1. Psyllid survey in GB carrot and potato crops

2. EPG feeding behaviour study

Larissa Collins

GB survey for psyllids in carrot and potato crops

- *Trioza apicalis* is reported to occur in the UK, as far north as York but the only published information on its distribution is nearly 40 years old.

- Tolerates temperatures as cold as -18˚ C and potentially as low as -30˚ C. Given its range in Scandinavia and Central Europe, it is possible that it is present throughout the UK.

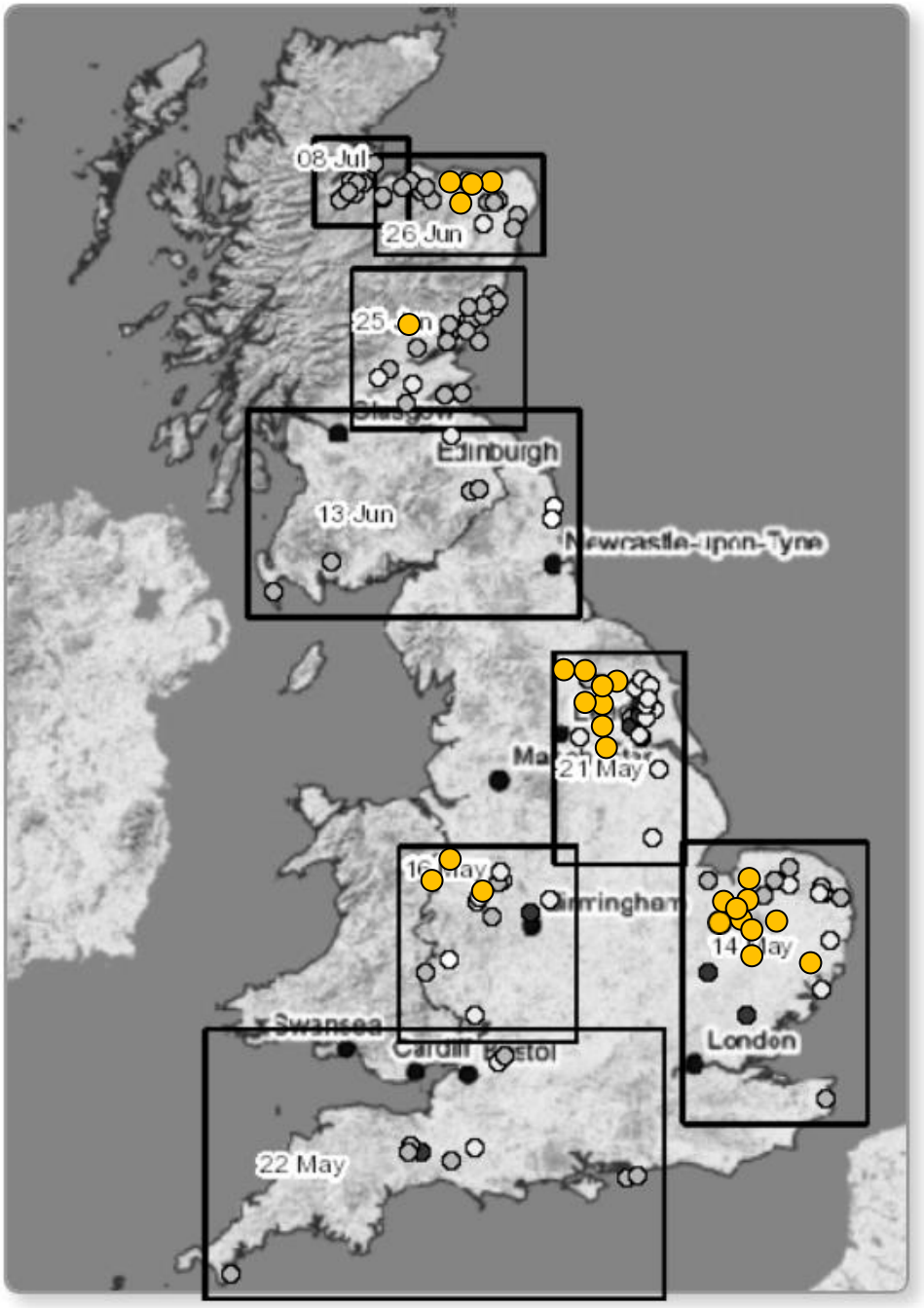
- Survey of carrot psyllids in carrot and potato fields in GB (Scotland, England and Wales) to determine whether any known vectors of *Ca. L. solanacearum* is present.

Survey method

- 23rd April – 13th September 2012.
- Yellow Water Traps (YWT) were placed in fields. We sent out trapping kits for growers and agronomists to set up and return samples each week.
- Choice between sticky traps or water traps.
- YWTs chosen for this survey – growers were familiar with their use in aphid monitoring and we were able to use same traps which were originally deployed for aphid monitoring, reducing the work involved for the growers.

Crops surveyed

- 26 YWTs were placed in carrot fields across GB.
- Samples from existing trap networks were also screened for the presence of psyllids.
- Weekly samples from approximately 200 traps in potato fields were also examined for psyllids.
- Asked growers to send in photos or samples of anything possible symptoms of psyllid feeding damage or diseased leaves – nothing received.



Positions of traps

Black and white = traps in potato fields (not all shown)

Orange = traps in carrot fields

Samples received and psyllid identification

- 289 samples from carrot fields
- 1114 samples from potato fields
- Assessed for the presence of psyllids, psyllids identified to genus or species level as far as possible.
- Male specimens are required to identify some psyllids to species.
- Some specimens were damaged and therefore these were not identifiable to species level.

