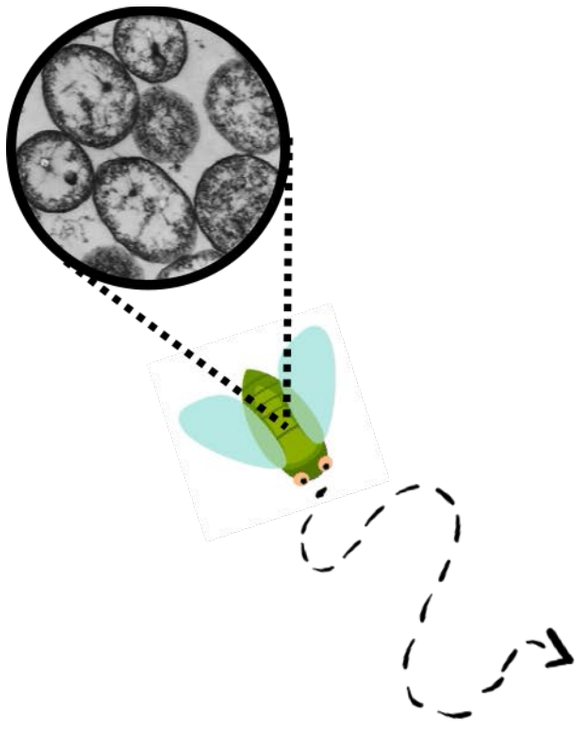
UNIVERSITY OF SASKATCHEWAN

Aster Yellows: effects of phytoplasmas on Aster leafhoppers´ development and preference

Berenice Romero, Tyler Wist, Chrystel Olivier & Sean Prager



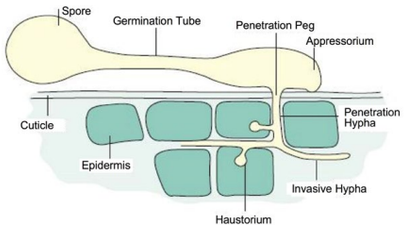
@saskbugs

@USaskEnt

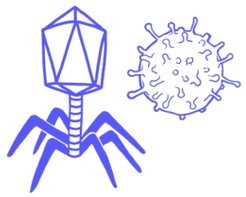




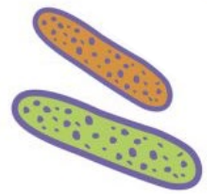

Phytoplasmas



Fungi



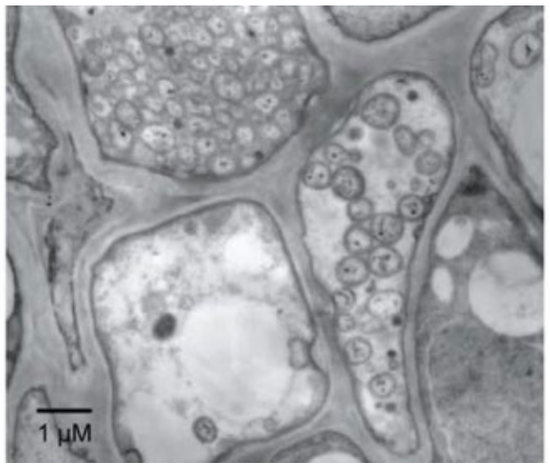
Viruses

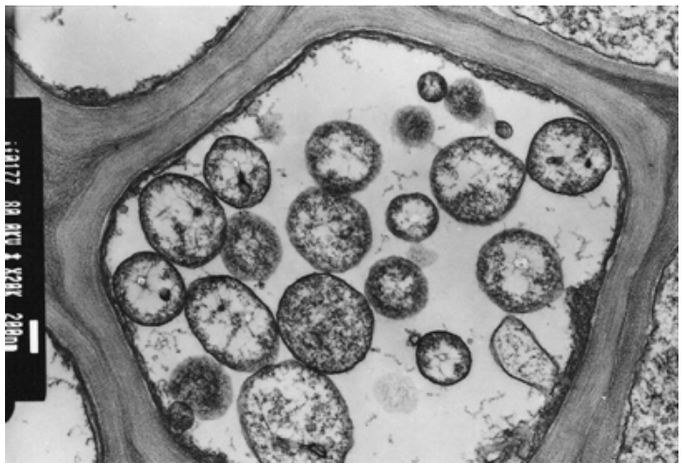


Bacteria

↳ Class Mollicutes

↳ Phytoplasmas





- ✓ Fastidious
- ✓ Cannot be cultured
- ✓ PCR detection

Bertaccini *et al*. 2019. Phytoplasmas : Plant Pathogenic Bacteria - II

Aster Yellows

- ✓ Phytoplasmas
- ✓ Outbreaks every 5-7 years
- ✓ Up to 90% of infection (Canola fields)
- ✓ Aster leafhoppers (*Macrosteles quadrilineatus* Forbes)
- ✓ Insect migration
- ✓ Pathogen reservoirs?

Hoy *et al*. 1999. *Annals of Entomological Society of America* 92, 523–528
Saskatchewan Ministry of Agriculture. 2012. Aster Yellows. Factsheet.
Bertaccini *et al*. 2019. Phytoplasmas : Plant Pathogenic Bacteria - II

Objectives & Research questions

✓ Conduct two-choice assays with selected host plants

✓ Conduct development assay of Aster leafhoppers on different host plants

Materials

Plant species

Canola
AC Excel

- Wheat

AAC Brandon

- Barley

CDC Copeland

- Oat

CS Camden

Dandelion
(*Taraxacum officinale*)

Marigolds
(*Tagetes* spp.)

Fleabane
(*Erigeron annuus*)

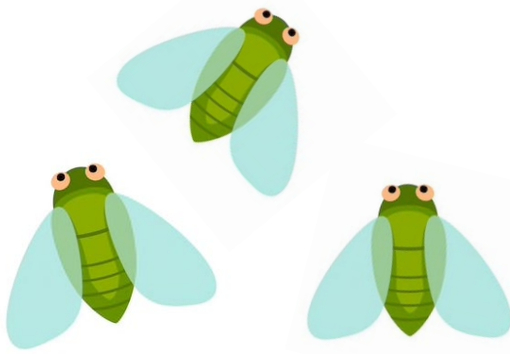
Spiny annual sow thistle
(*Sonchus asper*)

