Mechanisms of virus-vector interactions mediating disease transmission

Christiane Then, Fanny Bellegarde, Geoffrey Schivre, Tou Cheu Xiong, Martin Drucker, Stoyan Yordanov, Kaloian Koynov, Hans-Jürgen Butt, Jaclyn S Zhou, James C. K. Ng

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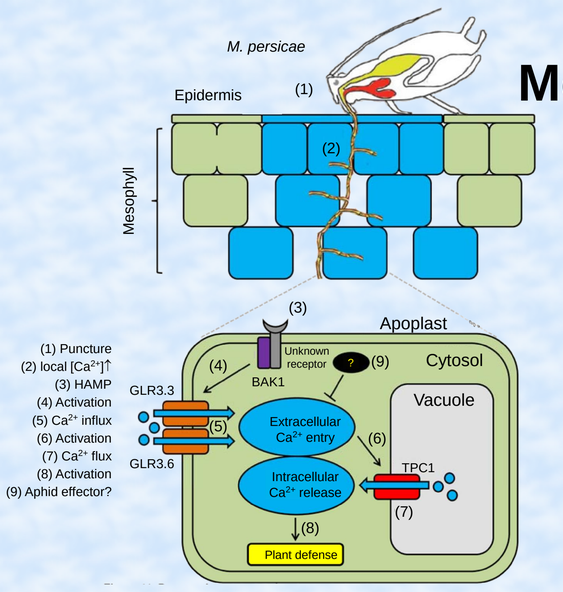
INRA Colmar (France): Christiane Then, Fanny Bellegarde, Géoffrey Schivre, Tou-Cheu Xiong, Martin Drucker
MPI Mainz (Germany): Stoyan Yordanov, Kaloian Koynov, Hans-Jürgen Butt
UC Riverside (USA): Jaclyn S. Zhou, James C.K. Ng

Do plant viruses perceive the presence of aphid vectors?

Model



Adapted from Vincent, T. R. et al. Plant Cell 29, 1460–1479 (2017)

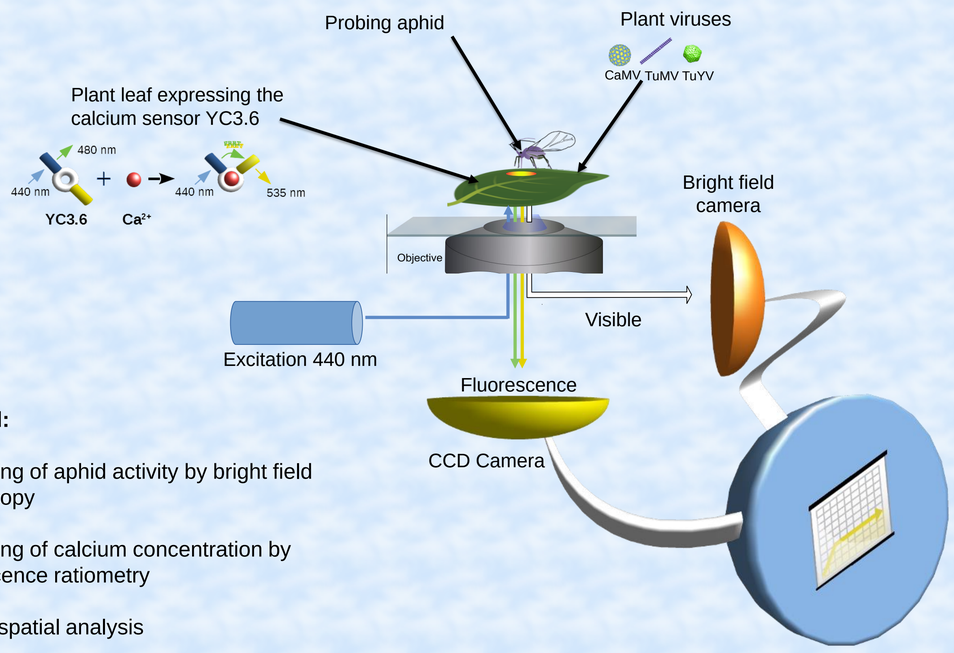
Aphid punctures trigger instant calcium elevations at the puncture site. They might be the first step in establishment of plant defense responses against these predators (see model above).

Many plant viruses are transmitted by aphids. There is evidence that viruses modify plant defenses, for example to modify interactions of plants with virus-transmitting aphids.

Such modifications could effect the very first steps in virus-aphid interactions (transmission).

Therefore, we tested whether virus infection interferes with local calcium elevations.