Survey results

- Psyllids were found in 42 samples.
- A total of 53 psyllids were found, 3 of which were unidentifiable due to decomposition or damage.
- Some of these were Triozidae but none were *T. apicalis*.
- Fewer insects in general were found in the traps than expected during 2012 due to the unusual (cold and wet!) summer weather.
- None of the species identified is known to be a vector of *Ca. L. solanacearum.*

Psyllids identified

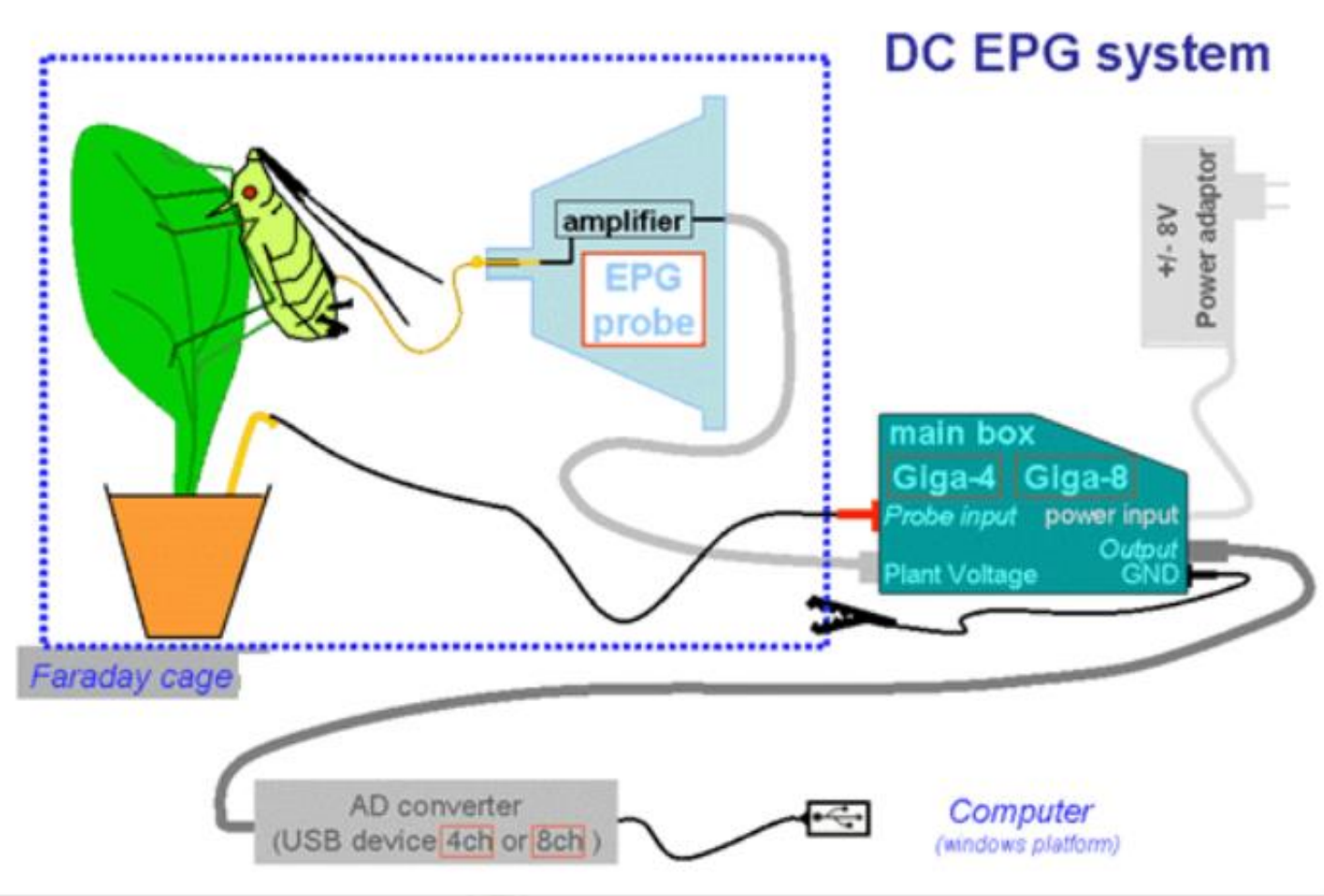
Psyllid species	Carrot	Potato	Host plants
Cacopsylla affinis or *C. melaneura* - male required to separate		2	*C. affinis* - *Crataegus* spp. and pine trees. *C. melaneura* - *Crataegus monogyna, C. oxycantha, C. maximowiczii, Malus, Pyrus communis* + conifers
Cacopsylla mali		3	*Malus silvestris, M. domestica, M. pumila*
Cacopsylla peregrina		1	*C. peregrina* - *Crataegus oxyacantha, C. monogyna, C. arnoldiana, C. maximowiczii*
Cacopsylla sorbi		10	*Sorbus aucuparia, S. amurensis*
Cacopsylla sp.	1	2	
Cacopsylla ambigua	1	1	*Salix aurita, S. caprea, S. cinerea, S. incana, S. lapponum, S. viminalis*
Craspedolepta nervosa		2	*Achillea millefolium, A. ptarmica, Cirsium arvense*
Craspedolepta subpunctata		1	*Chamaenerion angustifolium*
Psylla alni		1	*Alnus glutinosa, A. incana, A. viridis, A. japonica, A. hisuta, A. rhombifolia*
Psylla sp.		1	
Psylla visci		1	*Viscum album*
Psyllopsis fraxini	1		*Fraxinus* spp.
Trioza anthrisci	1		*Anthriscus silvestris, Angelica silvestris, Heracleum sphondylium* (poss. also *Peucedanum ostruthium, Pastinaca sativa*) + conifers
Trioza chenopodii	4		*Chenopodium* spp., *Atriplex* spp., *Halimione portulacoides, Spinacia oleracea, Beta vulgaris.*
Trioza sp. (not *T. apicalis*)	1		
Trioza urticae	7	9	*Urtica dioica, U. urens* + conifers

EPG feeding behaviour study - Anne Nissinen and Larissa Collins

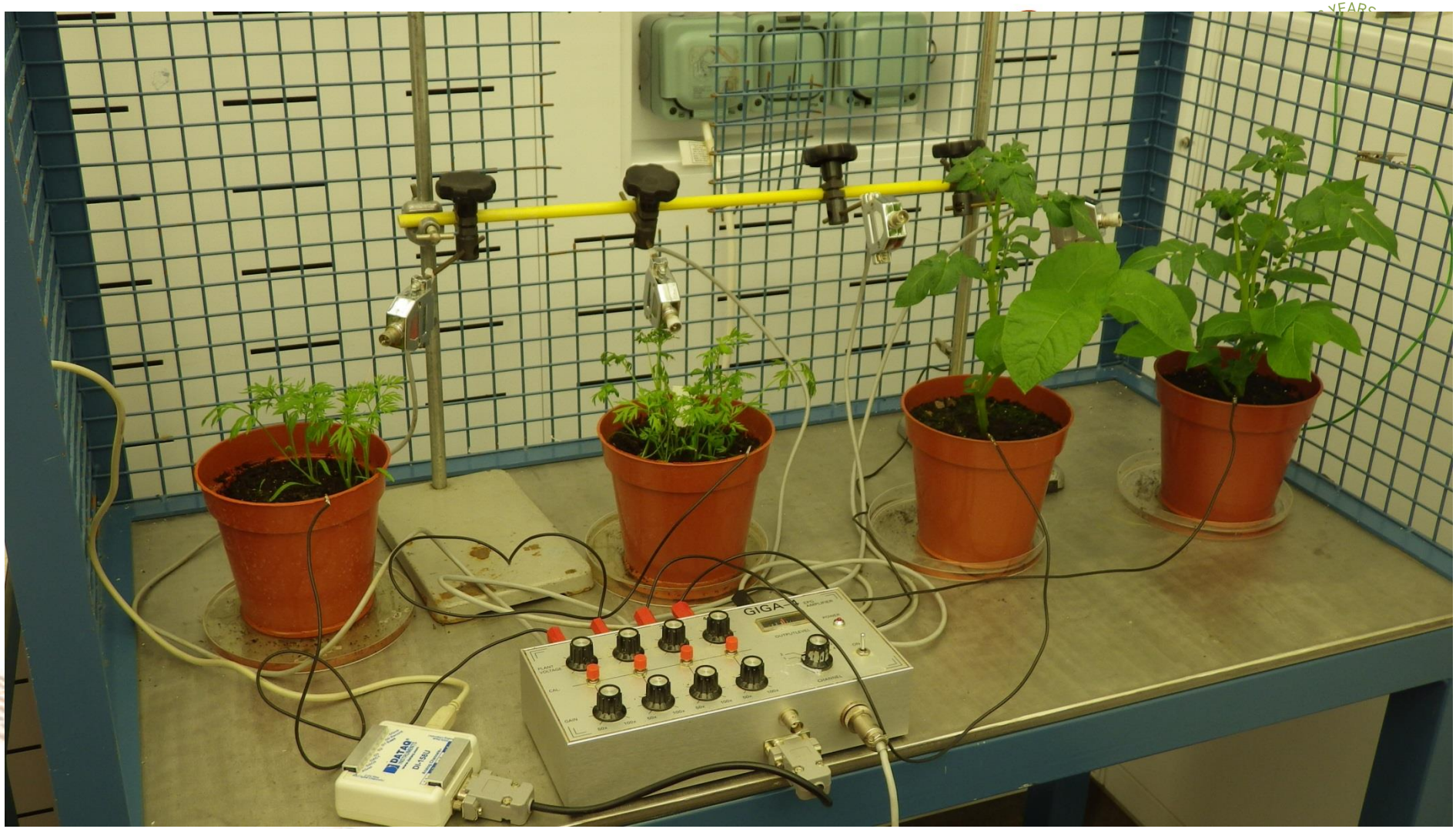
- Are carrot psyllids are capable of feeding on potato plants? Are carrot psyllids capable of phloem feeding on potato plants? *Ca. L. solanacearum* is a phloem limited bacterial disease.

- Are there any differences in feeding behaviour between female and male *T. apicalis* on carrot and potato plants? Female feeding on carrot plants causes more severe symptoms than male feeding (Nissinen, 2014).