\+

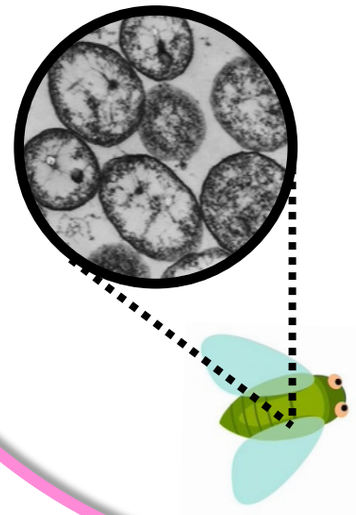
Arabidopsis thaliana

Insects

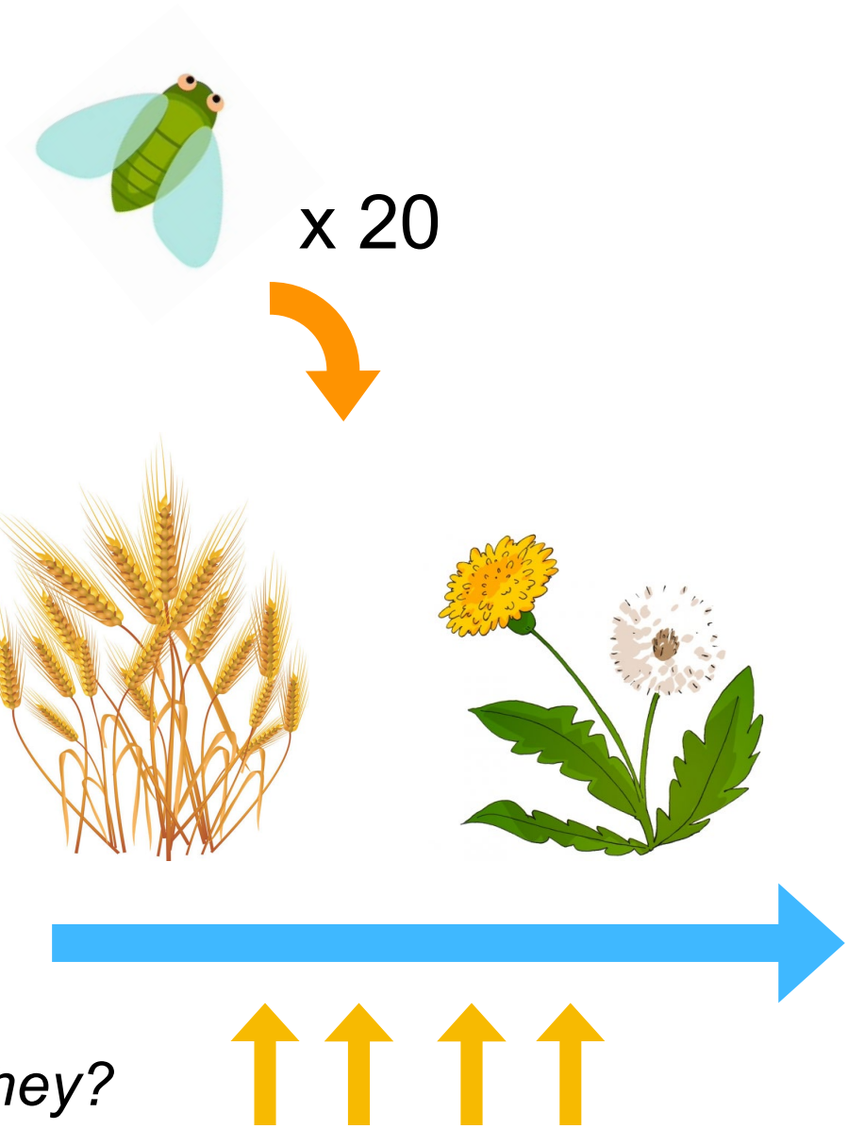
AY-uninfected



AY-infected

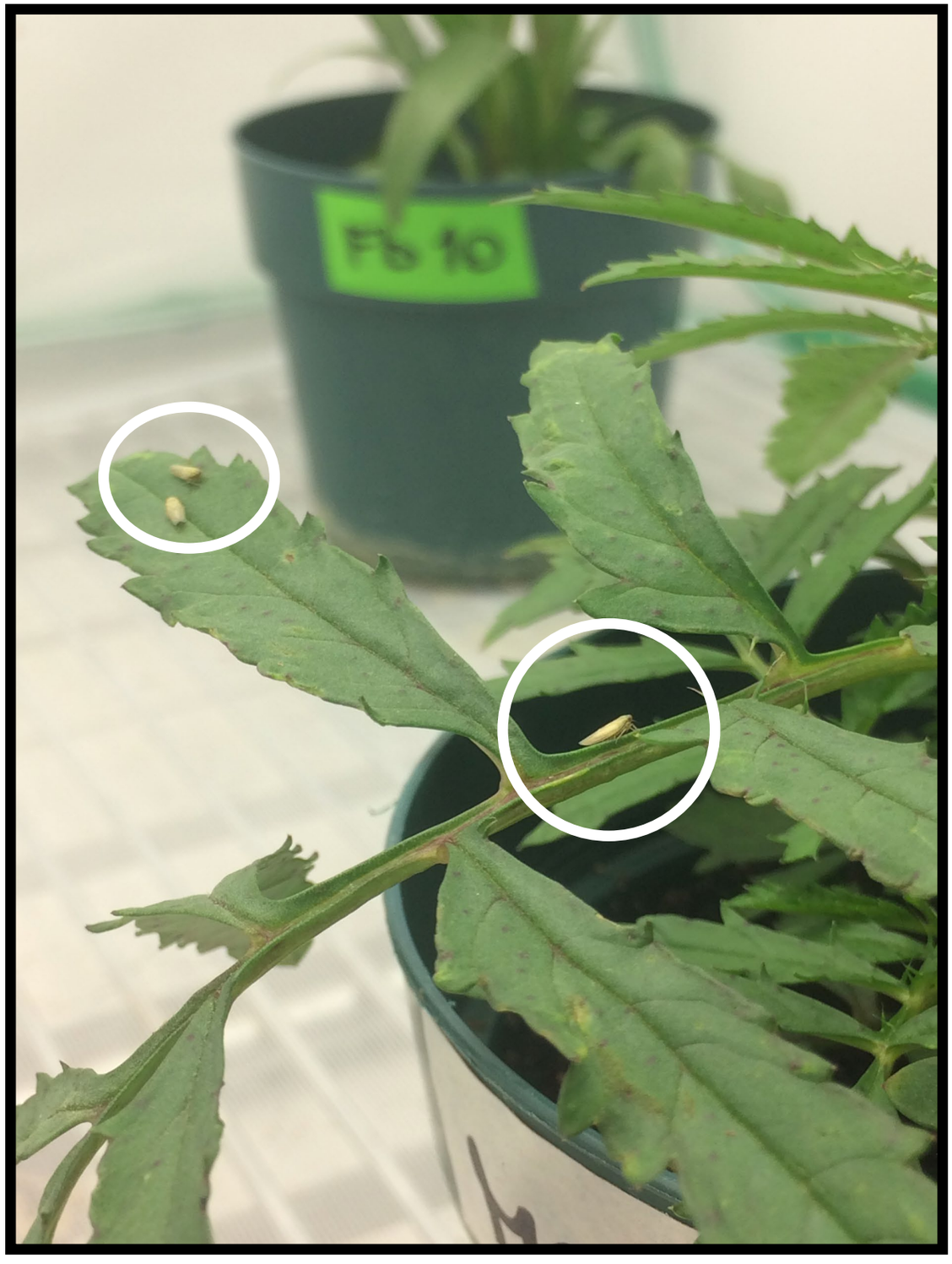


Two-choice assays



Permutated MANOVA

Two-choice assays



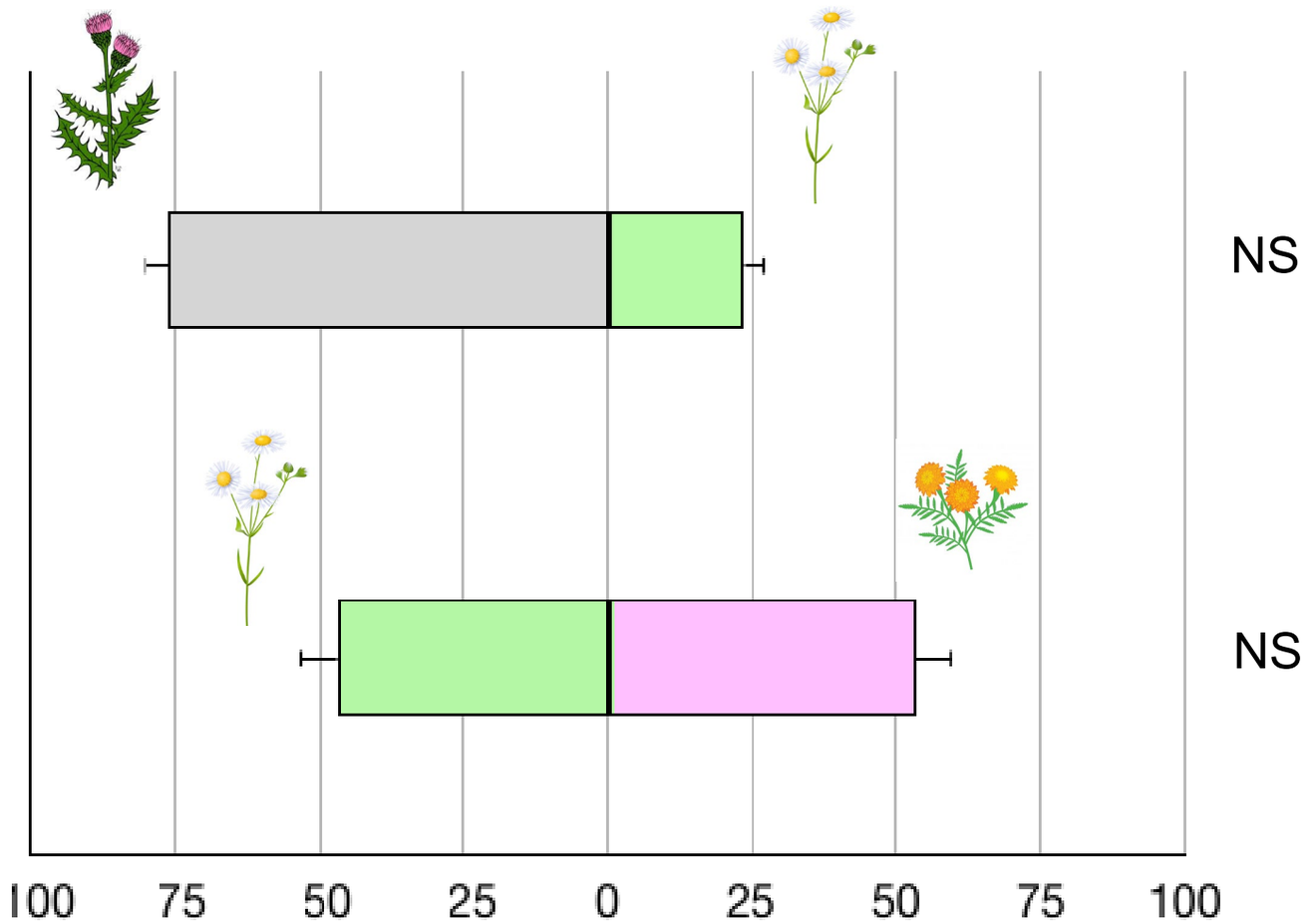
Two-choice assays

i) Weed vs. weed

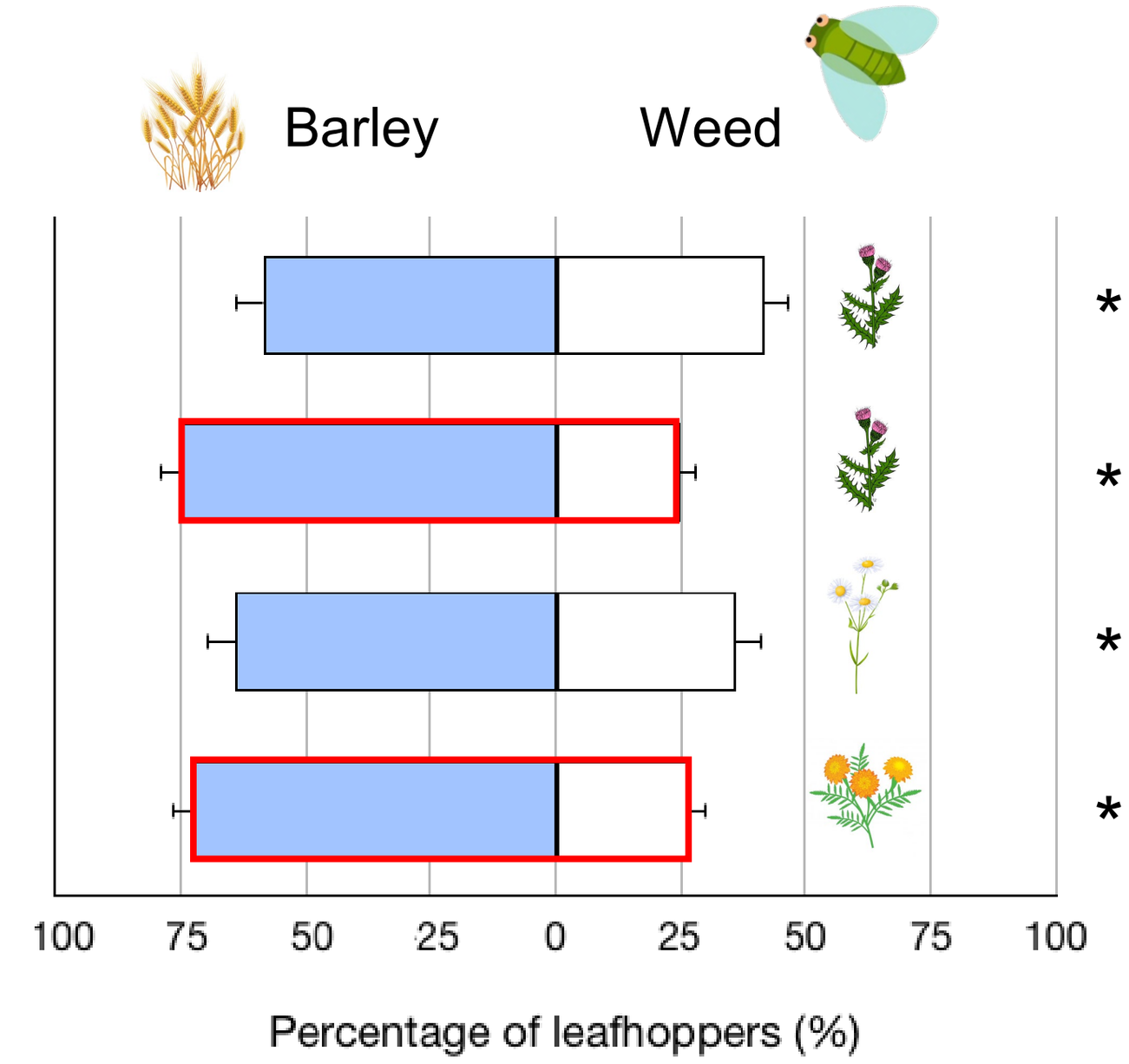
ii) Crop vs. weed

iii) Crop vs. crop

Two-choice assays: i) Weed vs. weed

