Occurrence of ‘Candidatus Liberibacter solanacearum’ in Finland: what do we know so far?

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Carrot psyllid damage according to old literature

Photo: Anne Nissinen

- Overwintered females cause the most severe damage
- Damage index (0-5):1h feeding 0,3; 4 h 1,9 and 24 h 2,9 (Markkula et al. 1976)
- Leaf curling occurs in 2 days (1-5 d) (Markkula et al. 1976)
- Carrot psyllid damage is thought to be caused by phytotoxic saliva (Láska 1964) but the toxin is not identified (Markkula & Laurema 1971)

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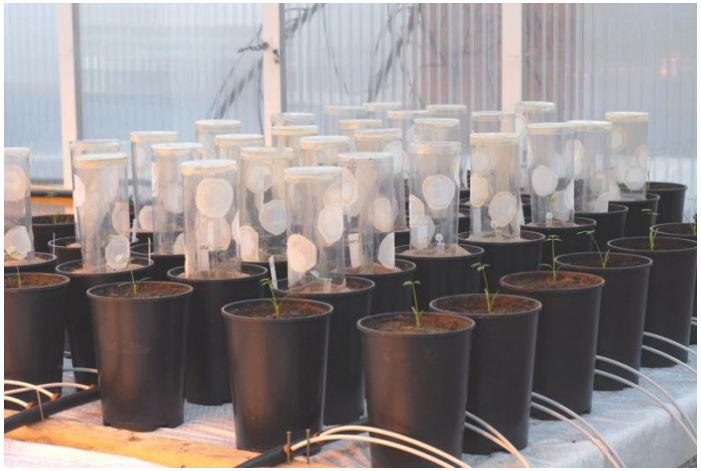
Damage intensity



- Does the amount of bacterial titer in the psyllid affect the damage intensity?
- 3-l pots, drip irrigation
- Exposure for 3 days
- **Field-collected population: June 2012**
- Mostly females (31), only 15 males
- Number of leaves counted and height measured weekly
- At harvest root fresh and dry weight, leaf weight, root diameter and length measured
- **qPCR from both psyllids and plants**

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Damage symptoms with and without liberibacter

Uninfected female

Nissinen et al. 2007:
”When the discolouration of the carrot leaves developed
Approximately 1 month after the feeding period, we could not exclude the possibility that infection by plant pathogenic mycoplasmas was responsible for leaf discolouration.”

Instead of mycoplasmas we found CLso in the infected plants

Lso-infected female

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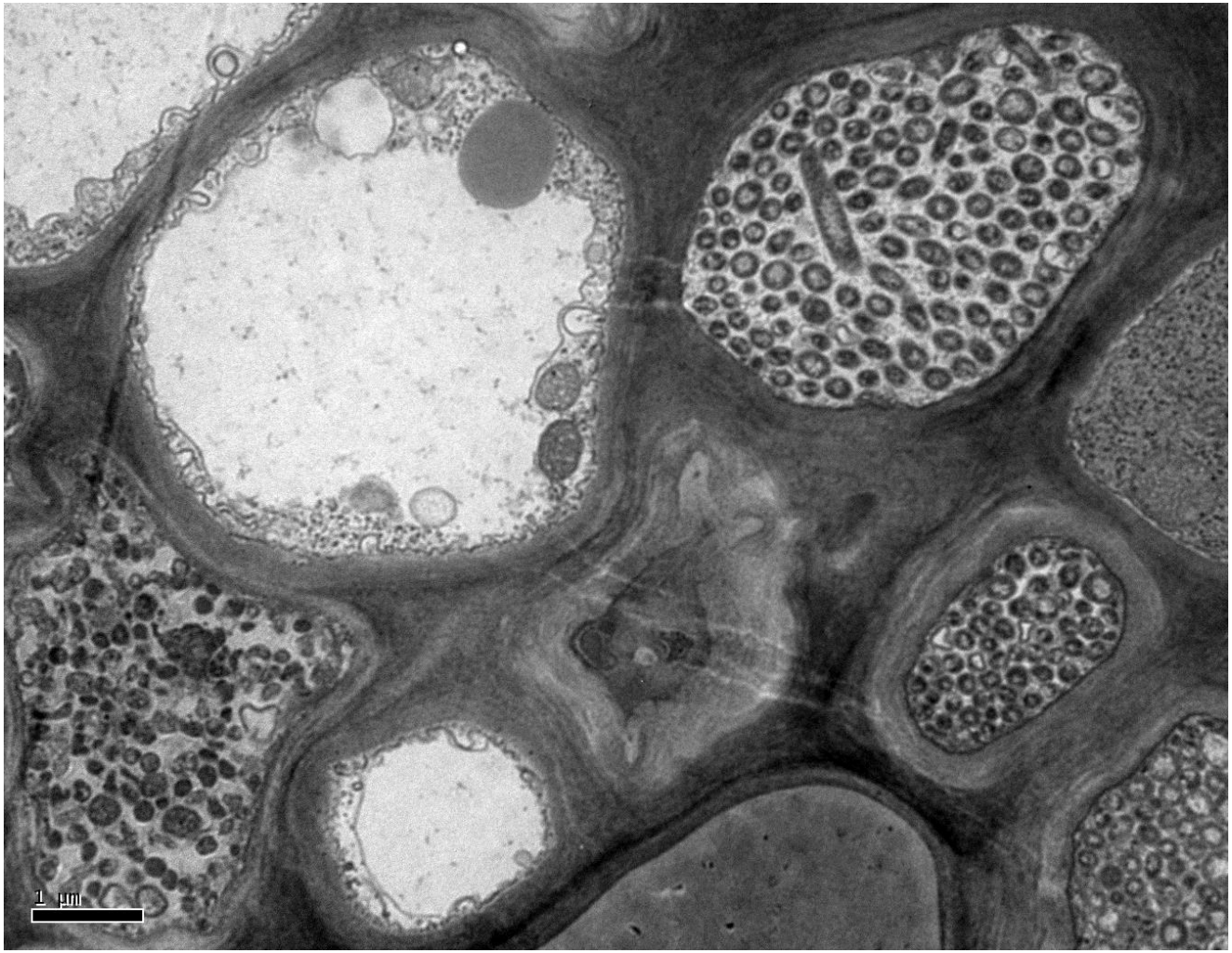

Photo : Minna Haapalainen

Nissinen et al. 2014. Plant Pathology 63, 812–820

Transmission electron micrograph of petiole phloem transsection of the symptomatic carrot, at 12000x magnification. The sieve tubes on the right are full of bacterial cells.

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Variables affecting root weight

Fixed factors		Root weight estimates
control		37.96
male		37.73
female	nymphs <10	20.67
female	nymphs >10	11.81
CLs/Dc <100		39.88
CLs/Dc >100000		15.50

	df	df	F	P
treatment	2	50	11.75	<0.0001
nymphs	1	50	2.68	0.1080
CLs/Dc	1	50	44.28	<0.0001

Nissinen et al. 2014. Plant Pathology 63, 812–820

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Factors affecting number of curled leaves

Fixed factors		Estimate for nubmer of curled leaves
control		0
male		0.66
female	nymphs <10	2.62
female	nymphs >10	4.41
CLs/Dc <100		2.01
CLs/Dc >100000		1.78

	df	df	F	P
treatment	2	50	48.13	<0.0001
nymphs	1	50	26.91	<0.0001
CLs/Dc	1	50	0.87	0.3559