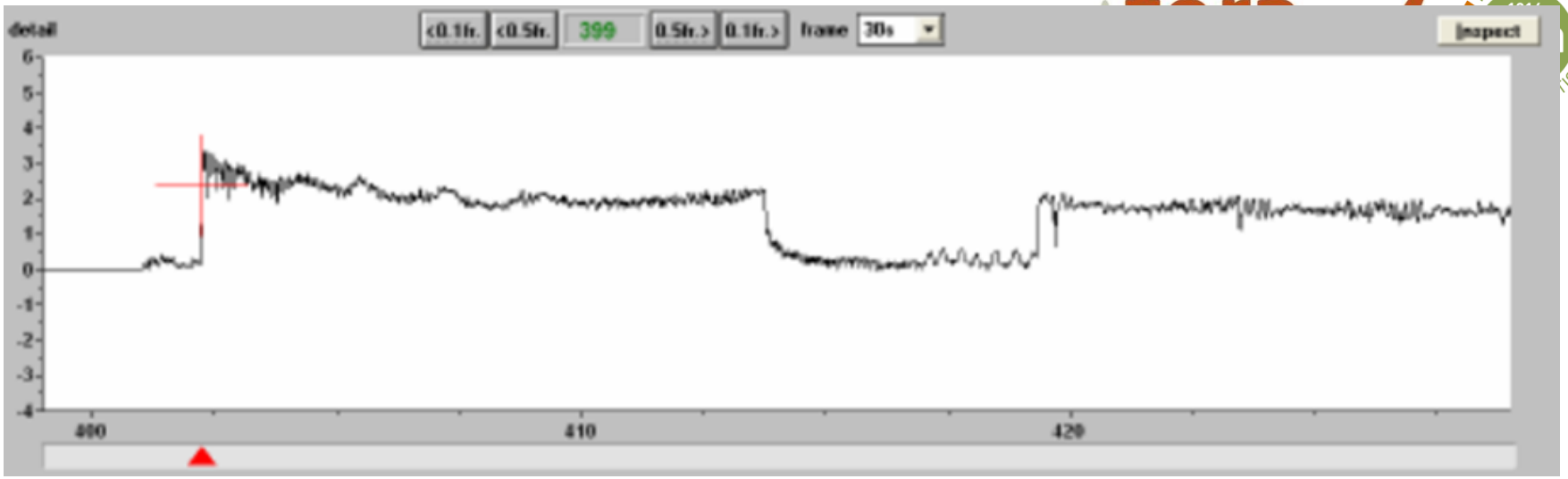
EPG


DC EPG system
amplifier
EPG probe
+/- 8V
Power adaptor
main box
Giga-4
Giga-8
Probe input
power input
Output
Plant Voltage
GND
Faraday cage
AD converter
(USB device 4ch or 8ch)
Computer
(windows platform)

Attaching the 18 µm diameter gold wire to the psyllid with silver glue


GIGA
DATAQ
DI-158U

Waveforms



NP – not probing

PA – start of penetration

C – stylet tip in parenchyma

D – stylet tip in sieve element, transition to PE1

PE1 - stylet tip in sieve element, phloem salivation

PE2 – stylet tip in sieve element, phloem ingestion (PE1 and PE2 can overlap

PG – stylet tip in xylem, xylem ingestion

W – walking

ET – elapsed time before first attempt at probing

F – difficulty probing

U – unassigned to any waveform (used where we could not assign the observed waveform to a recognisable pattern)

Recordings

- Each psyllid was monitored for between 21 and 23 h depending on the length of time the set-up procedure took.
- 4 psyllids were monitored during each recording period
- 6 recording periods giving total number of 24 recordings of individual psyllids.
- Each group of 4 recordings consisted of:
  - female on a carrot plant,
  - male on a carrot plant,
  - female on a potato plant,
  - male on a potato plant.
- So 6 individual recordings for each combination.

Statistical analysis

- There were differences in total time of the recordings so the times spent in each activity were expressed as ratios of category 1 “NP”. This category was chosen because it occurred in every recording and avoided dividing by zero.

- Categories compared were: 1/2 (np/PA), 1/3 (np/C), 1/4 (np/D), 1/5-6 (np/PE1 + PE2), 1/7 (np/PG), 1/8 (np/W), 1/10 (np/F), 1/9-11 (np/ET+U). Some of these were pooled to reduce the number of variables.

- The ratios were logged and MANOVA was used to compare the means of all groups. Where a statistical difference was detected by MANOVA, individual ANOVAs were carried out to pinpoint which categories were responsible for the overall difference.

Results

- Some statistical differences were found in time spent by males and females (taken together) between carrot or potato plants in some activities:
    - 2/1 (PA/np) – start of penetration
    - 3/1 (C/np) – stylet tip in parenchyma
    - 4/1 (D/np) - stylet tip in sieve element, transition to PE1
    - 5-6/1 (PE1-PE2 /np) - stylet tip in sieve element, phloem salivation + phloem ingestion
- There were no overall differences between time spent in different activities by males and females - only between plants.
- More time was spent by both males and females in PA, C, D and PE1-PE2 on carrots than on potatoes – which is expected!

T. apicalis is capable of phloem feeding on potato plants

- One male psyllid was recorded phloem feeding from a potato plant therefore we have shown that it should be possible for *T. apicalis* to transmit *Ca. L. solanacearum* to potato plants.

- Give the very small sample size of insects observed during this work, it would seem that transmission of *Ca. L. solanacearum* to potato plants is highly probable and that if it is not happening in the field there may be another mechanism preventing transmission.