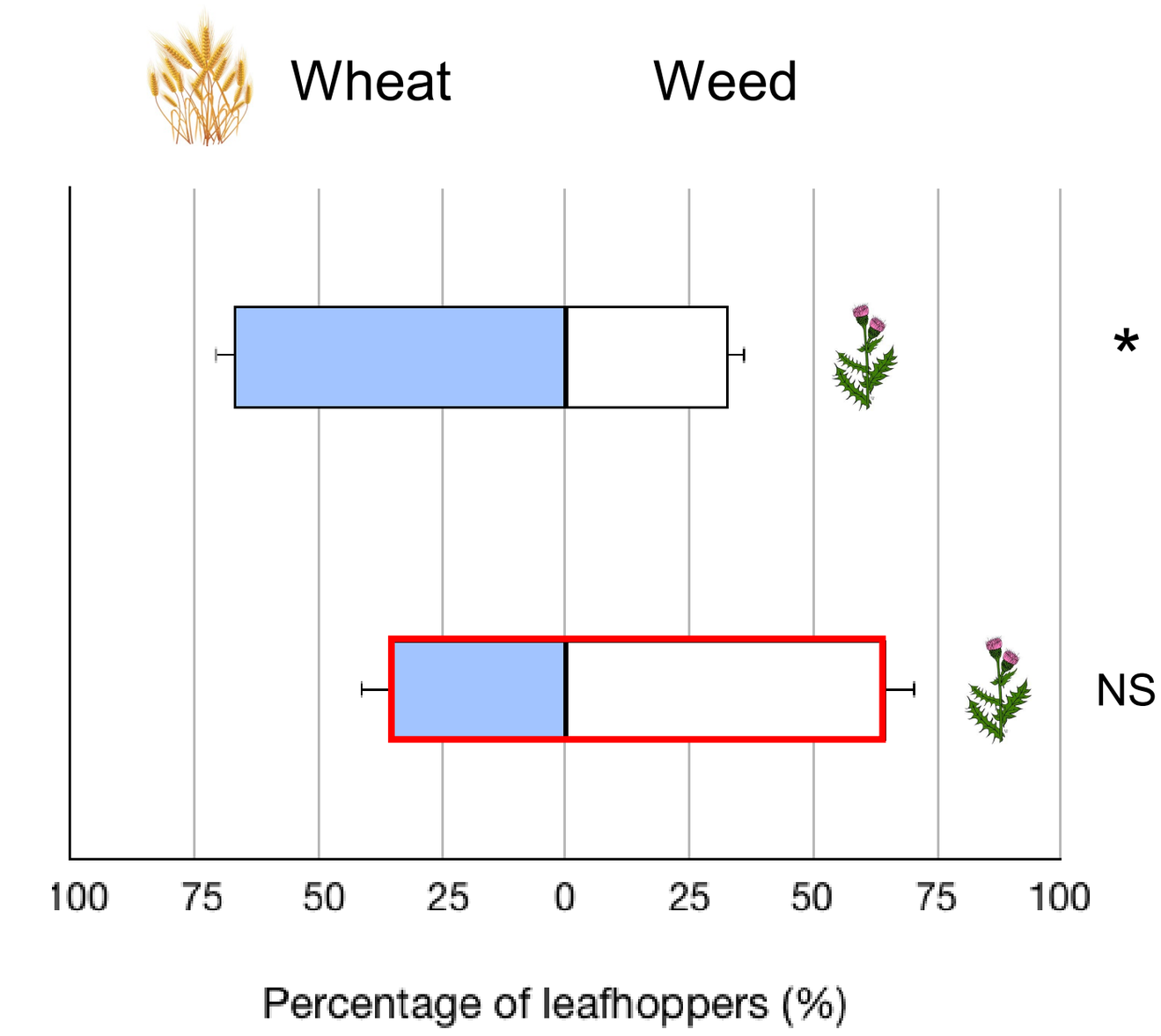


Two-choice assays: ii) Crop vs. weed



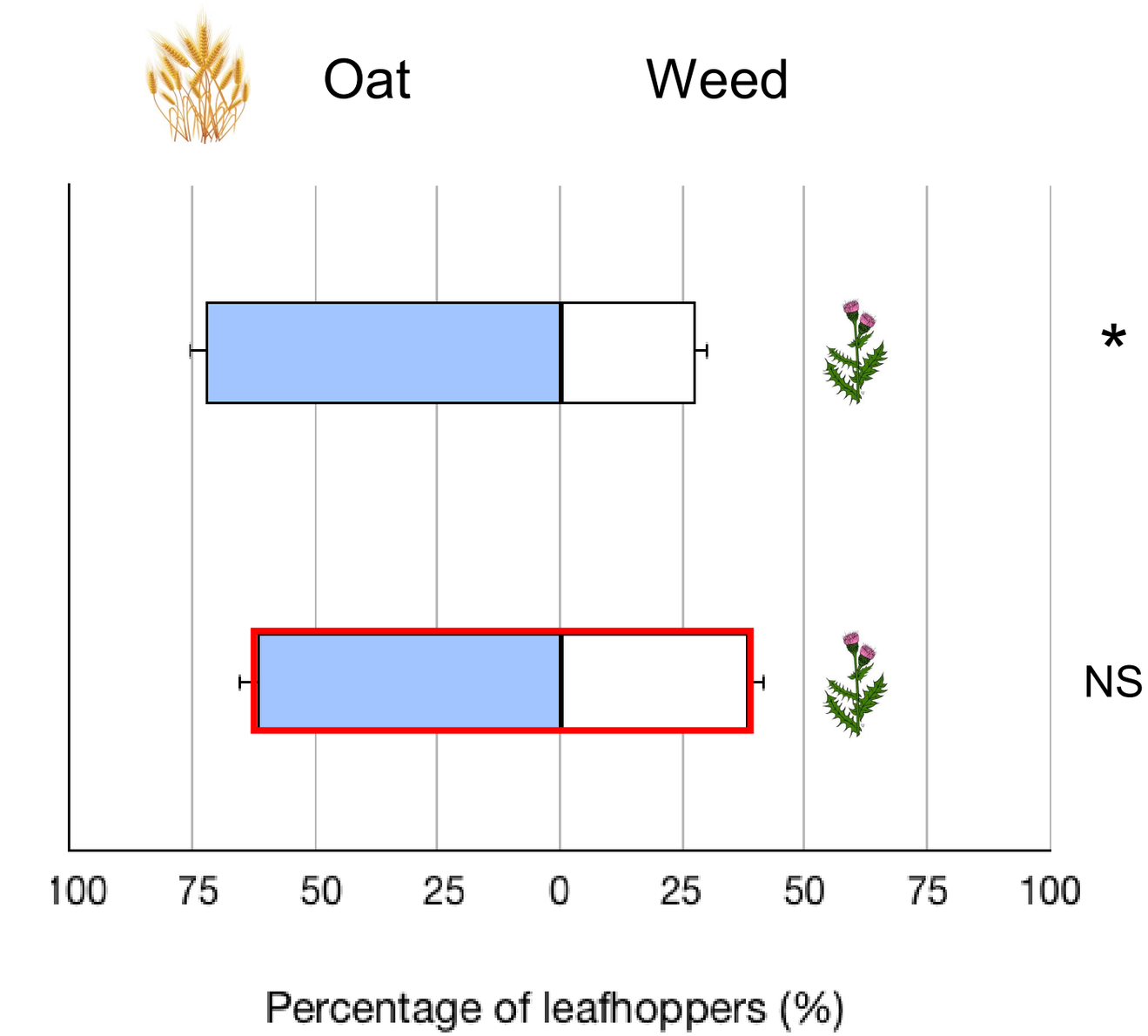
Infected leafhoppers

Two-choice assays: ii) Crop vs. weed

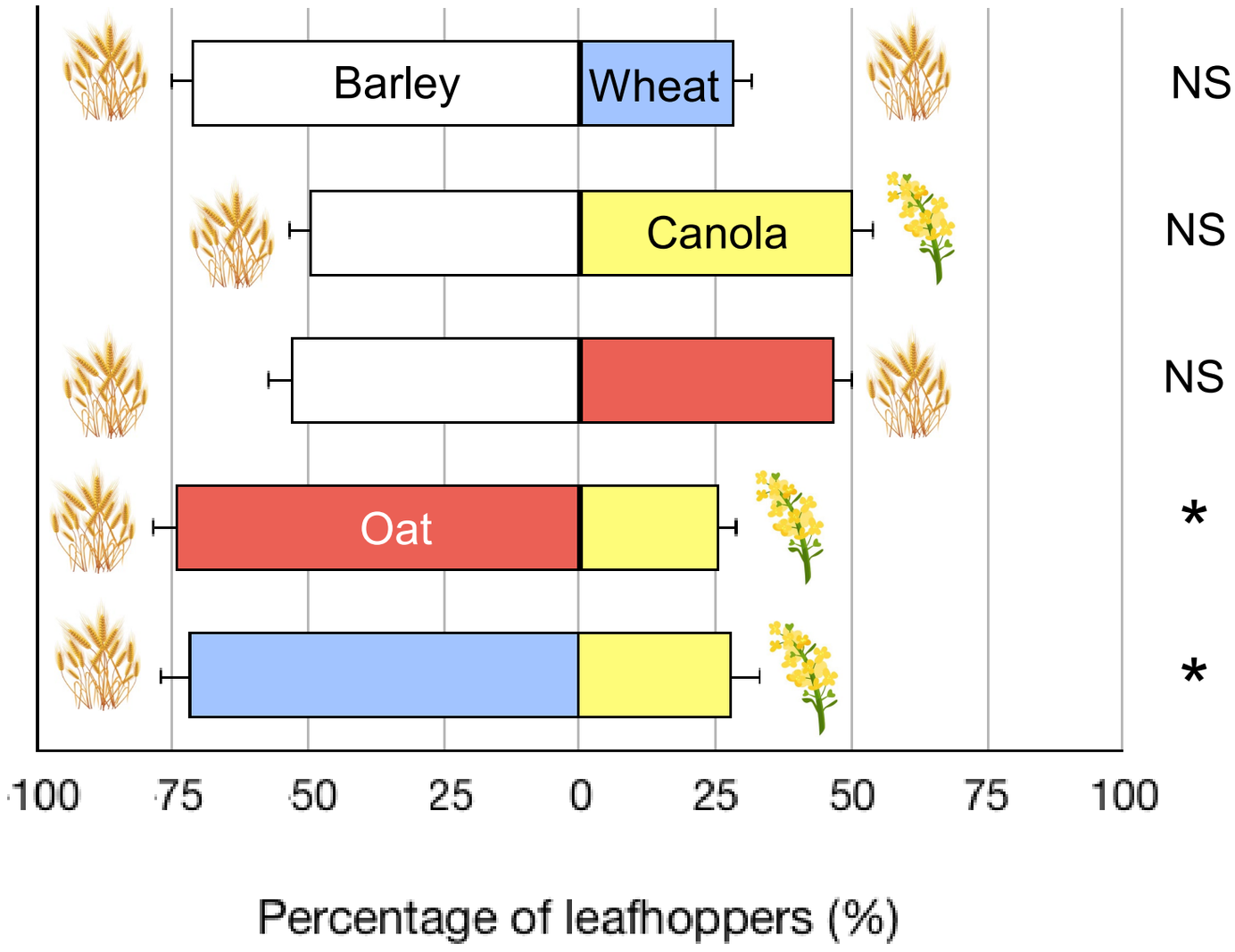


Infected leafhoppers

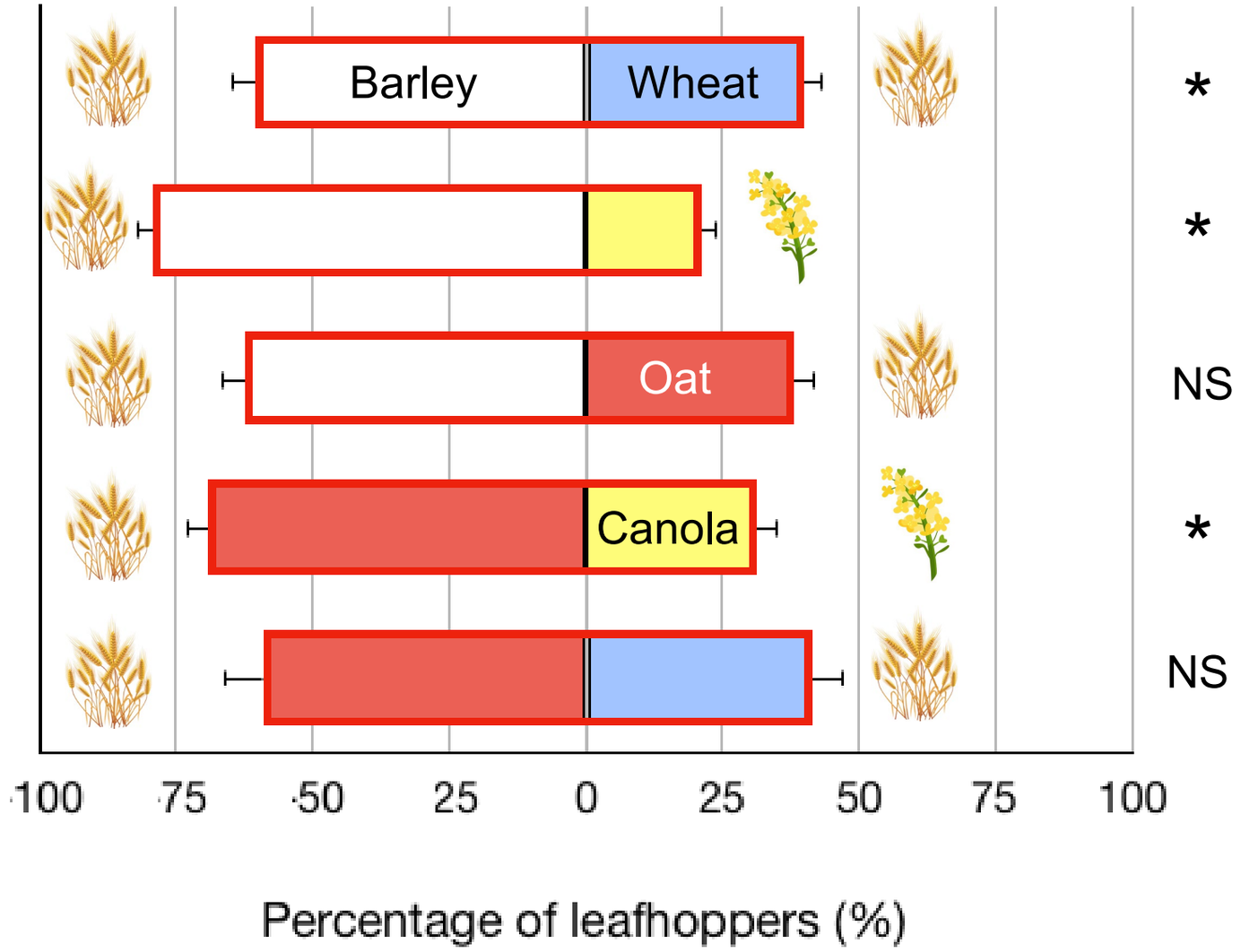
Two-choice assays: ii) Crop vs. weed



Two-choice assays: iii) Crop vs. crop



Two-choice assays: iii) Crop vs. crop

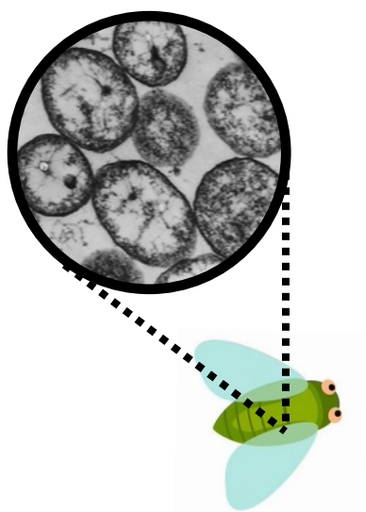


