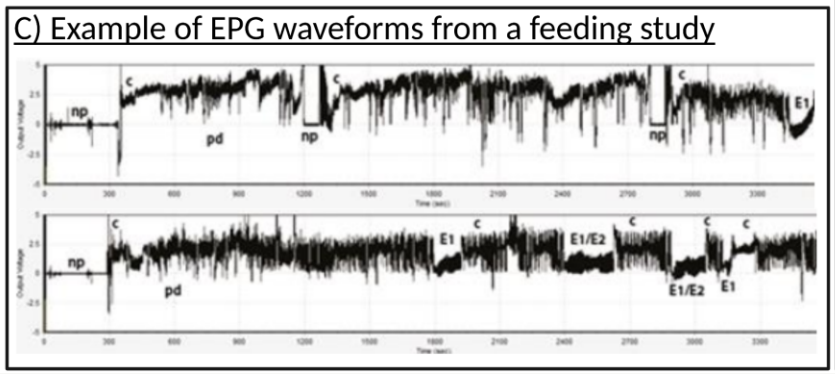
LMM (Population): $X^2 = 19.09$; $p = 0.008$

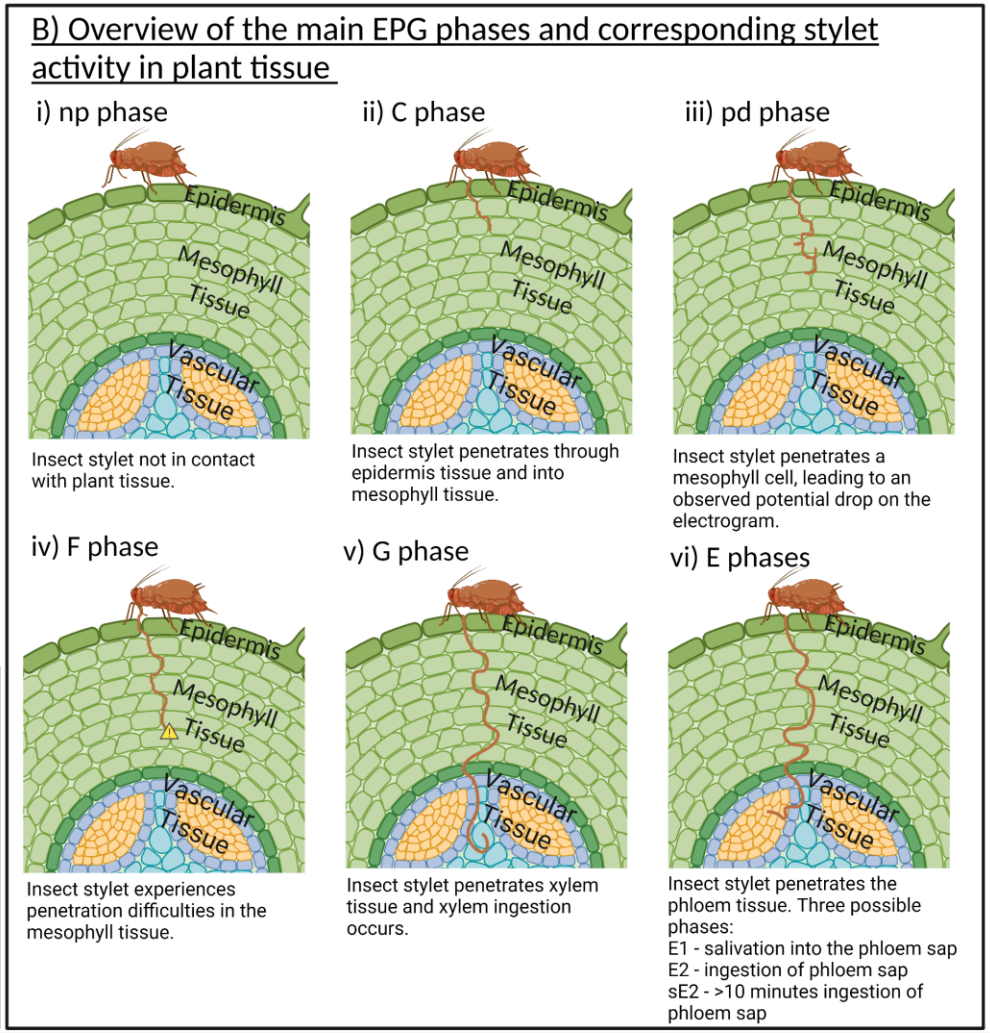
Leybourne et al., *In Prep*

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Leybourne & Aradottir, 2022, *Sci. Rep.*