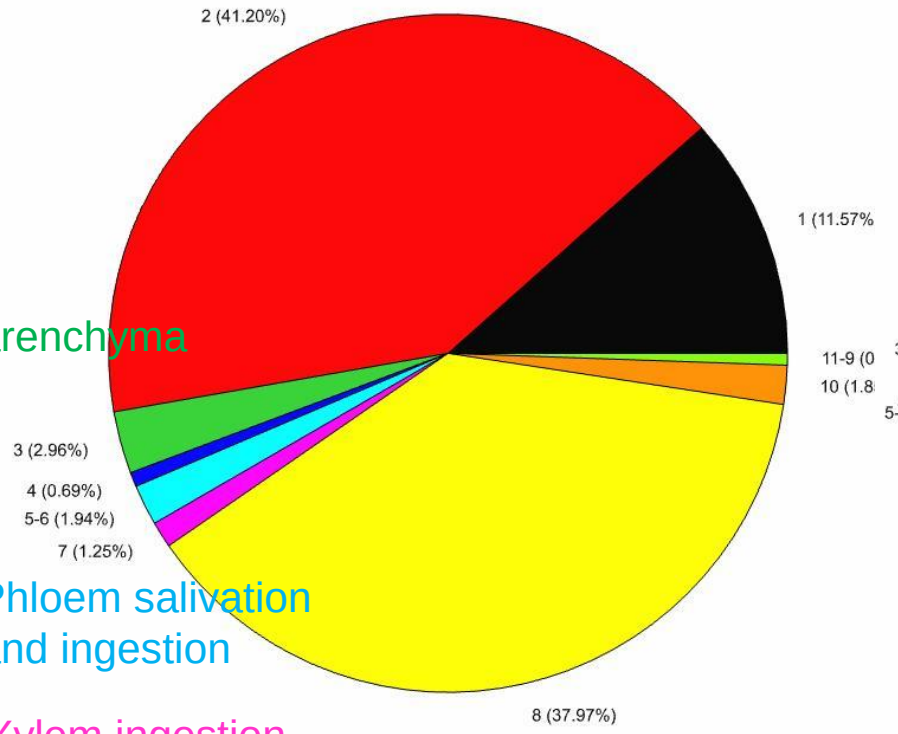
Frequency of activities on carrot and potato (male + female)

Start probing

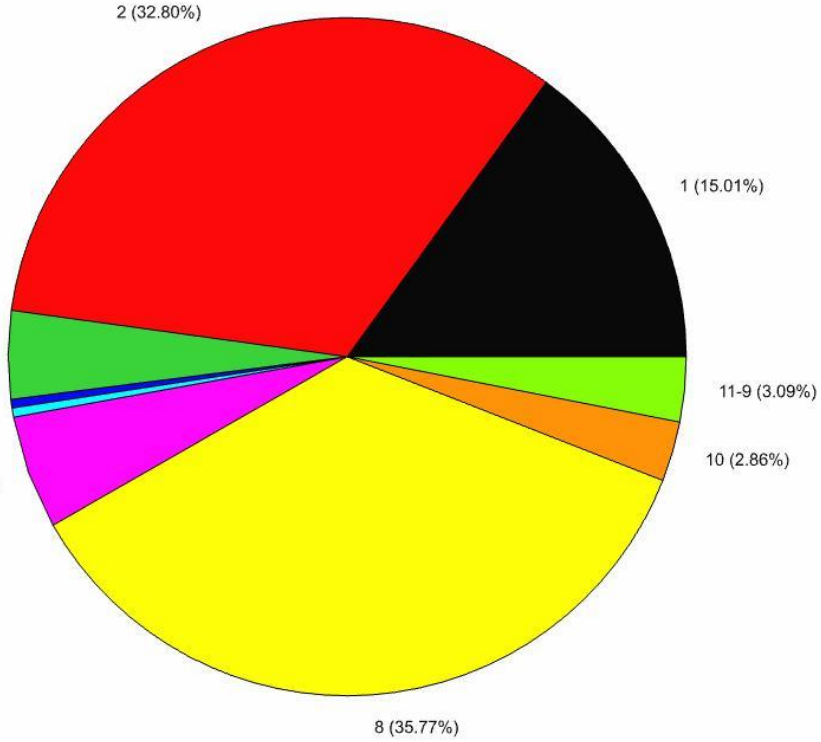
Parenchyma

Phloem salivation and ingestion

Xylem ingestion - drinking



carrot



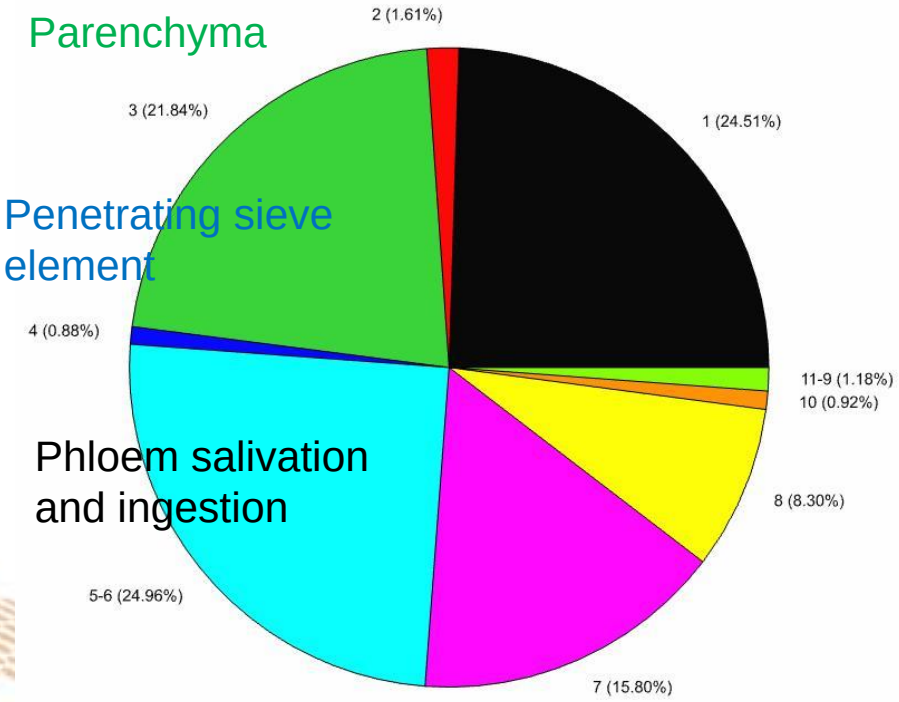
potato

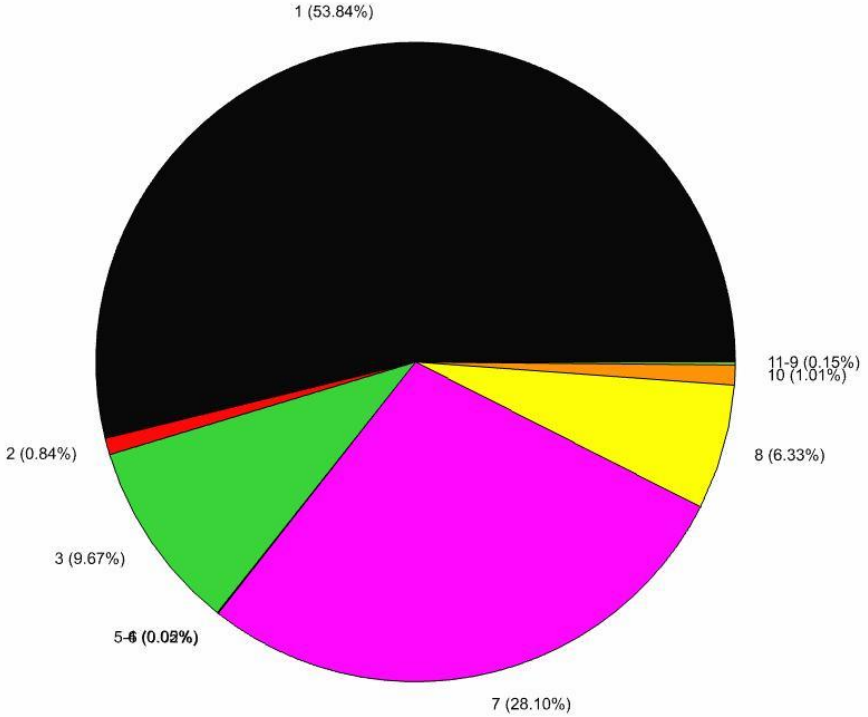
Time spent in activities on carrot and potato (male + female)