Infected leafhoppers

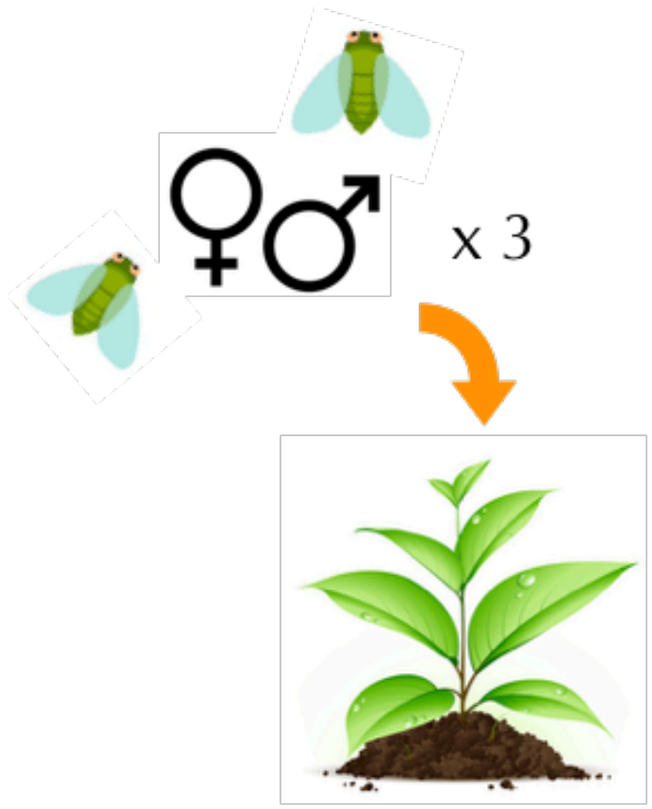
Two-choice assays: preliminary conclusions

In some cases

≠



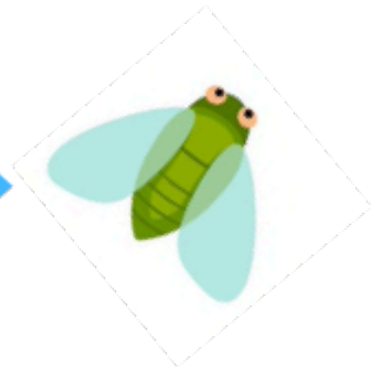
Development assays on different host plants



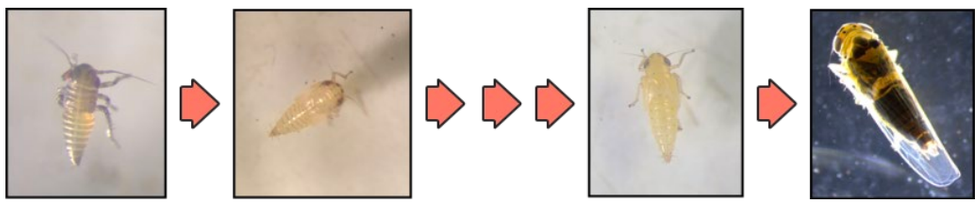
x 3

Adults removed

One week



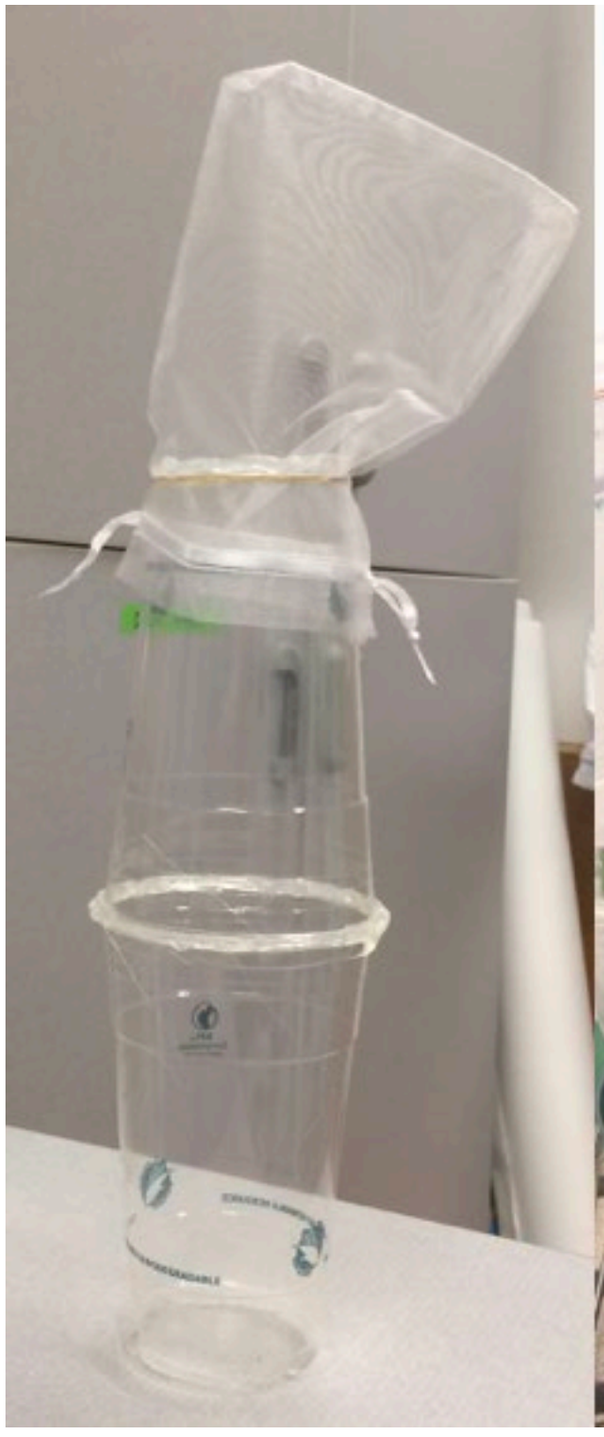
# of nymphal instars



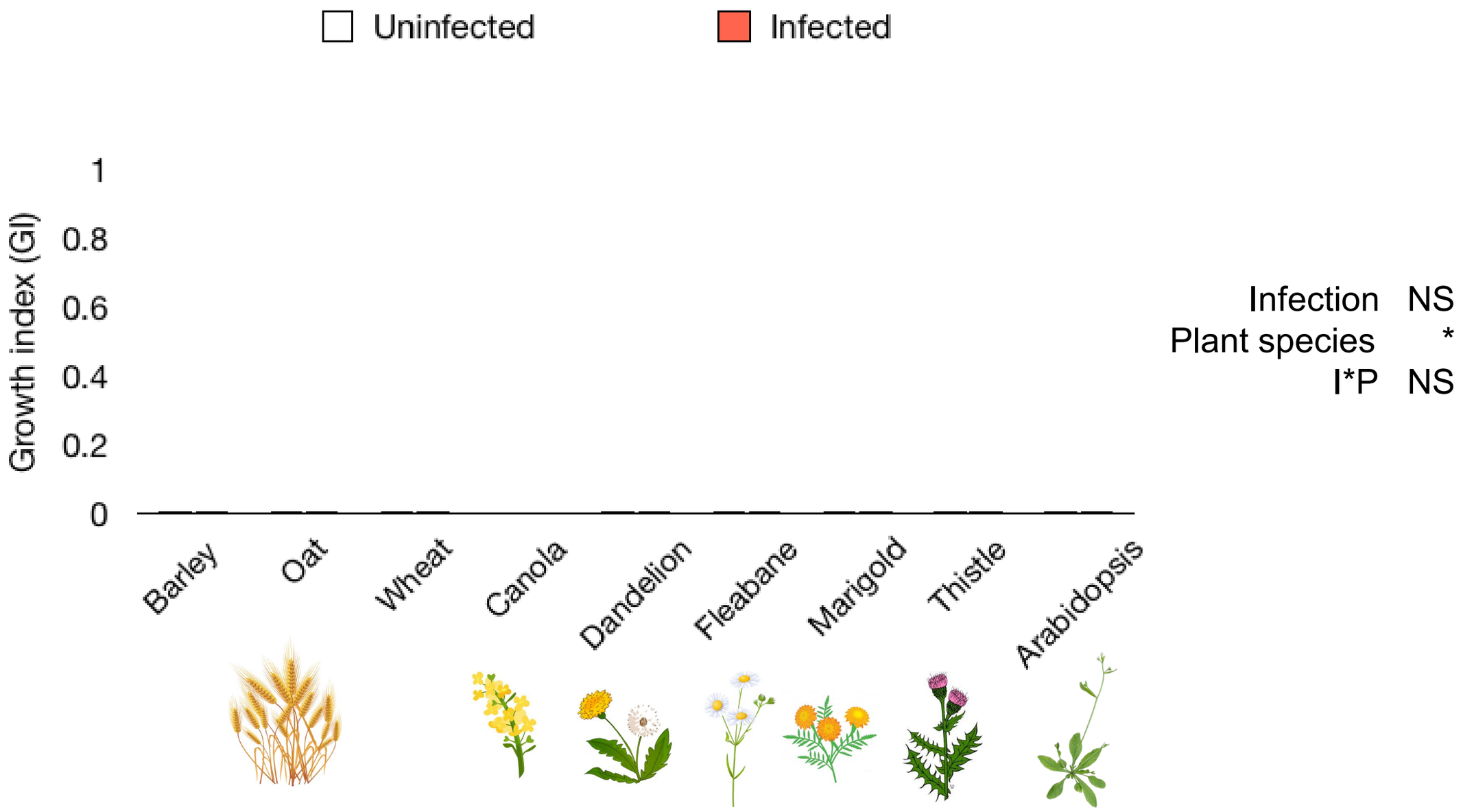
Growth index (GI)

Similar development?

