Cooperation between plant enemies - do raspberry viruses attract more aphid vectors?

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Plants can be simultaneously attacked by a range of organisms, including insects and viruses. Recent evidence suggests that viral pathogens can alter their host plants to recruit more aphid vectors, thereby facilitating further transmission.

The large raspberry aphid, *Amphorophora idaei*, is a highly mobile and effective vector of at least four viral pathogens afflicting red raspberry, *Rubus idaeus*, in the U.K., including Black raspberry necrosis virus (BRNV) and Raspberry leaf spot virus (RLSV).

Understanding the mechanisms underpinning the interaction between *A. idaei* and the viruses it vectors, and particularly the role that viruses play in altering host plant attractiveness could be crucial for the development of new control strategies.

Year One Experiments

Plant Material

BRNV and RLSV infected plants used in experiments were grown from vernalised root stock of parent plants that had been inoculated with the virus by means of bottle grafting. Plants were selected based on visual symptoms and the presence of the virus was subsequently verified using PCR diagnostics. Healthy plants were grown from certified healthy root stock.

Figure 1. Gel analysis from RT-PCR reactions testing Glen Ample plants for presence of BRNV. Lane 3 shows positive control from field material. Lanes 4-13 show samples from Healthy Ample root stock no. 72 and lanes 14-23 show BRNV infected Glen Ample samples from root stock no. 63. Product of interest present at ~500bp.

Figure 2. Symptoms of Black raspberry necrosis virus transmitted by *A. idaei*

(1) Individual Choice

Choice experiments were conducted in a controlled environment (19 ± 1°C, 16:8 L:D photoperiod). Two plant leaflets (one infected and one healthy) were positioned within a Perspex arena (23 x 23 x 1.5 cm). Each leaflet protruded through a small hole bored into the side of the arena allowing them to remain attached to the plant for the duration of the experiment One apterous adult aphid was released into the centre of the arena equidistant from both leaflets and its position was recorded every 60 seconds over a 30 minute time period.

(2) Population Choice

Aphid choice experiments were conducted in a controlled environment (conditions as above) with plants housed in custom built wire-mesh insect cages. Five apterous adult *A. idaei* were released at a point equidistant from a virus infected and healthy plant. Aphid positions within the cages were monitored every 24 hours over 7 days.

Results

(1) Individual Choice

When presented with a choice between BRNV infected or healthy host plants, a significantly higher number of adult *A. idaei* chose to settle on those that were infected with the virus. Although a higher number of aphids chose to settle on RLSV infected hosts, the relationship was not significant.

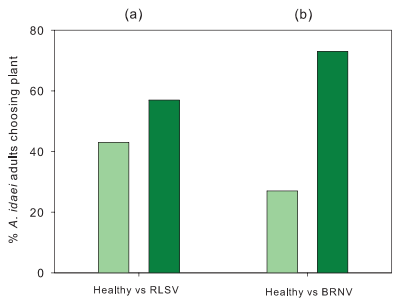

Figure 3.
(a) Percentage of individual adult *A. idaei* choosing to settle on RLSV infected or healthy host plants
(b) Percentage of individual adult *A. idaei* choosing to settle on BRNV infected or healthy host plants

(2) Population Choice

Significantly higher numbers of aphids were found to settle and feed on plants infected with RLSV when compared with healthy host plants. Similar experiments conducted using BRNV inoculated plants identified the presence of a similar interaction.

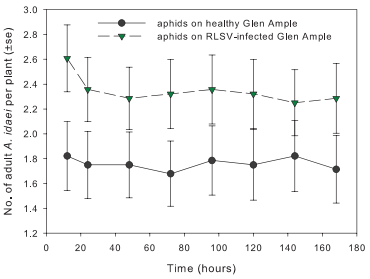

Figure 4.
Mean number of adult *A. idaei* (± se) on RLSV infected and healthy host plants.

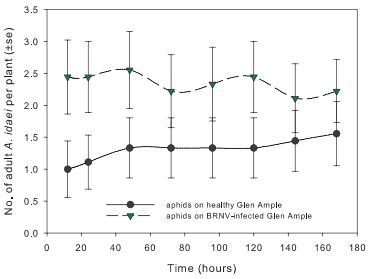

Figure 5.
Mean number of adult *A. idaei* (± se) on BRNV infected and healthy host plants.

Conclusions and Future Work

Preliminary experiments have provided encouraging evidence to suggest that BRNV and RLSV act to attract their insect vector, *Amphorophora idaei*. The results obtained facilitate the design of further experiments aimed at pinpointing the chemical mechanisms behind the behavioural interaction. Further experiments have been designed that will incorporate olfactometer apparatus in order to determine if it is a plant volatile that is acting as the attractant to the aphid.