Parenchyma

Penetrating sieve element

Phloem salivation and ingestion





carrot

potato

Time spent in activities on carrot and potato - females

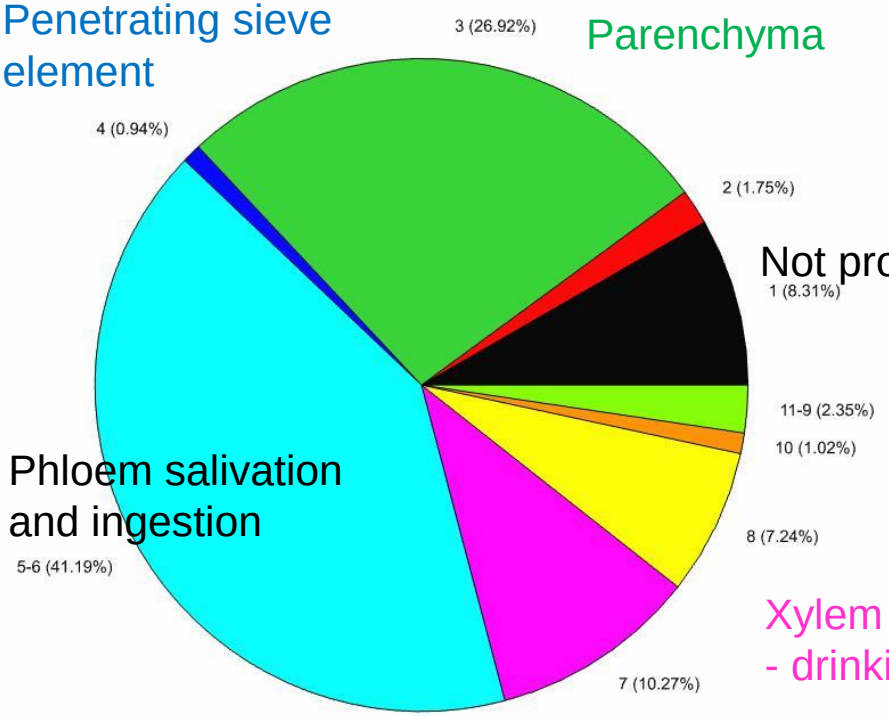
Penetrating sieve element

Parenchyma

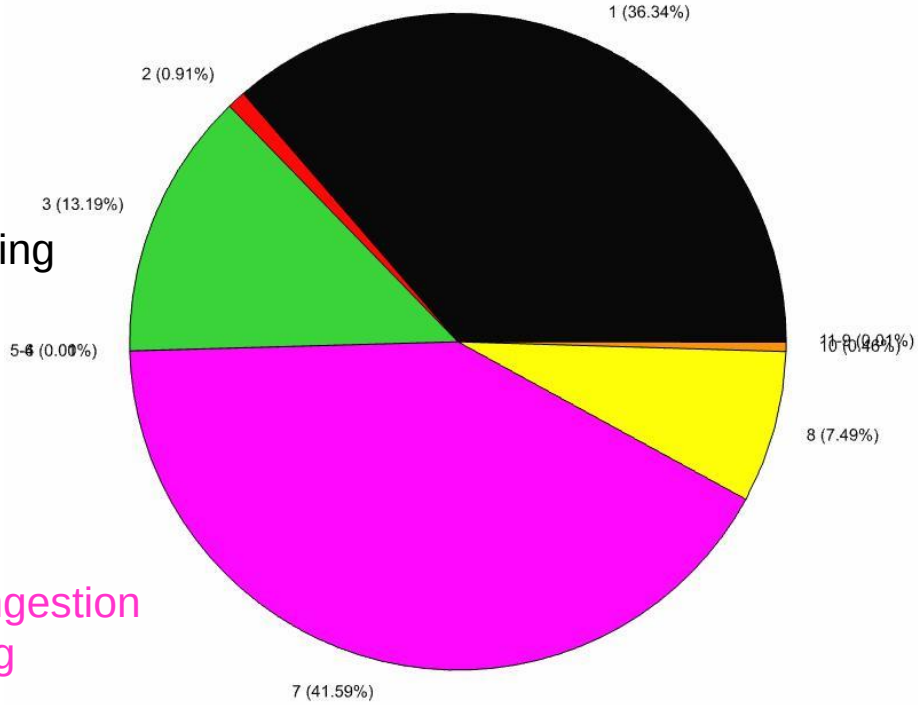
Not probing

Phloem salivation and ingestion

Xylem ingestion - drinking

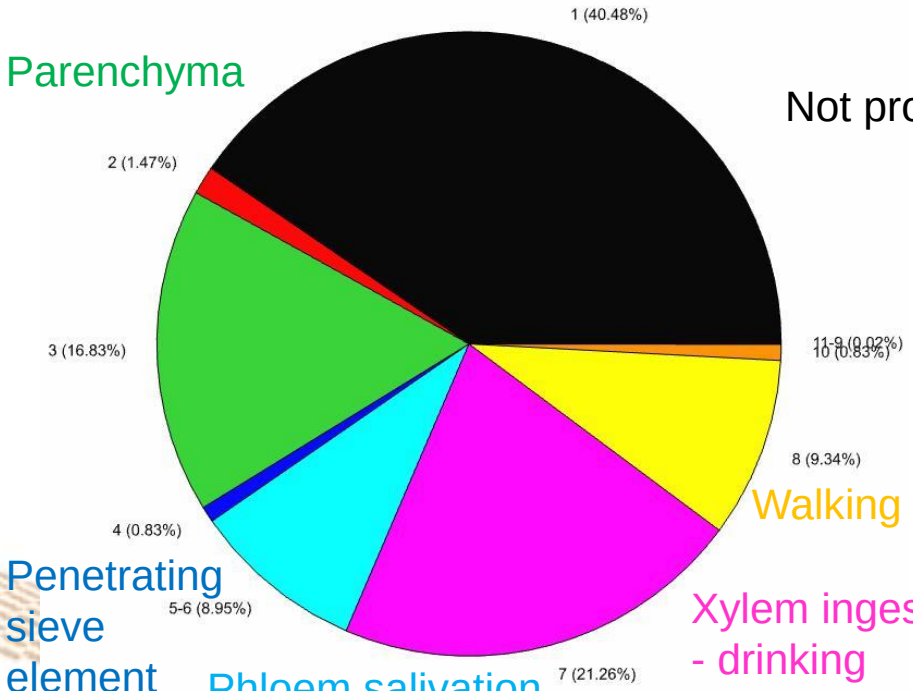


carrot



potato

Time spent in activities on carrot and potato - males



Parenchyma

Not probing

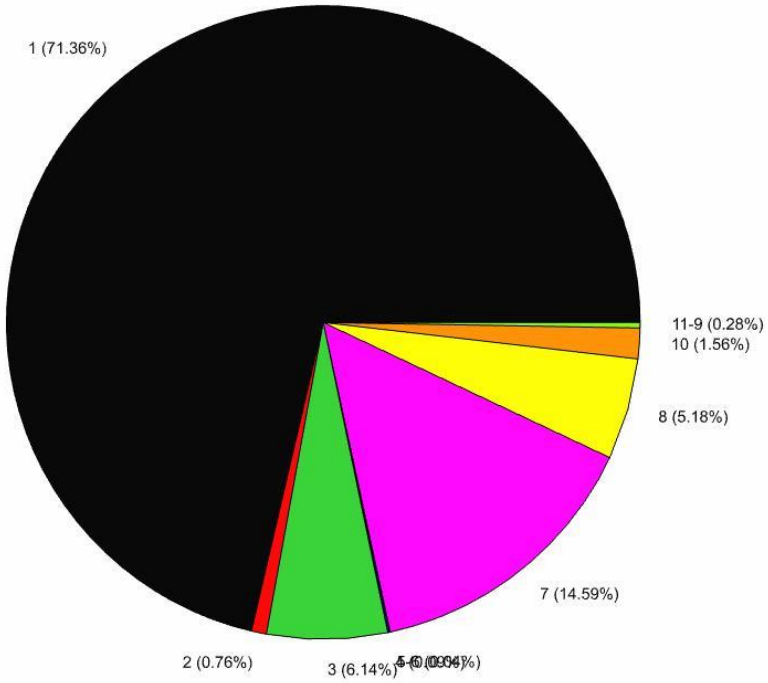
Walking

Penetrating sieve element

Xylem ingestion - drinking

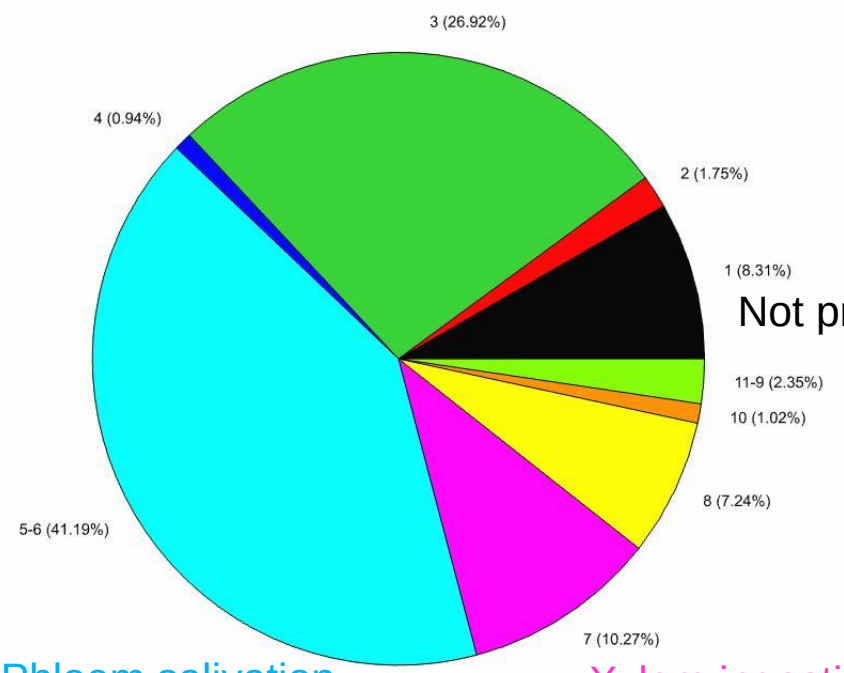
Phloem salivation and ingestion

carrot

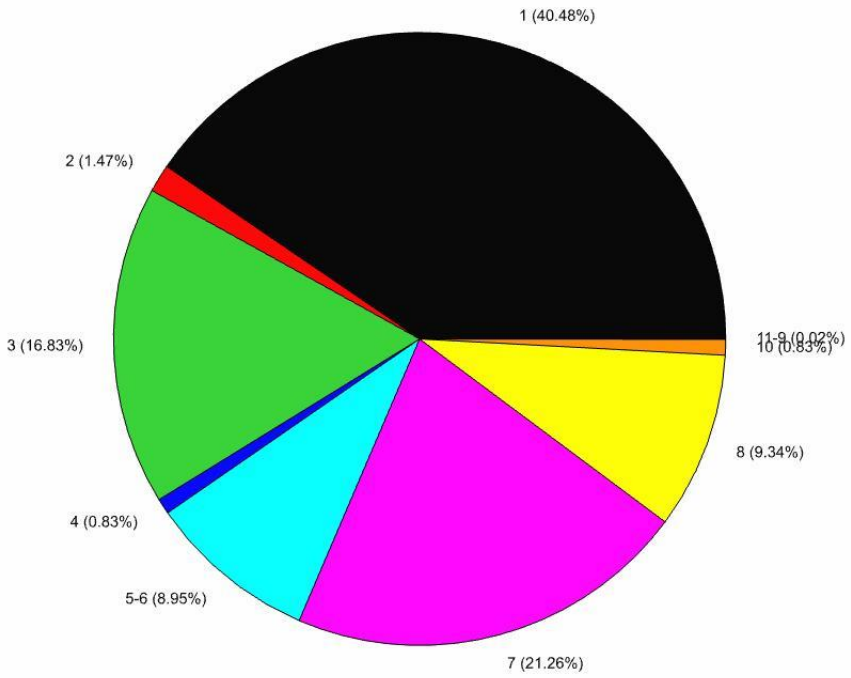


potato

Time spent in activities on **carrot** females and males – not statistically significant



Not probing



Phloem salivation and ingestion

female

Xylem ingestion - drinking

male

Probably explains Anne's observation of more feeding damage by females than males.

Main conclusions

- No known *Ca. L. solanacearum* vectors were found.

- *T. apicalis* can phloem feed from potato plants but much less frequently and for much shorter duration than on carrots.

- It appears that, on carrot plants, female carrot psyllids spend more time phloem feeding than males.

Acknowledgements

- Anne Nissinen
- Lisa Blackburn
- Joe Ostoja-Starzewski
- Stéphane Pietravalle
- Julie Bishop
- Katherine Robinson
- Jess Prickett
- James Mathers
- The many agronomists and growers who took part in the survey.