Experimental system



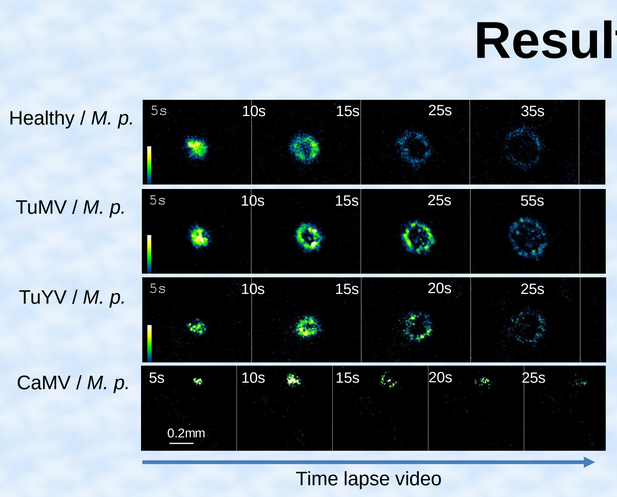
Method:

Recording of aphid activity by bright field microscopy

Recording of calcium concentration by fluorescence ratiometry

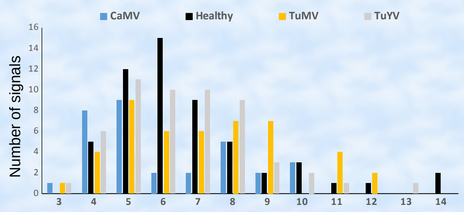
Tempo-spatial analysis

Results

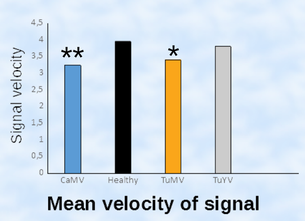


Movies!

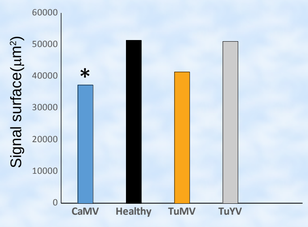
Analysis of calcium signal



Bimodal distribution for CaMV and TuMV, unimodal for TuYV and healthy



Decreased velocity for CaMV



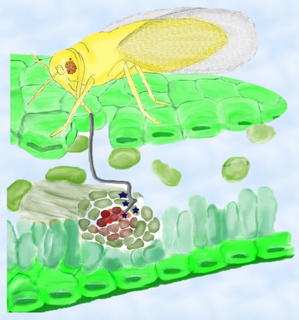
Decreased surface for CaMV

⇒ Viruses alter calcium signaling differently

Can a plant virus perceive the presence of a plant while being retained in its insect vector?

Model

Virus Inoculation by whitefly vector



Plant hosts of whiteflies

Brassica napus
Brassica rapa

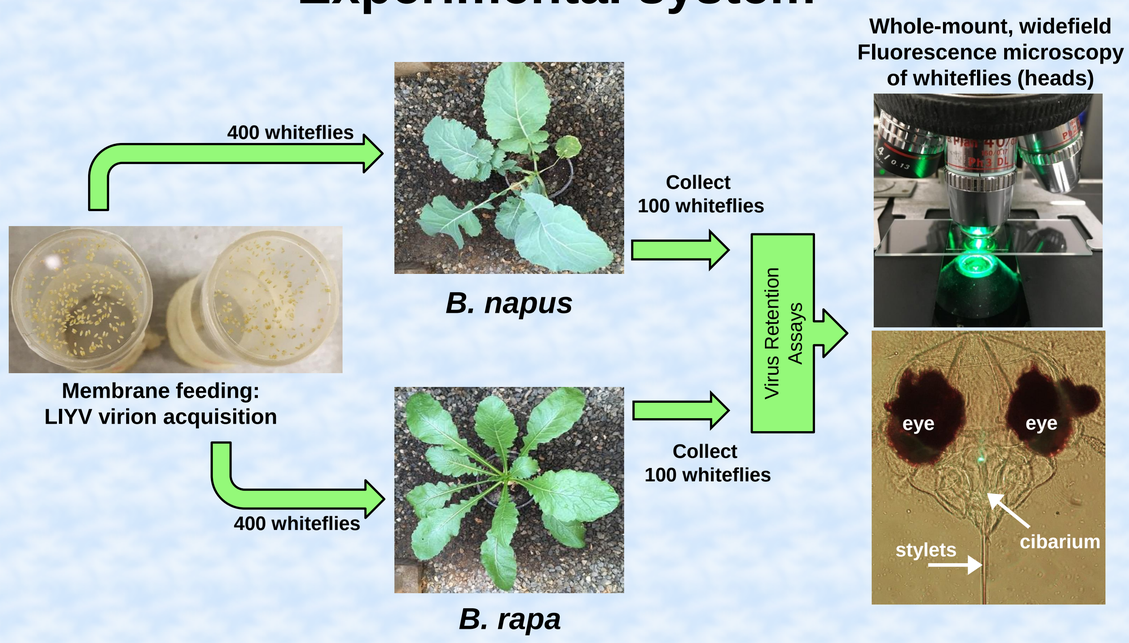
Viruses that retain in the foreguts of whitefly vectors must be released and inoculated into the plant in order to achieve transmission.

