Introduction

*Manduca sexta* (commonly known as the tobacco hornworm) feeds almost exclusively on plants in the family Solanaceae. On *Datura wrightii*, they can lay up to 100 eggs per night. *Datura wrightii* provides nectar for adult *M. sexta* in return for the benefit of pollination.

However, *Manduca* larvae rely exclusively on the plant for its complete nutrition. Thus, the interaction between *Datura* and *Manduca* is mutualistic when considered from the perspective of the adult insect, but antagonistic when considered from the perspective of the larva.

*Manduca* fitness, as measured by larval size (head capsule size, growth rate, mass), is affected by the amount and type of *Datura* leaves consumed. Previous research shows that the plant has the ability to distribute resources differently among the leaves, which can affect the caterpillar. Smaller leaves (newer growth) have higher photosynthetic rates and thus have higher nitrogen and phosphorous content, while larger, older leaves have higher photosynthetic rates and carbon/carbohydrate concentrations. These differences affect *M. sexta* consumption and growth in laboratory experiments.

Upon reaching the fifth instar, a single *M. sexta* larva can consume an entire *Datura* plant. Thus, the plant can be expected to defend itself against *M. sexta* herbivory. Here, we look at whether herbivory produces changes in the quality of leaves that reduce the performance of subsequent herbivores that might attack the plant.

We conducted a laboratory experiment to test whether *M. sexta* grow more poorly on plants that were subjected to an artificial herbivory treatment compared to a control. We also examined whether plants in the field that were subjected to an artificial herbivory treatment would accumulate less herbivore damage than would control plants.

Field Methods and Results

The greenhouse treatments had been roughly replicated in a plot of 92 *D. wrightii* established at the Campbell Avenue Farm for another experiment. In order to test whether less damage accrued on cut vs. uncut field plants, herbivory data were collected on:

- A control group, made up of 10 randomly chosen plants on which no leaves were cut
- A light herbivory group, made up of 10 randomly chosen plants on which one-third of leaves had been cut in half along the midrib
- A heavy herbivory group, made up of 10 randomly chosen plants on which two-thirds of leaves had been cut in half along the midrib.

Data from six leaves per plant in the control group were taken. From the herbivory groups, data were collected from three cut leaves and three uncut leaves per plant. Herbivory data were collected three times per week for three weeks. Leaf condition was assessed by assigning a damage class of 0–5: 0 = no damage, 1 = 1–25% damage, 2 = 26–50% damage, 3 = 51–75% damage, 4 = 76–99% damage and 5 = 100% damage.

No significant difference in average herbivory damage class was found among these groups (ANOVA, *P* > 0.1), suggesting that differences in leaf quality documented in the greenhouse do not translate into different levels of damage in the field. The field results, however, could have been affected by leaf damage prior to the experiment, size differences of the plants, or uneven watering of the plot. In addition, the field data were taken before *Manduca* typically begin to start feeding on *Datura*, so the damage observed was mainly from other herbivores.

Conclusions

Our hypothesis was that, once a plant suffers herbivory, it would begin to defend itself by removing resources from all of its leaves to reduce the rate of subsequent consumption. To some extent, our hypothesis was supported. Head capsule measurements indicate that *Manduca* fed on control leaves grew significantly larger than those fed on cut leaves, as seen in figures 1 and 2. Surprisingly, the data show a significant difference in growth rate and mass between *Manduca* that were fed cut leaves from cut plants, and those that were fed from the control leaves and uncut leaves from cut plants (figures 2, 3). There was no significant difference in these measurements between the control group and the group that had fed uncut leaves from a cut plant (figures 2, 3). This indicates that *Datura* can selectively pull resources from individuals, partially damaged leaves, instead of unequally from all leaves on the plant.

Plants’ ability to allocate resources strategically is likely to increase their fitness. However, we did not find evidence that this ability translated into differential levels of herbivory in the field. Initial field census data did not suggest any difference between subsequent herbivory on cut and uncut leaves. However, the field census was conducted before the monsoons, which is a cue for *Manduca* emergence. It is possible that differential herbivory will be detected as the census continues throughout the summer.

Acknowledgements

We gratefully acknowledge Andy McCall with his assistance with this project. Stephen Beall and Daniella Figueroa were supported by a National Science Foundation Grant awarded to the Plant Collaborative.

Greenhouse Methods

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<th>Treatments</th>
<th>Control (Uncut Leaves from Uncut Plant)</th>
<th>Cut Leaves from Cut Plant</th>
<th>Uncut Leaves from Cut Plant</th>
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<tr>
<td>Weight (g)</td>
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<tr>
<td>P</td>
<td>A</td>
<td>AB</td>
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Figure 1. Development Time

Figure 2. Head Capsule Distribution

Figure 3. Head Capsule Size

Figure 4. Mass

* Different letters above each bar indicate treatments that are significantly different
* Head capsule size was measured using a hand-held micrometer

Greenhouse Results

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<tr>
<th>Treatment</th>
<th>Male (g)</th>
<th>Female (g)</th>
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<tbody>
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<tr>
<td>Cut Leaves from Cut Plant</td>
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<td>Uncut Leaves from Cut Plant</td>
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Figure 5. Development Time

Figure 6. Head Capsule Distribution

Figure 7. Head Capsule Size

Figure 8. Mass

* Different letters above each bar indicate treatments that are significantly different
* Head capsule size was measured using a hand-held micrometer

Effects of *Datura wrightii* herbivory on *Manduca sexta* performance

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