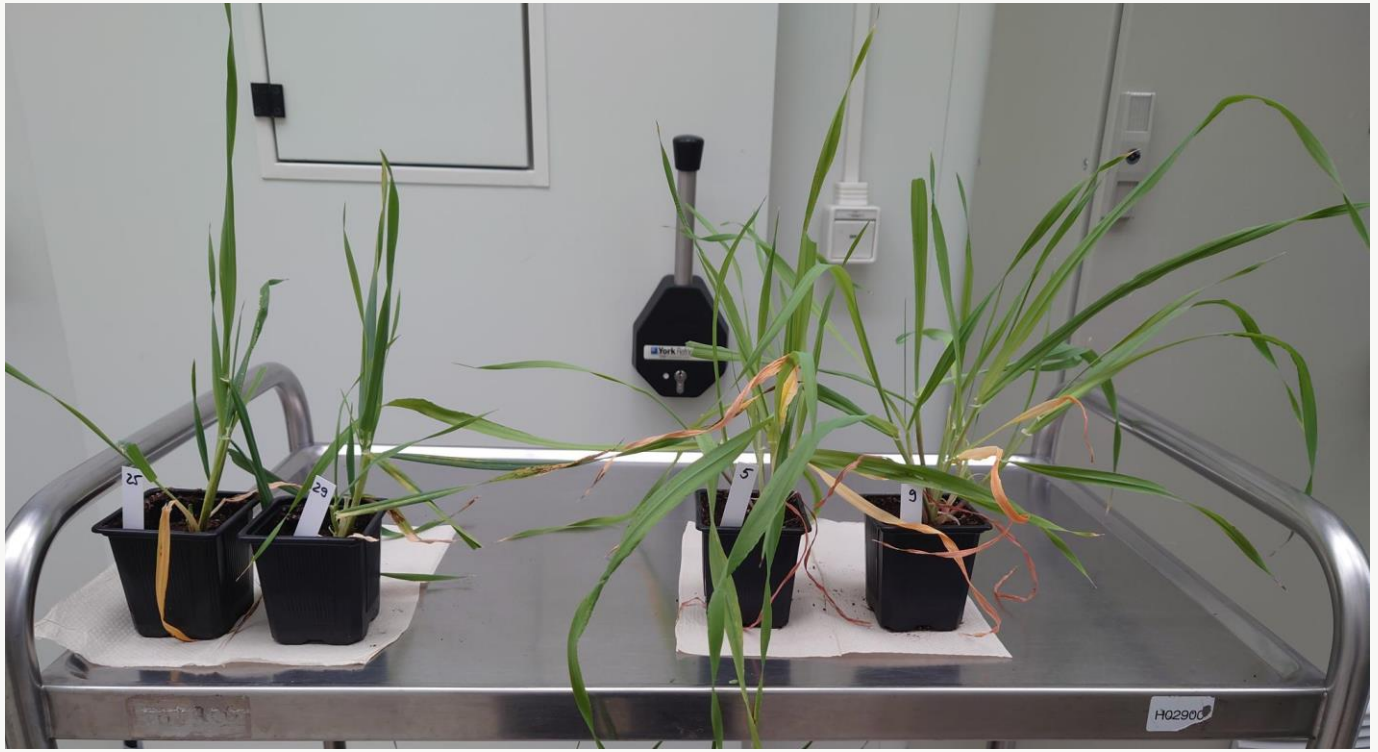
CAN ENDOSYMBIONTS INFLUENCE PHENOTYPE?

