Effects of UV-B Radiation on Insect Herbivore Levels in Field-Grown *Arabidopsis thaliana* Plants

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Introduction

Most plants experience herbivory by primary consumers like insects. Plants have several mechanisms to defend themselves from herbivore attacks, such as chemical and structural defenses. Glucosinolates are secondary metabolites present in *Arabidopsis thaliana* and other members of the Brassicaceae family. The concentration of these chemicals in plants can be affected by environmental factors such as light, CO_2, and soil nutrient levels. For example, there is evidence that ultraviolet-B (UVB) radiation may influence insect herbivore levels likely as a result of changes in the biosynthesis of plant secondary metabolites (Caldwell et al. 2003; Bassman 2004; Caputo et al. 2006). However, many of these studies have been conducted in laboratory rather than field settings and have focused on UVB effects at the plant species- rather than genotype-specific level. Here, we present results from a field study in which plant intra-specific variation in the response to insect herbivory was assessed under two UVB levels (i.e., solar UVB and filtered UVB). Information from this study regarding the role of UVB on plant resistance to insect herbivory is important because: 1) *A. thaliana* shares defensive characteristics with several cash crops (e.g., cabbage, broccoli and cauliflower), and 2) levels of UVB radiation are currently changing as a result of anthropogenic activities.

Hypothesis

Variation in UVB radiation may influence levels of insect herbivory in field-grown A. thaliana *plants due to potential UVB effects on plant secondary metabolism. We predicted that different UVB levels would modify plant responses to insect herbivory and that these responses would be plant genotype-specific.*

Results

1) There was a significant decrease in the number of days to first observed herbivore damage in plants excluded from UVB radiation when compared with plants exposed to ambient UVB (Figure 1A) and this effect was genotype-specific (Figure 1B). Likewise, a higher number of plants were damaged in UVB- plots (Figure 1C).

2) Herbivore damage to plant rosette leaves was significantly higher in plants excluded from UVB than plants exposed to ambient UVB radiation (Figure 2A). In addition, there was significant genetic variation in rosette damage as well as in the way that genotypes responded to the UVB treatments (significant G×E interaction).

Conclusion

1) Even though there was intra-specific variation in plant responses to insect herbivory, UVB exclusion affected the order of plant colonization by insect herbivores in the field as well as the number of plants attacked.

2) UVB exclusion influenced the amount of damage inflicted by insect herbivores on plants; although this effect was also genotype-dependent.

References

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Methods

To test our hypothesis, we used the annual weed Arabidopsis thaliana, *which belongs to the Brassicacea family. This plant family includes economically important plants, such as broccoli and cabbage. We used 100 different recombinant inbred lines (RILs) expressing variation in their chemical defense profiles. This allowed us to assess intra-specific variation in plant resistance to insect herbivory under different UVB settings. A split plot design was used to assess the effect of plant genotype (RILs) and UVB radiation on levels of natural insect herbivory. The two UVB treatment levels consisted of ambient (UVB+) and UVB removed using a film (Mylar) that screened this type of radiation (UVB-). UVB+ plots were covered with a film that allowed most UVB to pass through. Two plants of each genetic line were randomly planted into 80 flats (i.e., 25 RILs per flat) and distributed among 10 plots (5 plots assigned to each UVB level) accounting for a total of 2000 plants. Each plot was surrounded with a wire-mesh fence to exclude mammalian herbivory. To evaluate the role of UVB on plant resistance to insect herbivory, we measured the following traits: order of insect herbivore colonization, number of plants attacked and actual plant damage (i.e., percent area of rosette leaves removed by insect herbivory). Plant damage was estimated using a qualitative damage index (adapted from Bidart-Bouzat et al. 2005).*

Picture Left: Plugs arranged under a plot

Picture Right: Entire set up on the field (total of 20 plots)

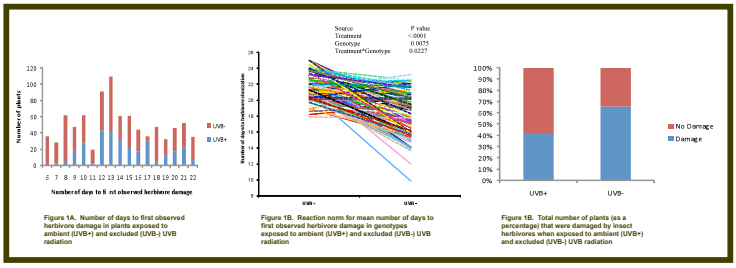

Figure 1A. Number of days to first observed herbivore damage in plants exposed to ambient (UVB+) and excluded (UVB-) UVB radiation

Figure 1B. Reaction norm for mean number of days to first observed herbivore damage in genotypes exposed to ambient (UVB+) and excluded (UVB-) UVB radiation

Figure 1B. Total number of plants (as a percentage) that were damaged by insect herbivores when exposed to ambient (UVB+) and excluded (UVB-) UVB radiation

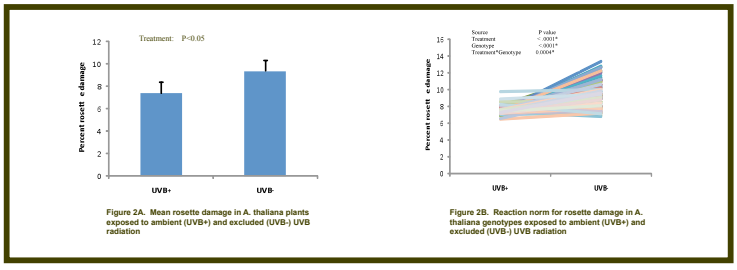

Figure 2A. Mean rosette damage in A. thaliana plants exposed to ambient (UVB+) and excluded (UVB-) UVB radiation

Figure 2B. Reaction norm for rosette damage in A. thaliana genotypes exposed to ambient (UVB+) and excluded (UVB-) UVB radiation