Many whitefly-transmitted viruses are emerging viral pathogens of important food and fiber plants.

Although whitefly feeding (on plants) contributes to the inoculation of foregut borne viruses, nothing is yet known about the role(s) that plants play, if at all, in virus inoculation.

Therefore, we conducted studies to test the hypothesis that the inoculation of a foregut borne virus can be mediated by a plant trigger.

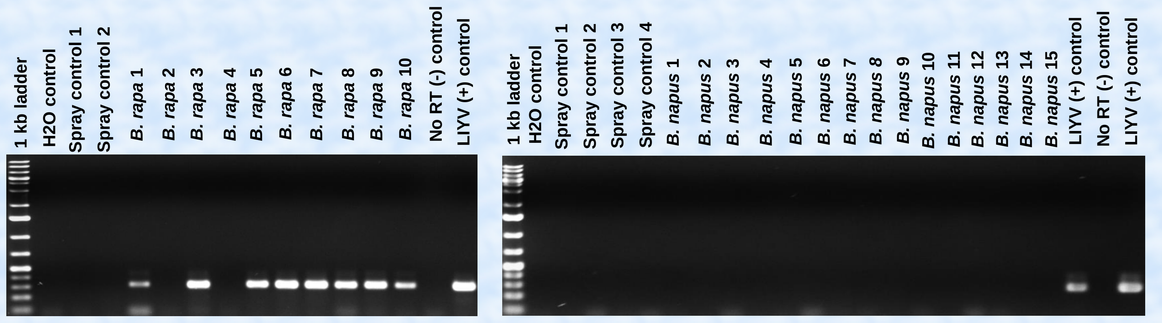
Experimental system



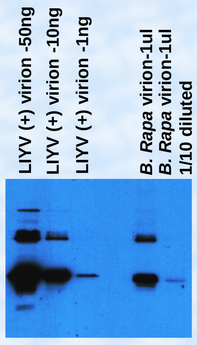
Results

Establish virus host (*B. rapa*) and non-host (*B. napus*)

Plant-to-plant transmission of lettuce infectious yellows virus (LIYV) to *B. rapa* or *B. napus*



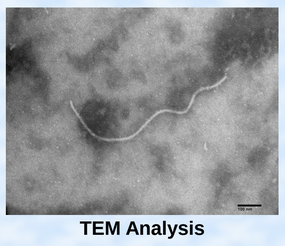
Reverse transcription (RT) – PCR



28 kDa CP

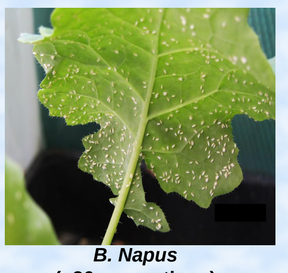
Western Blot

LIYV virion purified from *B. rapa*

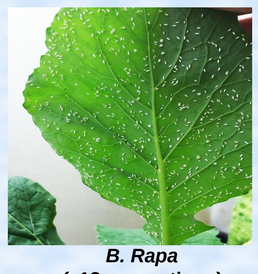


TEM Analysis

Establish whitefly colonies



B. Napus
(>36 generations)

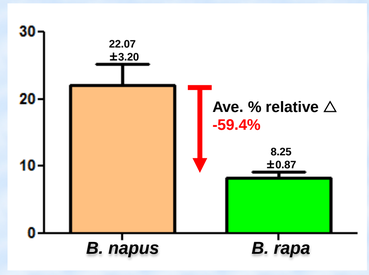


B. Rapa
(>18 generations)

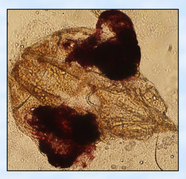
Virus Retention Assays

% foreguts with fluorescent signals & relative △

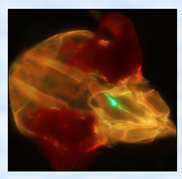
	B. napus			*B. rapa*			
Experiment	Total number of whitefly heads viewed	Number of whitefly heads with fluorescent signal	% of whitefly heads with fluorescent signal	Total number of whitefly heads viewed	Number of whitefly heads with fluorescent signal	% of whitefly heads with fluorescent signal	% Relative Change
1	124	19	15.32%	149	11	7.38%	-52%
2	81	19	23.46%	79	7	8.86%	-62%
3	86	29	33.72%	94	6	6.38%	-81%
4	84	15	17.86%	96	7	7.29%	-59%
5	100	20	20.00%	97	11	11.3%	-43%



B. napus

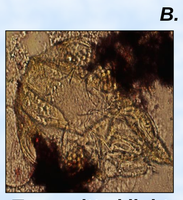


Transmitted light

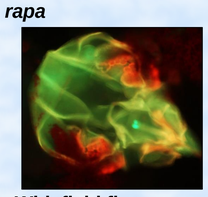


Widefield fluorescence

B. rapa



Transmitted light



Widefield fluorescence

Acknowledgments: