Plant-mediated effects of drought on predator-prey interactions

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Summer drought is predicted to adversely affect crop production within the next 30 years, yet the impacts on subsequent trophic levels are understudied. In Scotland, barley (Hordeum vulgare) cultivation is likely to be hindered under predicted climate change scenarios, in terms of yields and quality.

The objectives of this study were to understand how plant-mediated effects of drought (plant height and mass; elemental and nutritional chemistry) affect the performance of the aphid Rhopalosiphum padi at the individual (aphid quality; individual mass) and population level (population growth; number of nymphs and winged aphids). We also investigated how such effects influenced the foraging behaviour of its parasitoid, Aphidius ervi (attack rate; host preference; foraging time).

Methods

Experiment 1
- Using a randomized experimental layout, 60 identical H. vulgare plants (cv. Optic) comprising ten groups of six were grown under controlled glasshouse conditions. Each group of six plants were allocated to the following treatments:

<table>
<thead>
<tr>
<th>Insect condition:</th>
<th>Control</th>
<th>Aphid</th>
<th>Aphid-parasitoid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought treatment:</td>
<td>Ambient 50% rainfall</td>
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- Aphid and aphid-parasitoid treated plants were infested with two adult R. padi from a clonal culture after 21 days.
- Control and aphid treated plants were harvested and analysed using High Performance Liquid Chromatography (HPLC) and Elemental Analyser techniques after 42 days.
- A single mated female wasp was introduced to aphid-parasitoid treated plants and attack rate monitored over 30 minutes.

Experiment 2
- 20 H. vulgare plants were grown as previous and allocated to a drought treatment.
- Two adult R. padi were introduced and attached to leaf material in clip cages after 21 days. Honeydew was extracted after seven days and analysed using HPLC.
- Parasitoid choice assays were conducted using aphids and honeydew produced by aphids reared under differing drought treatments (Fig. 1).

Results

- Shoot growth (Fig. 2) and dry shoot mass (Fig. 3) decreased with herbivory and drought treatment. However, dry root mass decreased with herbivory only (Fig. 3).
- Drought treatment reduced percentage shoot nitrogen, while percentage root nitrogen decreased with drought treatment and herbivory by R. padi (Fig. 5).
- Free essential amino acid content contained in shoot tissue increased with herbivory and the interaction between drought and herbivory (Fig. 4).
- R. padi feeding on drought-stressed plants produced honeydew with a lower total amino acid content (Fig. 6a) and lower essential amino acid content (Fig. 6b).
- In a no-choice experiment, attack rate of A. ervi significantly decreased with 50% drought treatment (Fig. 7).

Barley production is likely to be hindered by summer drought through a reduction in total biomass production.

Our results support evidence of nitrogen remobilization under reduced rainfall regimes.

Further work needs to be conducted to assess drought-induced changes to aphid population demography.

Plant-mediated changes to prey quality may reduce the efficacy of parasitoid foraging under drought conditions.