Hypothesis: Endosymbiont-infection modulates aphid virus transmission

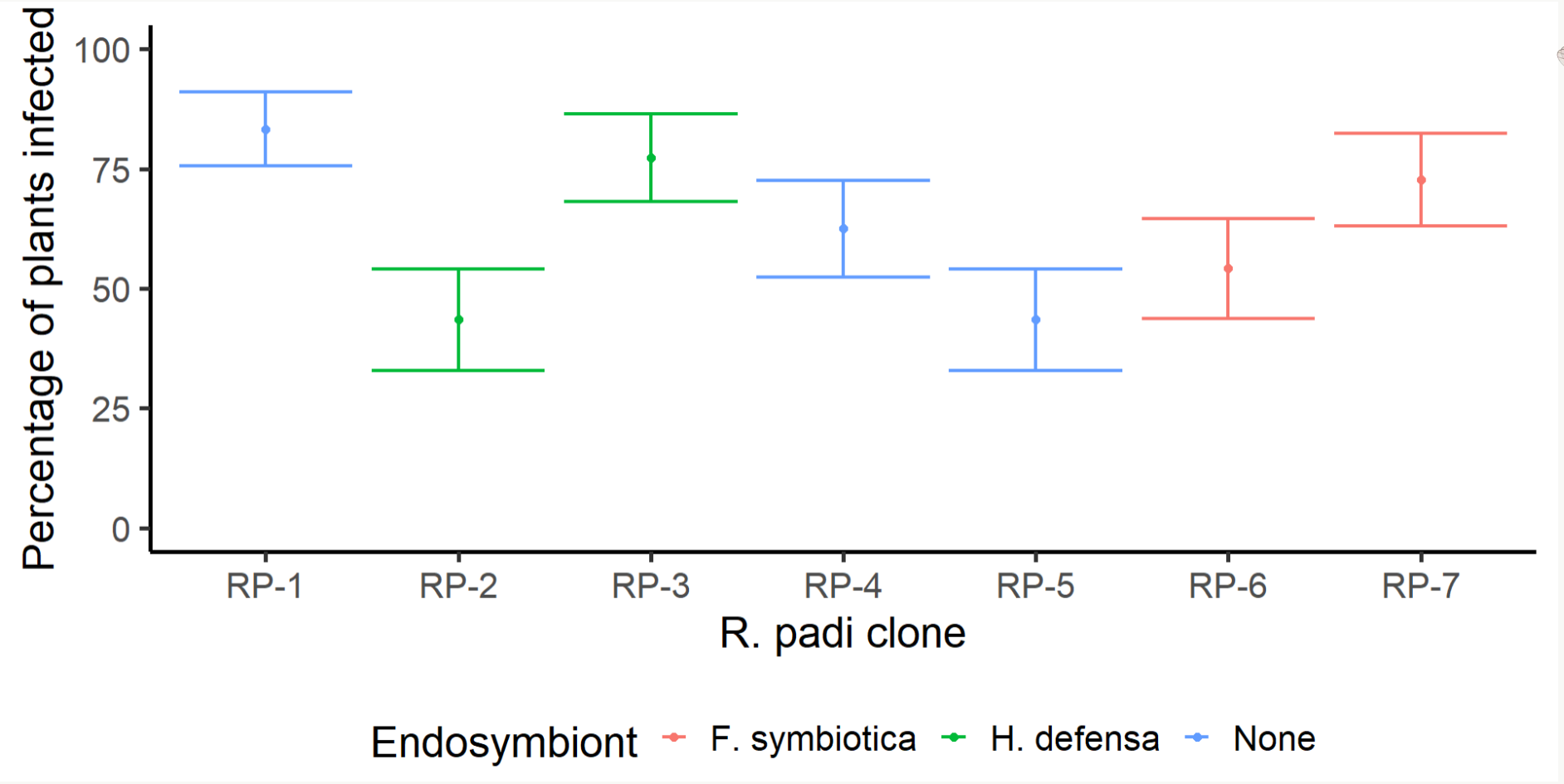
Multiple aphid populations $BYDV^{PAV}$-transmission assays

