Will climate change accelerate the breakdown of aphid-resistance in raspberry?

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Over the last 50 years, red raspberry (*Rubus idaeus*) has been bred for genetic resistance to the European large raspberry aphid (*Amphorophora idaei*) - a major vector of at least four plant viruses. However, this resistance has begun to partially break down due to strong selection pressures and rapid regeneration in aphids. The ability of *A. idaei* to overcome resistance can be classified according to aphid biotype. We investigated whether elevated atmospheric CO_2 accelerated this breakdown using three raspberry varieties with different levels of aphid resistance[(1)] (Table 1).

Table 1. Raspberry cultivars with different levels of resistance and predicted suitability of plants for two *A. idaei* biotypes that occur in the UK. ✓✓✓ = optimal host, ✓✓ = suitable host, ✓ = adequate host, × = inadequate host.

Plant details			Aphid biotype	
Raspberry cultivar	Resistance gene	Resistance level	Biotype 2 (most common in UK)	A10RB (A10 resistance-breaking biotype)
Malling Jewel	None	No resistance	✓✓✓	✓✓✓
Glen Lyon	A1	Some resistance	✓✓	✓✓✓
Glen Rosa	A10	Stronger resistance	×	✓

Experiments

- Raspberry plants were grown at two CO_2 concentrations (ambient: 380ppm and predicted levels in 2100: 700ppm). Cabinets maintained a diurnal air temperature peaking at 20°C during the day, decreasing to 10°C at night.[(2)] The experiment is to be run four times.
- After 3 weeks, all plants were caged (Fig. 1). Two teneral adult aphids and one third instar larvae were inoculated onto half of the plants in the cabinet, with the remaining plants remaining insect-free controls.
- Aphids remained on plants for a further 10 days. Aphids were then counted and a random selection of second instar larvae weighed.

Preliminary results

- Here we present findings from our first run of this experiment.
- Populations of both aphid biotypes increased in response to elevated CO_2 (Fig. 2) ($P < 0.05$). For biotype 2 aphids, the biggest increase was seen on Malling Jewel followed by Glen Lyon. For biotype A10RB, the largest increase was seen on Glen Rosa.
- There was no effect of elevated CO_2 on larval mass for biotype 2 aphids, except when reared on Glen Lyon (Fig. 3a). In contrast, larval mass of A10RB aphids increased in response to elevated CO_2 when reared on both Glen Rosa and Glen Lyon.

Initial conclusions and remaining work

- Our preliminary findings suggest that elevated CO_2 promotes *A. idaei* performance. In particular, the effects of elevated CO_2 potentially increased the susceptibility of some cultivars; Glen Lyon became a much better host for biotype 2 aphids and Glen Rosa became a better host for A10RB.
- The mechanism underpinning resistance to *A. idaei* is thought to involve epicuticular waxes.[(3)] Further work will be undertaken to explore the effects of elevated CO_2 on such waxes.
- In general, crop breeding should consider 'future-proofing' against insect pests to mitigate the effects of climate change.

Fig. 1. Caged plants in climate cabinets.

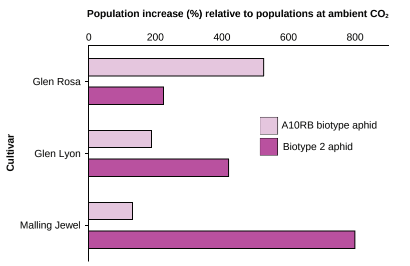

Fig. 2. Increase in aphid populations under elevated CO_2 conditions.

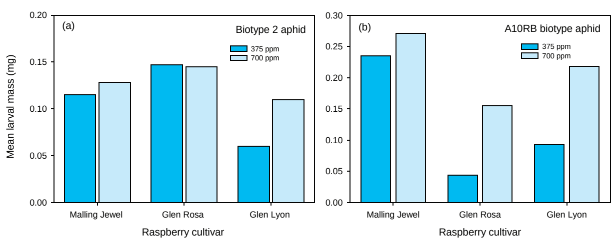

Fig. 3. Effects of elevated CO_2 on larval mass for (a) biotype 2 and (b) A10RB aphids.

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