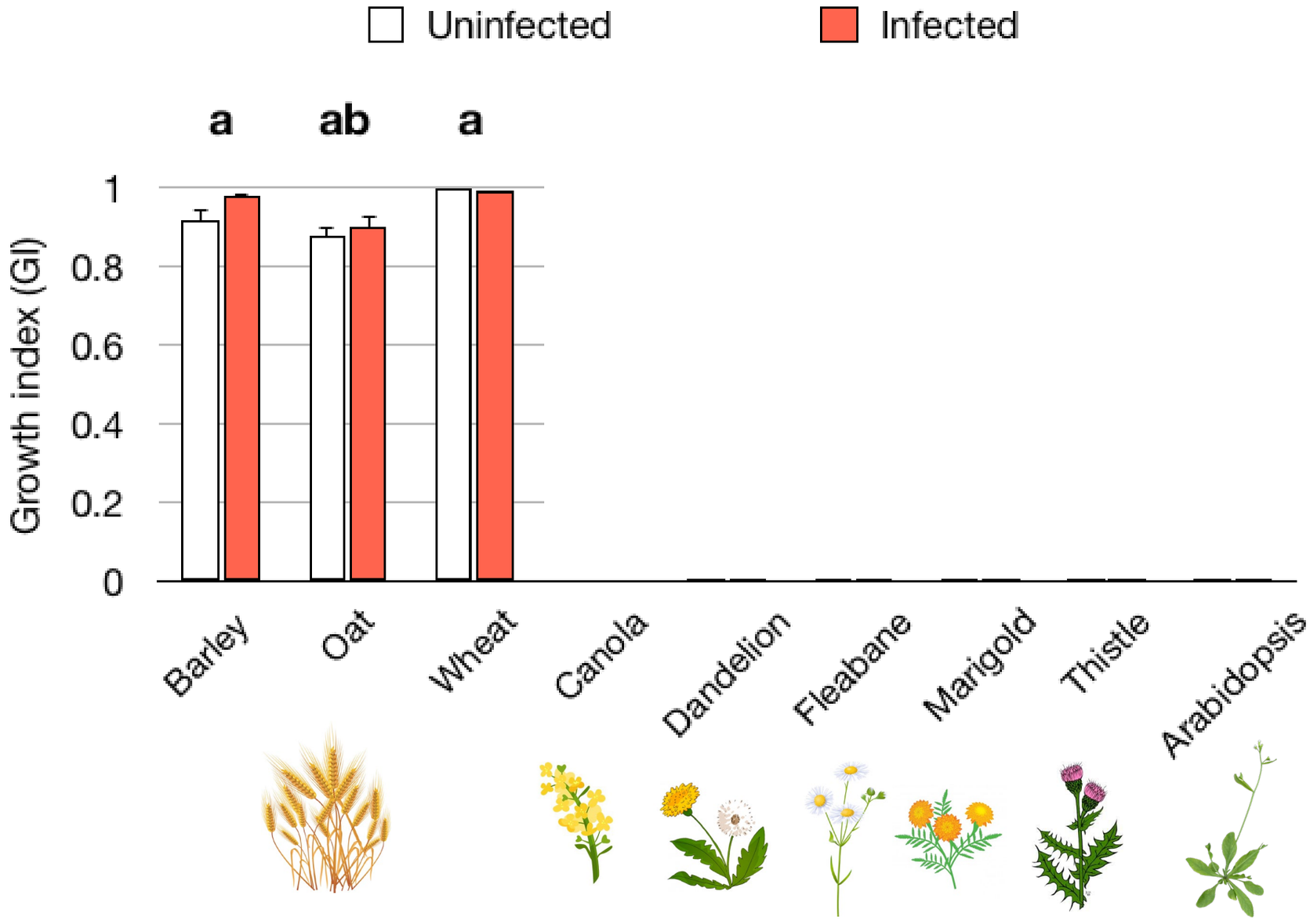
Development assays on different host plants



Development assays on different host plants: Growth Index (GI)

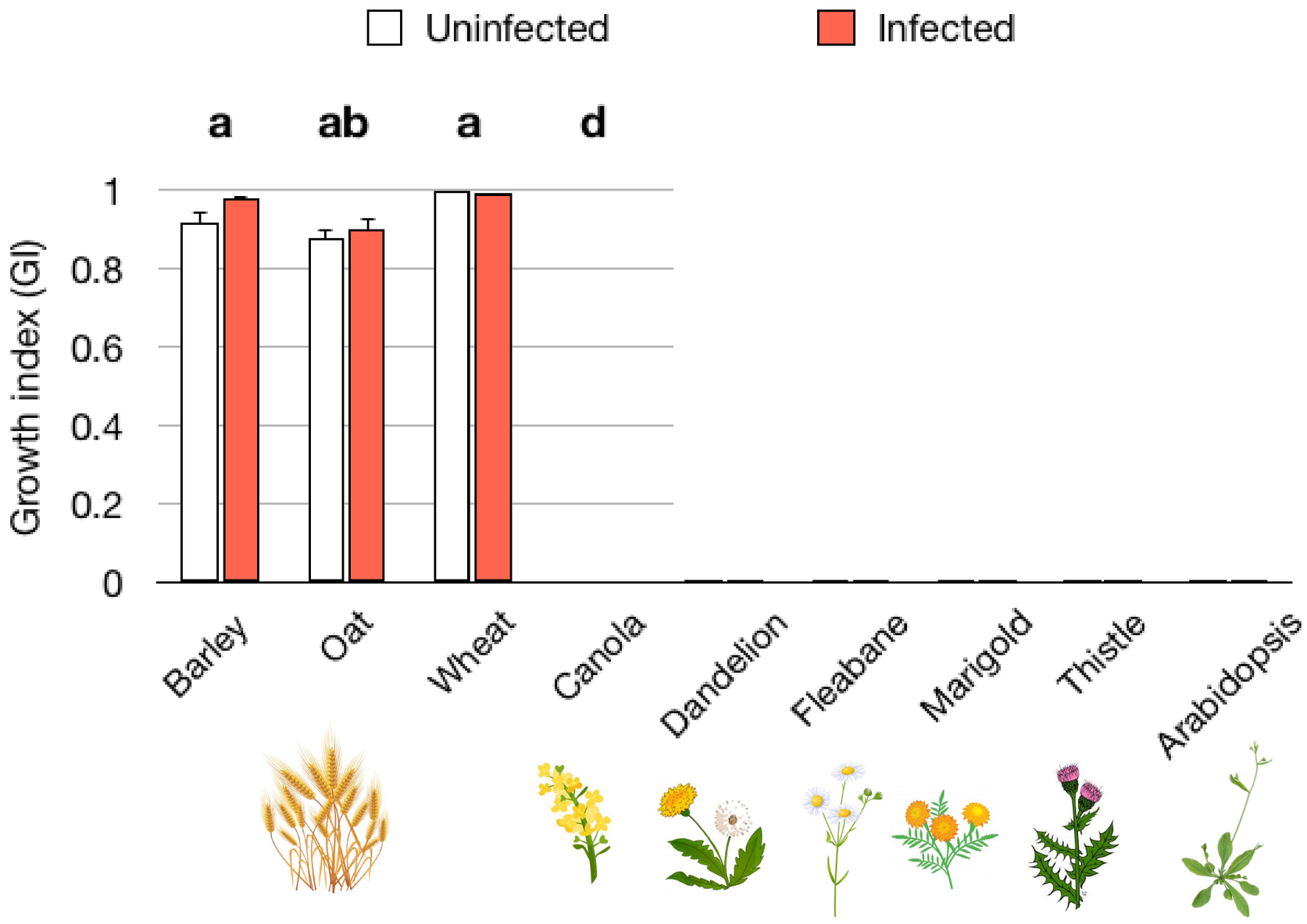


Development assays : Growth Index (GI)



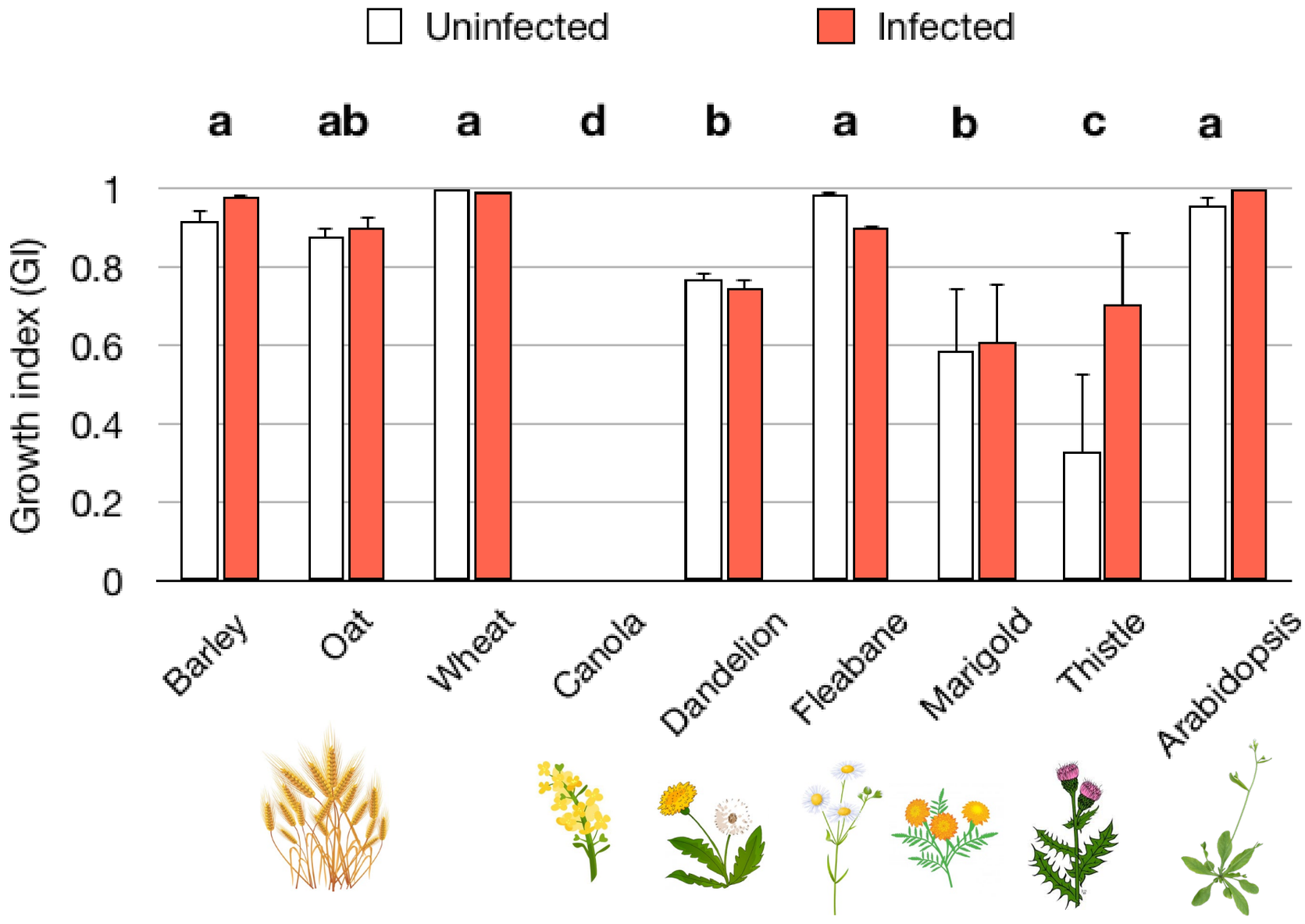
Infection	NS
Plant species	*
I*P	NS

Development assays : Growth Index (GI)