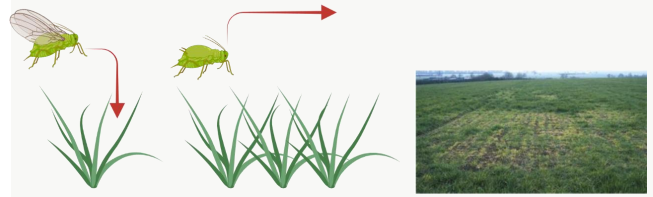
7 *R. padi*
- 3 x no secondary endosymbiont
- 2 x *F. symbiotica*
- 2 x *H. defensa*

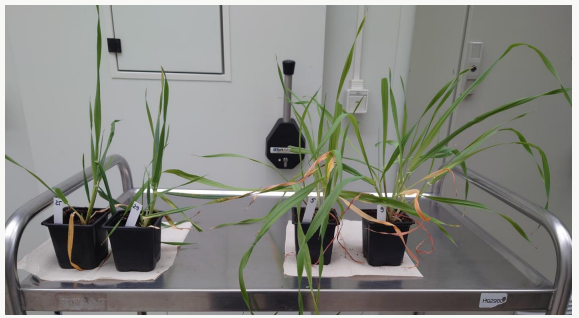
25 *S. avenae*
- 2 x no secondary endosymbiont
- 2 x *F. symbiotica*
- 18 x *R. insecticola*
- 3 x co-infected (*Fs* + *Ri*)



CAN ENDOSYMBIONTS INFLUENCE PHENOTYPE?