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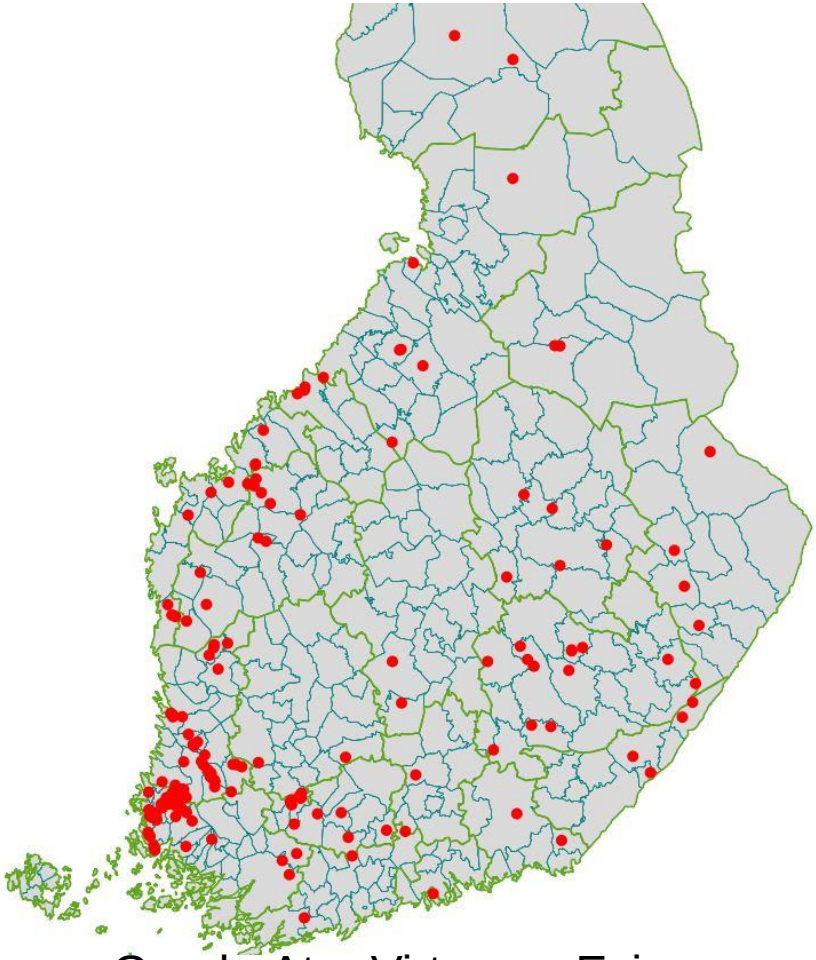
Carrot cultivation in Finland



Graph: Atro Virtanen, Evira

- 2010: 1606,5 ha, 67257,7 tn
- organic carrot: 47 ha
- Carrot psyllid is the major pest
- carrot psyllid occurs approximately south of line Joensuu-Oulu

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Field survey 2011-2013

Photo: Marika Rastas

- 27 commercial carrot fields, where leaf discoloration symptom was observed
- of these 13 fields contained volunteer potatoes
- 6 potato fields next to symptomatic carrots
- 198 sweep netting samples from different parts of the fields collected in late June-early July,
- Sweep netting samples contained 0-158 psyllids

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Transmission trials to potato: 2011-2013

Photo: Anne Nissinen

Photo: Anne Nissinen

- 2011: 10 potatoes – exposed to feeding of 20 carrot psyllids for 7 days (no-choice)
- 10 carrots – exposed to feeding of 5 carrot psyllids for 7 days (no-choice)
- 5 unexposed controls in both carrots and potatoes
- tested for liberibacter 1,5 months after exposure with primer pair OA2/O12c
- All the psyllid samples were tested CLs-positive
- 2012: Exposure to 30 carrot psyllids for 11 days
- in each cage one potato seedling and two carrot seedlings (choice)
- psyllids were still observed on potato
- 2013: each potato exposed to 60 carrot psyllids for two weeks (no-choice)
- **None of the potatoes were tested positive for CLs!**

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Transmission experiments

Left: transmission experiment with dodder. Dodder winds together an infected carrot and a healthy potato

Right: transmission experiment by grafting: leaves from Clso-infected carrot plants were grafted into the leaf axils of healthy potato plants

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Conclusions

- Carrot psyllid feeding and number of nymphs increased the number of damaged leaves, but the bacterial titer had no effect, which suggest that the leaf curling is caused by insect feeding and the leaf discoloration by the bacteria (Nissinen et al. 2014).
- In greenhouse transmission of CLs to potatoes by carrot psyllids was not shown in the level of 20, 30 or 60 psyllids per plant, which suggest that a high psyllid pressure is needed for transmission to happen

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