Infection	NS
Plant species	*
I*P	NS

Development assays : Growth Index (GI)



Infection	NS
Plant species	*
I*P	NS

Summary

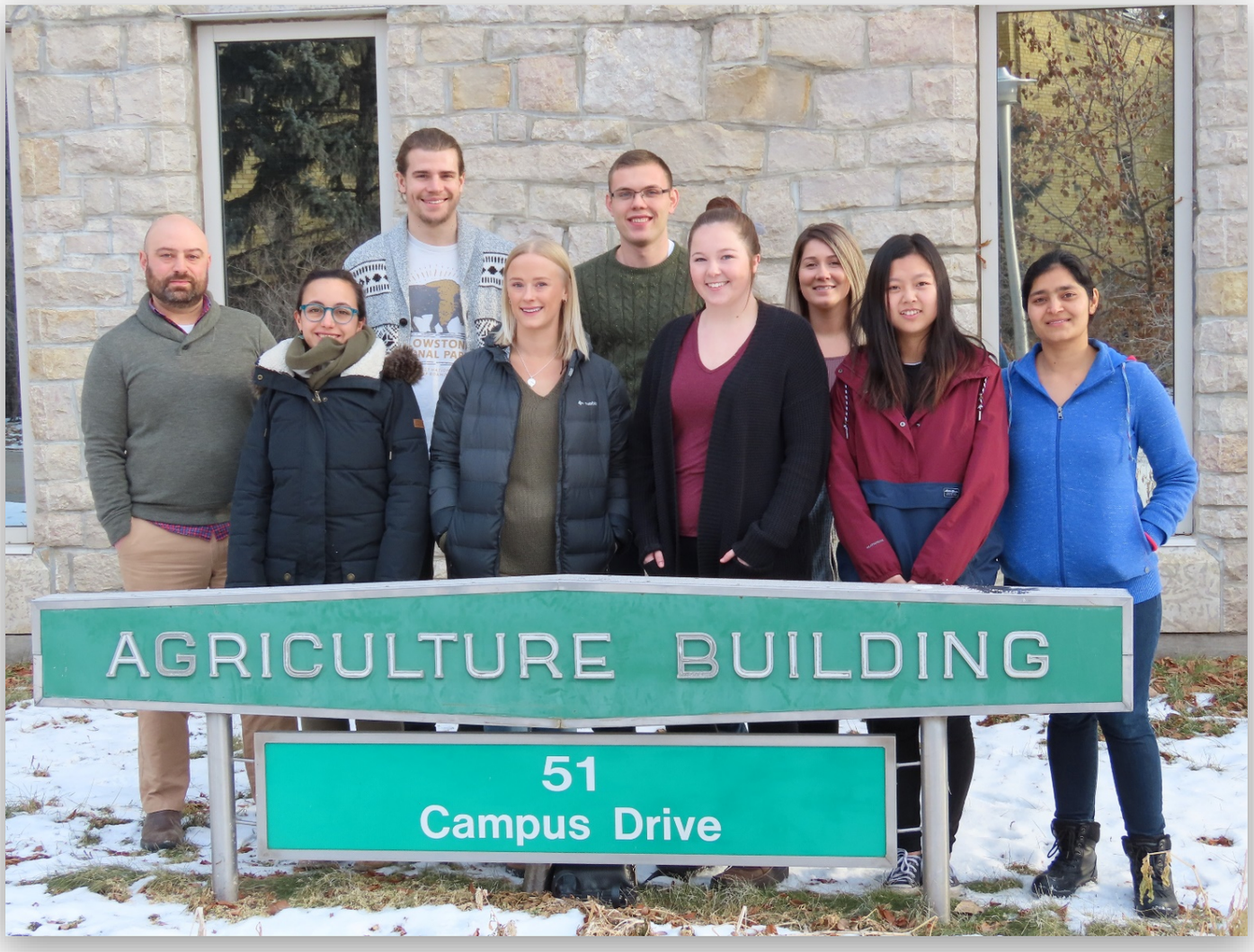
- Aster leafhoppers prefer crops over weeds
- In some cases, infection with phytoplasmas can affect such preference
- Aster leafhoppers´ development differs among plant species
- No effect of phytoplasma infection on leafhoppers´ development

Preliminary recommendations

1. Weed removal is crucial in barley, oat, and wheat fields early in the season
2. Weed management in canola fields is complicated respecting leafhoppers
3. Scouting cereal fields is important as these plants are preferred and are suitable hosts for Aster leafhoppers to reproduce

@saskbugs

@USaskEnt



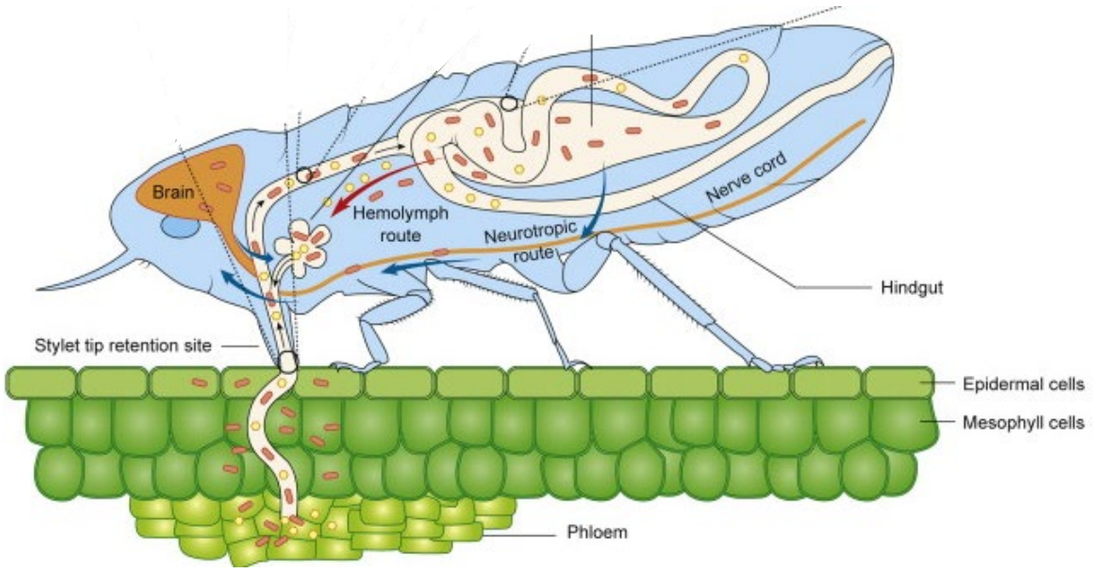
SCAN ME

Acknowledgments

University of Saskatchewan
SaskCanola
Western Grains Research Foundation
Agriculture and Agri-Food Canada

Dr. Tim Dumonceaux
Dana Leedahl
Randy Sommerville
Alicia Kaplan

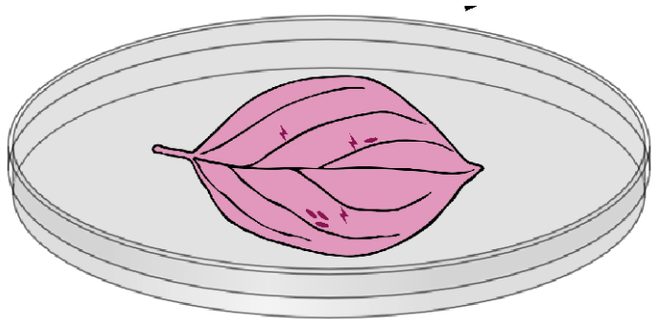
Two-choice assays: McBride´s staining protocol



Whitfield, et al. 2015. Virology, 479–480, 278–289.

