Combining biological control and plant resistance to control the large raspberry aphid

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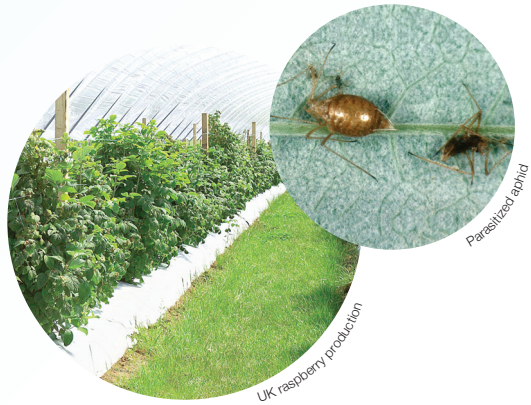


Introduction

The large raspberry aphid *(Amphorophora idaei)* is an important virus transmitting vector in UK raspberry production. Combining a bottom-up control mechanism (plant resistance) with a top-down mechanism (parasitoid) was tested as a possible novel method of controlling the aphid. In the laboratory, we investigated (1) whether the performance of *A. idaei* differed on two cultivars with varying resistance and (2) whether the performance of the aphid parasitoid, *Aphidius ervi*, differed on the two cultivars.

Materials and Methods

Both experiments used an aphid susceptible cultivar (Malling Jewel) and an aphid resistant cultivar (Glen Rosa). The experiments were conducted in growth cabinets at 20 ± 2.5 °C, 70 ± 2 r.h. under a 16:8 L:D photoperiod (280 µmol m^2 s^{-1}).

Aphid performance experiment

Eighty teneral aphids were individually clip caged to the underside of 40 Malling Jewel plants and 40 Glen Rosa plants (one aphid per plant). After 24 hours, the adult and all but one newly emerged nymph was removed from each of the clip cages. Every 24 hours the clip cages were examined and the following parameters were recorded: (1) pre-reproductive period, (2) total reproduction, (3) longevity and (4) the intrinsic rate of increase r_m (Wyatt and White 1977). The data were analysed using a Kruskal-Wallis one-way analysis of variance.

Parasitoid and aphid interaction experiment

Second instar aphids were positioned on the underside of the leaf at densities of 5, 10, 20 and 50. There were five replicates at each density on both cultivars. An experimental plant was placed in a clear acrylic cage and a mated female *A. ervi* was released onto the aphid infested leaf. The number of attacks by the parasitoid and the number of aphids falling from the plant was recorded. Any aphids falling from the plant were repositioned to maintain a constant density. The data were analysed using a generalised linear model with Poisson error structure and log-link function.

Results

Aphid performance experiment

There was a significant effect of cultivar on the four parameters studied with aphids feeding on Malling Jewel performing significantly better.

Aphids on Malling Jewel had a shorter pre-reproductive period, produced more offspring, lived longer and had a higher r_m compared with those reared on Glen Rosa. (Figure 1)

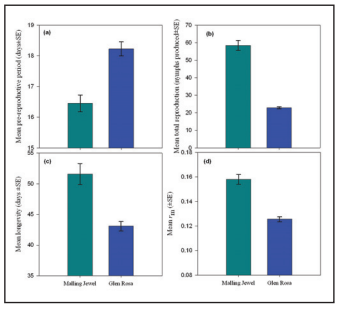


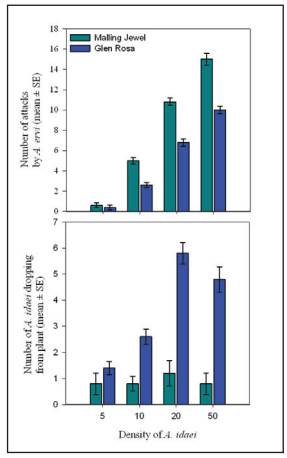
Figure 1 - *Amphorophora idaei* performance on raspberry cultivars, Malling Jewel and Glen Rosa. (a) Mean pre-reproductive period (H_1 = 22.128; P < 0.001). (b) Mean total number of nymphs produced (H_1 = 51.492; P < 0.001). (c) Mean longevity (H_1 = 21.975; P < 0.001) (d) Mean r_m (H_1 = 49.361; P < 0.001).

Parasitoid and aphid interaction experiment

There were significantly more ($F=13.26_{1,32}$;$P<0.001$) attacks on aphids feeding on Malling Jewel than on Glen Rosa and there was a significant increase ($F=52.76_{3,32}$;$P<0.001$) in the number of attacks as density increased.

There were significantly more ($F=35.64_{1,32}$;$P<0.001$) aphids on Glen Rosa dropping from plants than on Malling Jewel and there were significantly more ($F=5.3_{3,32}$;$P=0.0044$) aphids dropping from plants at densities of 20 and 50 when compared with densities of 5 and 10. (Figure 2)

Figure 2 – (a) The mean number of attacks by *A. ervi* of second instar *A. idaei* nymphs and (b) the number of second instar nymphs dropping from Malling Jewel and Glen Rosa.



Conclusions

Aphids feeding on the resistant cultivar, Glen Rosa, showed depressed performance suggesting that the aphid remains poorly adapted to feeding on the resistant host.

The number of nymphs attacked on the resistant host, Glen Rosa, was lower, indicating that the parasitoid either perceives the aphid as a poorer quality host or is less able to interact with it.

The aphids on the resistant host were more likely to drop from the plant in response to the parasitoid foraging. This energetically costly action also suggests that the aphid perceives the host as poorer quality.

Combining the bottom-up control mechanism (plant resistance) with the top-down control mechanism (parasitoid) has potential to control this aphid but the situation is complex and requires further investigation to ensure success.

Large raspberry aphid

References

Wyatt, IJ and White, PF (1977) Simple estimation of intrinsic increase rates for aphids and tetranychid mites. Journal of Applied Ecology, **14**: 747-766.

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