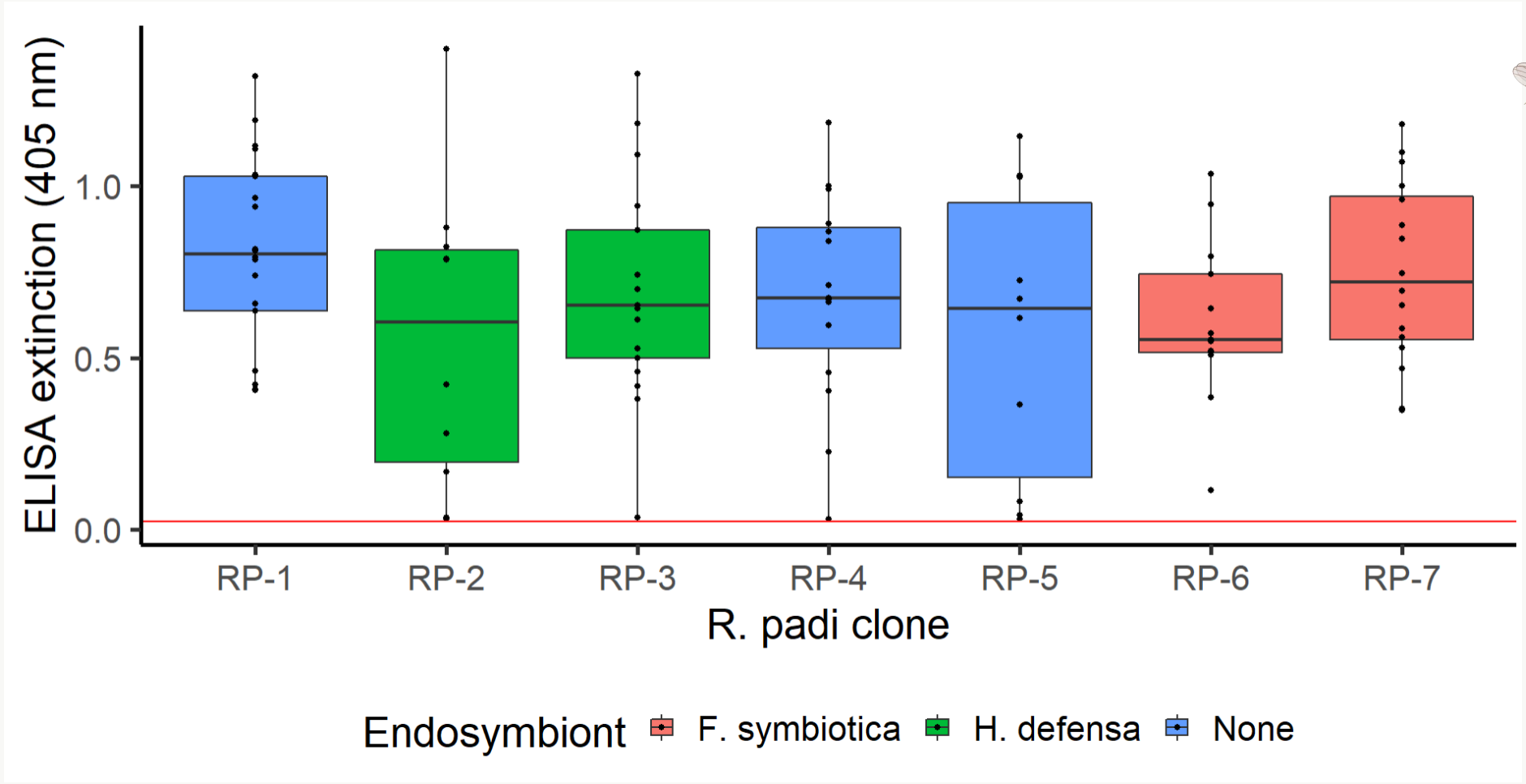


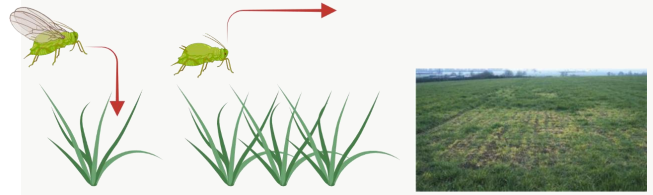


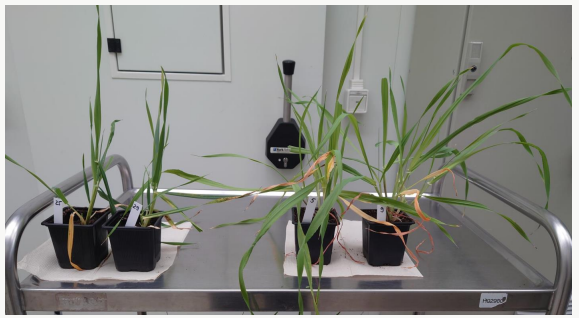


Binomial GLMM (Population): $X^2 = 15.46$; $p = 0.017$

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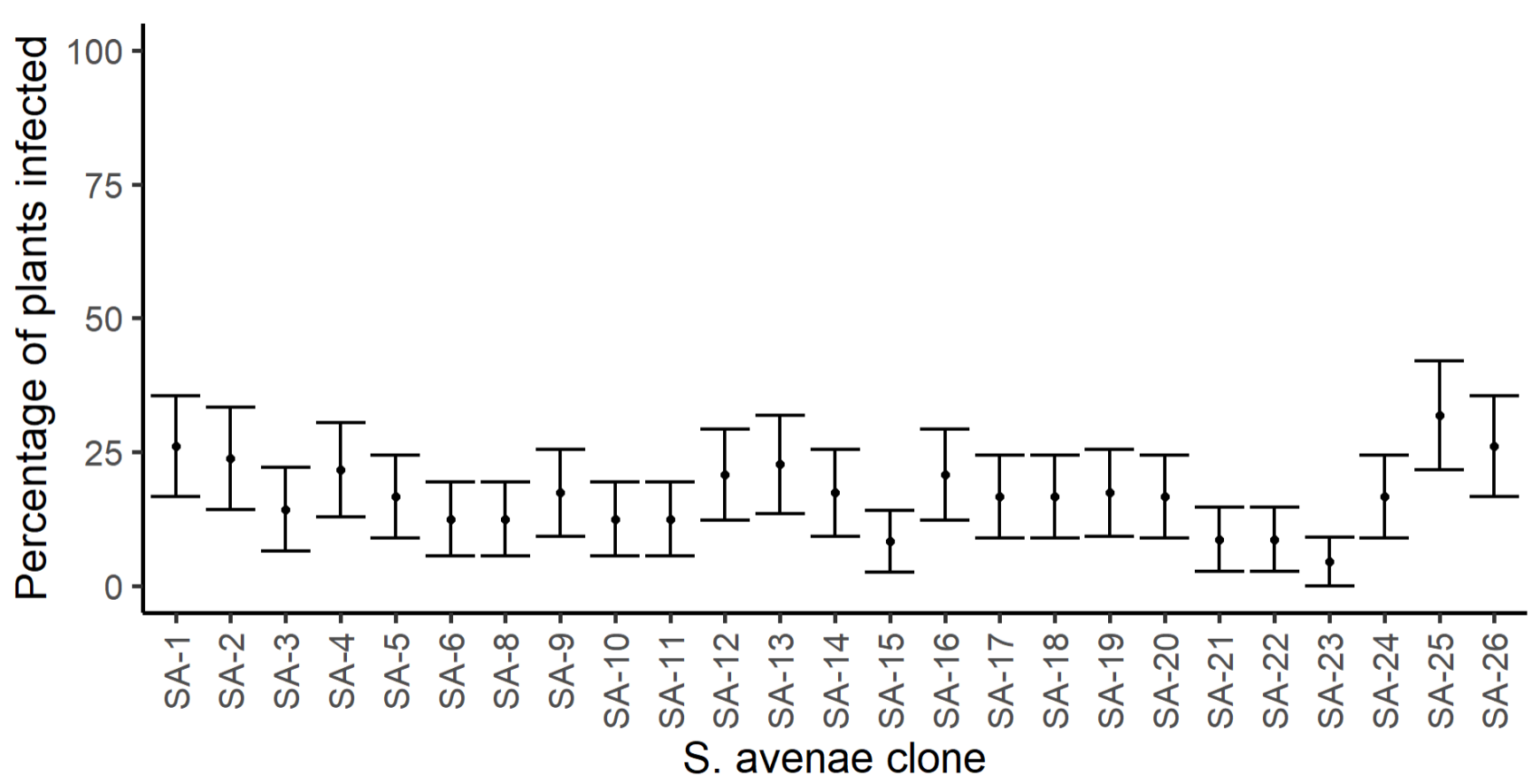