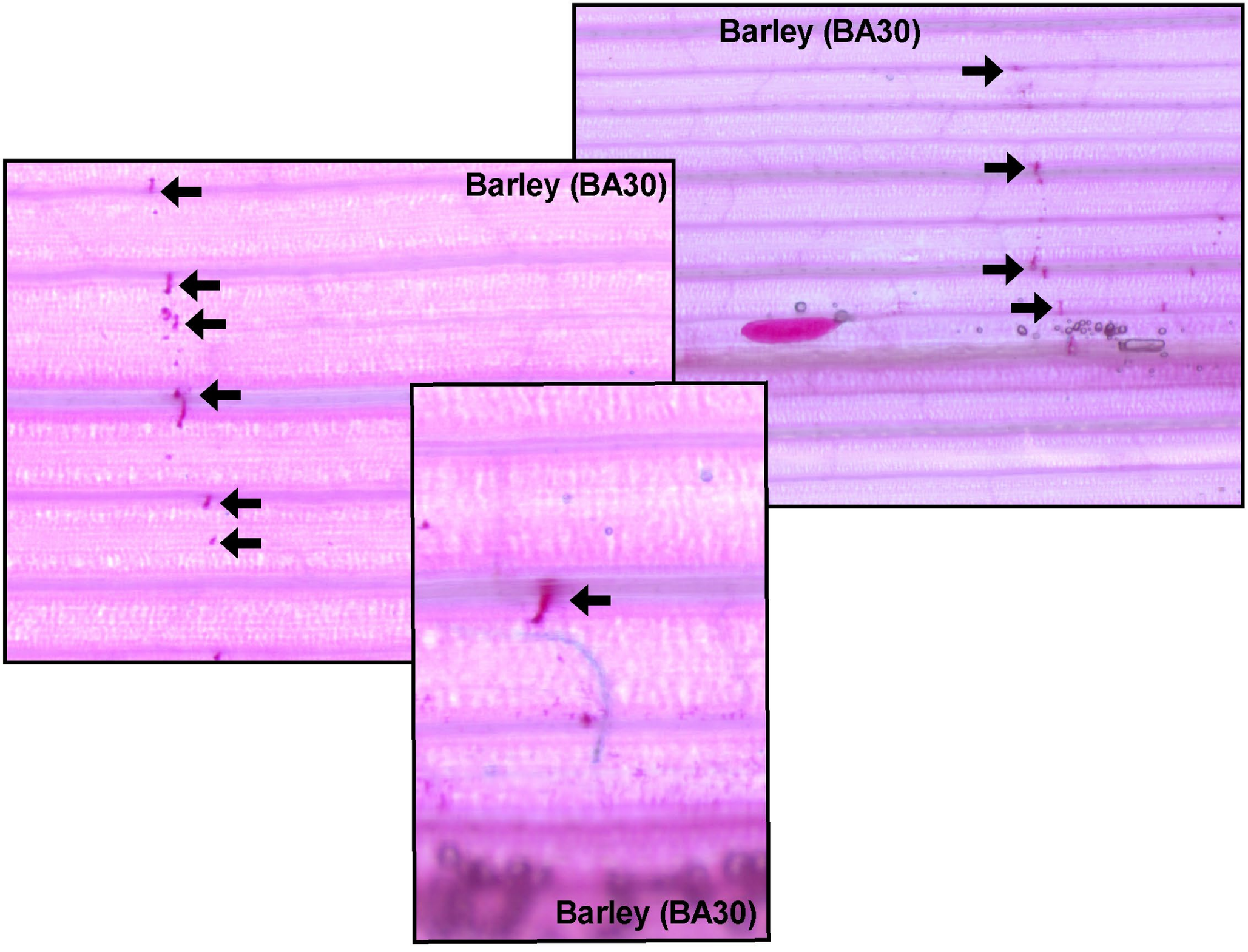
Leaf sampling

Staining

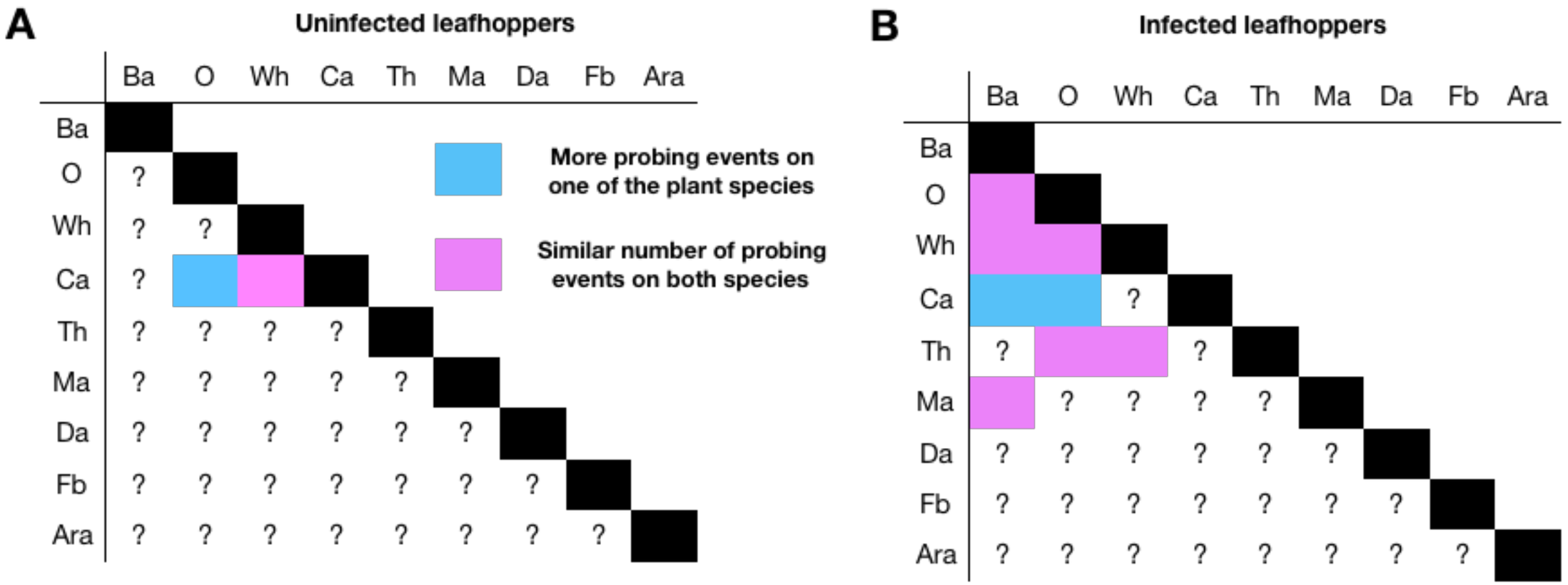


Two-choice assays: McBride´s staining protocol

Two-choice assays: McBride´s staining protocol

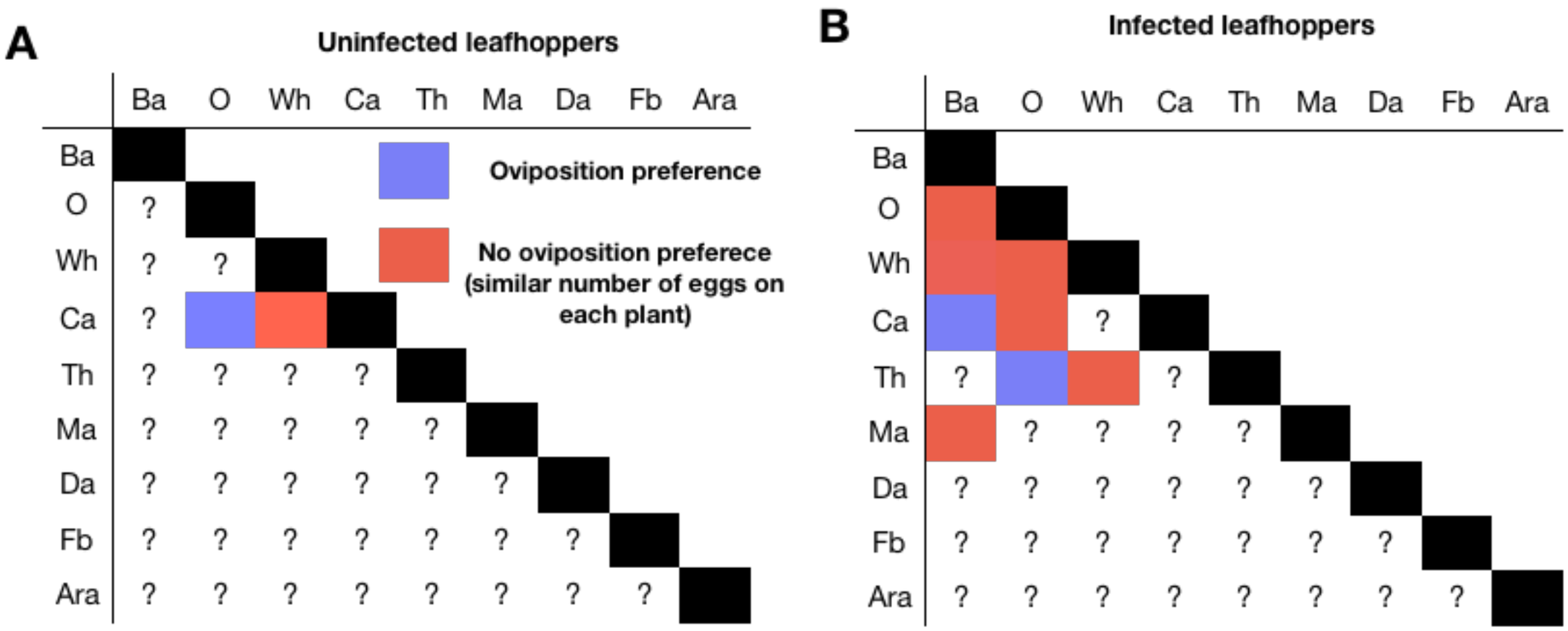


Two-choice assays: McBride´s staining protocol



Ba = barley, O = oat, Wh = wheat, Ca = canola, Th = thistle, Ma = marigold, Da = dandelion, Fb = fleabane, Ara = *Arabidopsis*

Two-choice assays: McBride´s staining protocol



Ba = barley, O = oat, Wh = wheat, Ca = canola, Th = thistle, Ma = marigold, Da = dandelion, Fb = fleabane, Ara = *Arabidopsis*

Two-choice assays: McBride´s staining protocol

Plant combination	Inf	n	PERMANOVA p-value	Plant 1 # of probing events	Plant 2 # of probing events	Paired t-test p-value	Plant 1 # of eggs	Plant 2 # of eggs	Paired t-test p-value
Ca - O	-	5	**0.02**	24.2 ± 8.7	542 ± 65	**< 0.001**	1.8 ± 1.1	16.7 ± 3.0	**(*) 0.03**
Wh - Ca	-	5	**0.02**	455.0 ± 150	55 ± 13	**0.051**	17.2 ± 5.3	5.6 ± 2.3	0.15
Ba - O	+	5	0.21	412 ± 142	157 ± 42	0.15	24.8 ± 2.3	23.2 ± 7.9	0.86
Th – O	+	5	0.07	143 ± 46	367 ± 62	0.06	3.6 ± 2.7	36 ± 13	**0.05**
Ca – O	+	5	**0.03**	66 ± 24	676 ± 142	**0.01**	4.8 ± 2.6	14.2 ± 4.5	0.08
Ba – Ca	+	5	**0.03**	335 ± 22	14.0 ± 7.0	**< 0.001**	14.6 ± 3.1	1.2 ± 0.8	**0.02**
Ba - Ma	+	5	**0.02**	352 ± 174	2.4 ± 1.5	(*) 0.06	35.0 ± 9.4	8.0 ± 4.1	(*) 0.06
Wh - O	+	5	0.93	231 ± 82	49 ± 19	0.13	18.4 ± 8.7	13.0 ± 3.7	0.62
Wh - Th	+	5	0.14	74.8 ± 58.4	37.4 ± 18.2	0.60	4.4 ± 2.32	0	0.13
Ba - Wh	+	10	**0.02**	143 ± 61	105 ± 39.74	0.32	49.2 ± 18.3	13.2 ± 5.09	0.12

Ba = barley, O = oat, Wh = wheat, Ca = canola, Th = thistle, Ma = marigold,

Two-choice assays: McBride´s staining protocol

Plant combination	Inf	n	PERMANOVA p-value	Plant 1 # of probing events	Plant 2 # of probing events	Paired t-test p-value	Plant 1 # of eggs	Plant 2 # of eggs	Paired t-test p-value
Ca - O	-	5	**0.02**	24.2 ± 8.7	542 ± 65	**< 0.001**	1.8 ± 1.1	16.7 ± 3.0	**(*) 0.03**
Wh - Ca	-	5	**0.02**	455.0 ± 150	55 ± 13	**0.051**	17.2 ± 5.3	5.6 ± 2.3	0.15
Ba - O	+	5	0.21	412 ± 142	157 ± 42	0.15	24.8 ± 2.3	23.2 ± 7.9	0.86
Th – O	+	5	0.07	143 ± 46	367 ± 62	0.06	3.6 ± 2.7	36 ± 13	**0.05**
Ca – O	+	5	**0.03**	66 ± 24	676 ± 142	**0.01**	4.8 ± 2.6	14.2 ± 4.5	0.08
Ba – Ca	+	5	**0.03**	335 ± 22	14.0 ± 7.0	**< 0.001**	14.6 ± 3.1	1.2 ± 0.8	**0.02**
Ba - Ma	+	5	**0.02**	352 ± 174	2.4 ± 1.5	(*) 0.06	35.0 ± 9.4	8.0 ± 4.1	(*) 0.06
Wh - O	+	5	0.93	231 ± 82	49 ± 19	0.13	18.4 ± 8.7	13.0 ± 3.7	0.62
Wh - Th	+	5	0.14	74.8 ± 58.4	37.4 ± 18.2	0.60	4.4 ± 2.32	0	0.13
Ba - Wh	+	10	**0.02**	143 ± 61	105 ± 39.74	0.32	49.2 ± 18.3	13.2 ± 5.09	0.12

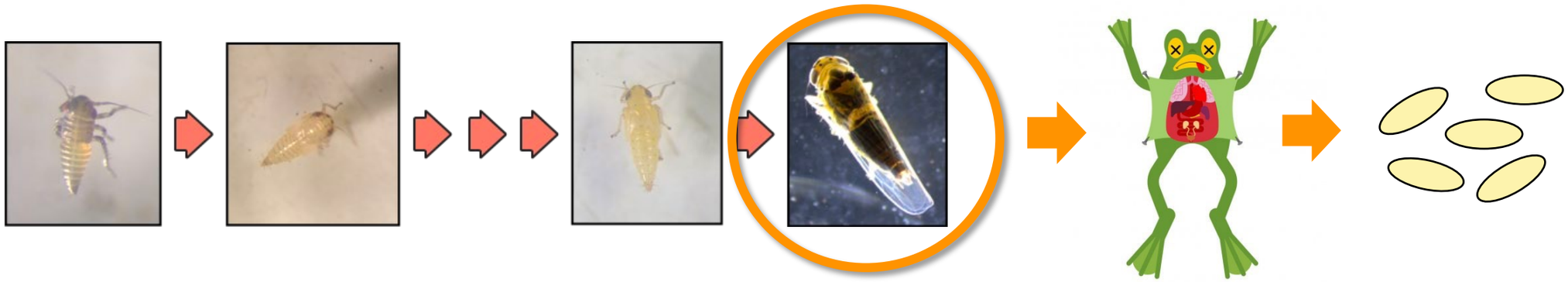
Ba = barley, O = oat, Wh = wheat, Ca = canola, Th = thistle, Ma = marigold,

Two-choice assays: McBride´s staining protocol

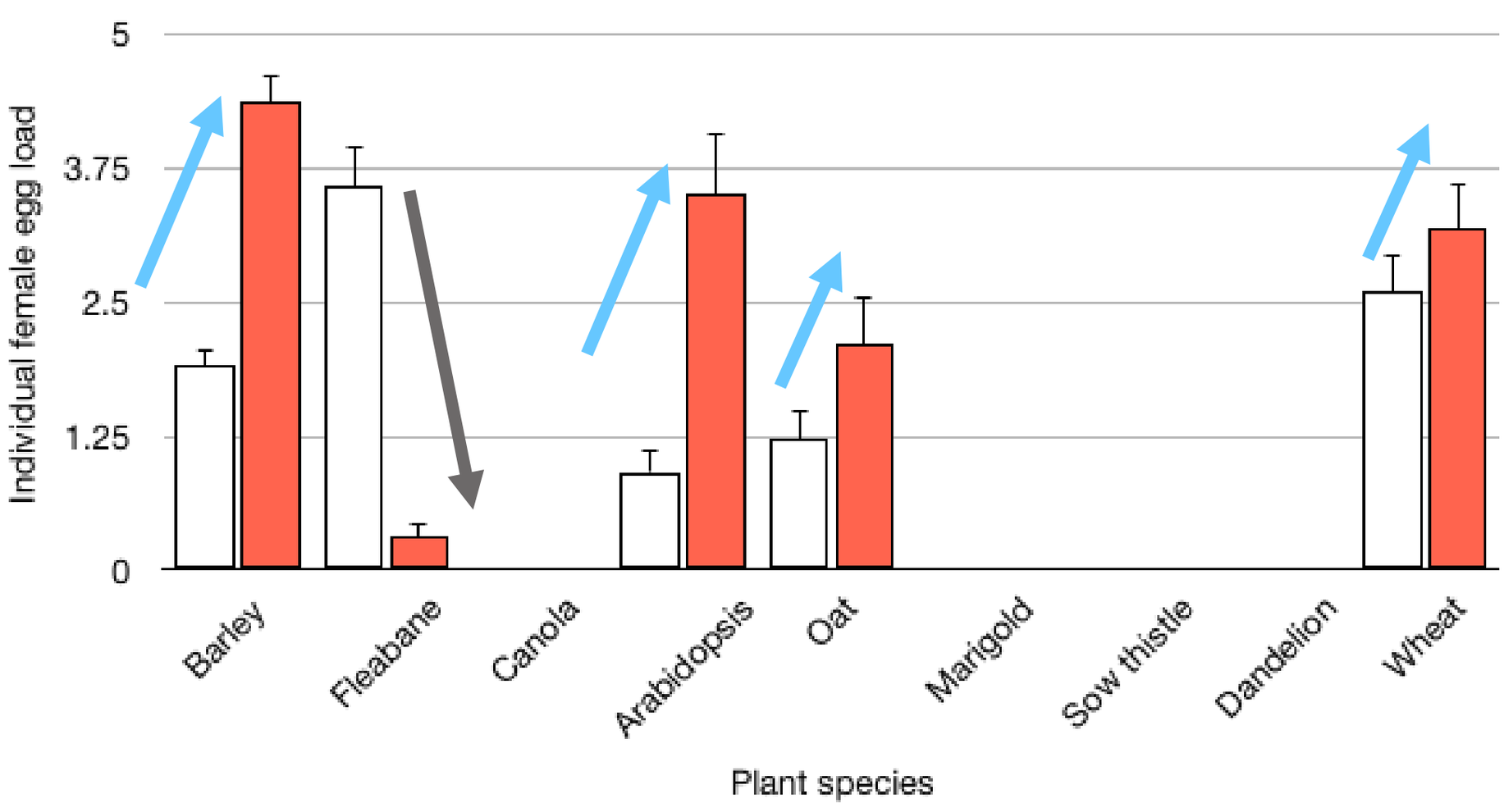
Plant combination	Plant 1 Correlation coefficient p-value	Plant 2 Correlation coefficient p-value
Ca - O	0.51	0.50
Wh - Ca	0.94	0.28
Ba - O	0.25	0.66
Th – O	0.96	0.40
Ca – O	0.06	0.97
Ba – Ca	0.44	0.64
Ba - Ma	0.48	0.29
Wh - O	0.07	0.17
Wh - Th	0.07	-
Ba - Wh	0.94	0.86

Ba = barley, O = oat, Wh = wheat, Ca = canola, Th = thistle, Ma = marigold,

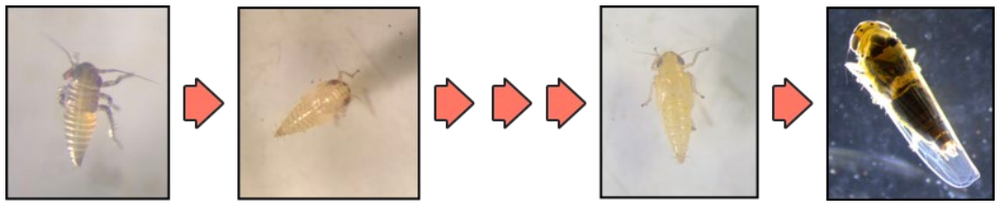
Life tables: individual female egg load

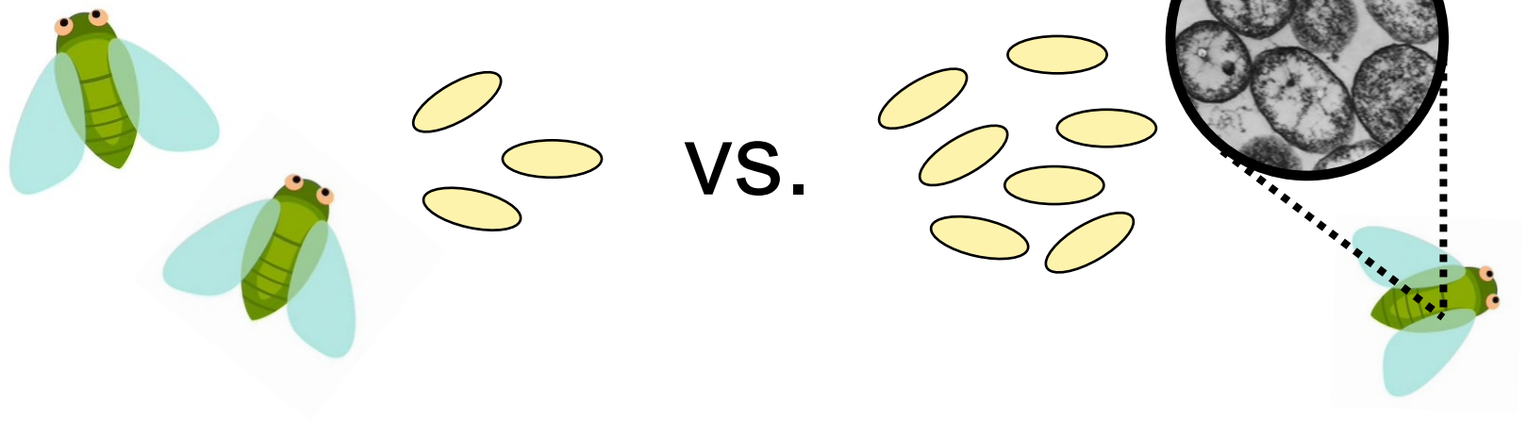


Uninfected Infected

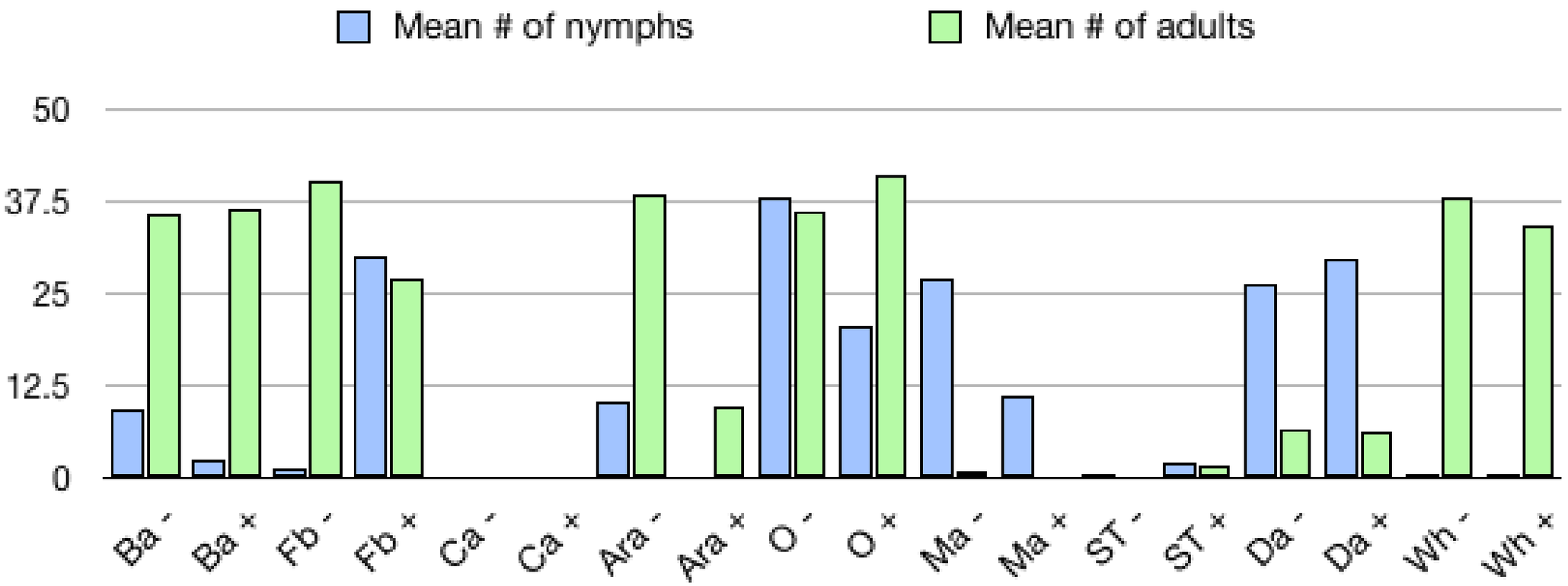


Life tables: preliminary conclusions





Life tables



Ba = barley, O = oat, Wh = wheat, Ca = canola, Th = thistle, Ma = marigold, Da = dandelion, Fb = fleabane, Ara = *Arabidopsis*
"-" = uninfected, "+" = infected