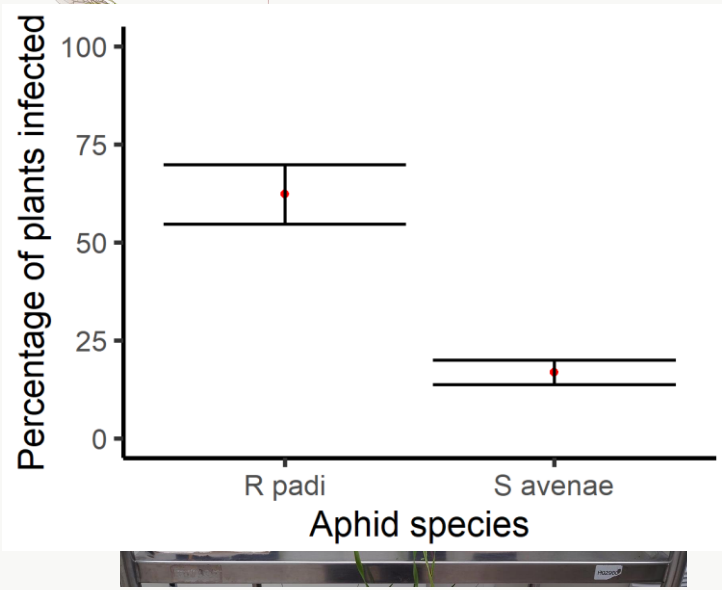




LMM (Population): $X^2 = 8.08$; $p = 0.232$

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SUMMARY

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Endosymbionts:

- Protect against parasitism (*H. defensa*)
- Reduce nymph growth on less suitable plants (*H. defensa)*
- Modulate development time (*F. symbiotica)*
- Modulate aphid feeding and probing behaviour (*H. defensa*)
- Do not affect insecticide susceptibility



Aphid clonal diversity:

- Differential reproductive success
- Wide variation in BYDV transmission (40-80%)







Opportunities:

- 12 month lab tech (June/July 2023) – advertisement “live” next week



Collaborators & project partners:

Dr Emily Martin (LUH)

Dr Sharon Zytynska (UoL)

Dr Torsten Will (JKI)

Petra Melloh (LUH)

Zoological Biodiversity Group (LUH)

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