

Indirect Effects of Deer on Insect Pest Populations in Soybean Fields

Summary

We tested for **direct and indirect effects of deer and insect pest herbivory** on soybean yield.
Increased deer browse on soybeans indirectly increases pest insect abundance.
Deer herbivory is a **stronger predictor** of soybean yield than plant height and pest insect abundance.

Introduction

- White-tailed deer and insect herbivores negatively impact plant growth.^{1,2}
- Little is known about interactions between these herbivores in annual crop systems.²
- Insights into these interactions could lead to new pest management techniques.
- The objective of this study was to understand the relationship between two taxonomically different herbivore groups and their combined effects on crop plant defense and yield.



Figure 1. Deer browsing in soybean plots of the Ecology Research Center in Oxford, Ohio.

Hypotheses and Predictions

- We hypothesized that deer browse influences insect pest abundance and herbivory in agroecosystems and that soybean yield would be affected by herbivory from both deer and insect pests.
- We predicted that the deer browse would increase pest abundance and herbivory through changes in leaf nutrients. We also predicted deer herbivory would have a stronger negative effect on soybean yield than insect pest herbivory.

Methods



- Six soybean plots (60x70 m) were marked with six evenly spaced transects.
- Sweep net samples and interval leaf samples were taken from center 10m of each transect.
- Plant height and stem browse ratio were recorded along center 5 m of each transect.
- Three randomly selected leaf samples were analyzed for insect damage using ImageJ and three were prepared for C:N analysis.
- An appraisal of crop yield was conducted to measure soybean reproductive output.
- Linear regression, AICc model selection, and structural equation models were used to assess direct and indirect relationships among variables.

Figure 2. Aerial map of experimental agricultural plots in the Miami University Ecology Research Center in Oxford, Ohio. Numbers represent soybean fields used in this study.

Results

- 2,460 individual insects were sampled, representing 12 pest species.
- 6,263 plant height and stem browse measurements were taken.
- Mean percent deer browsed stems ranged from 9% to 32% in early August.
- Leaf nutrient analyses are being conducted to investigate induced plant defense effects on insect herbivores.

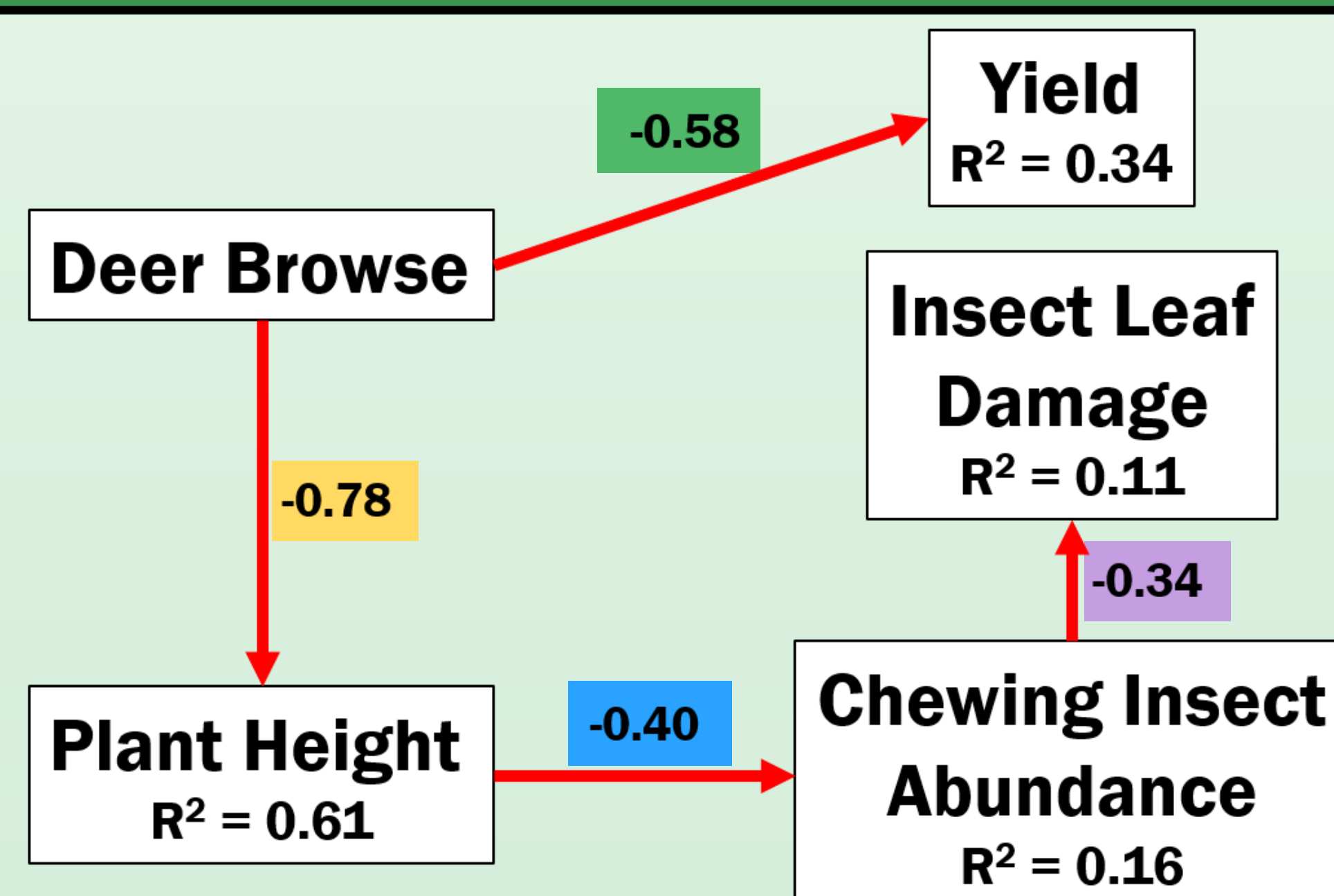


Figure 3. Structural equation model showing standardized strength of relationships among variables and goodness of fit. Box colors correspond to the outline colors of regressions in Figure 4.

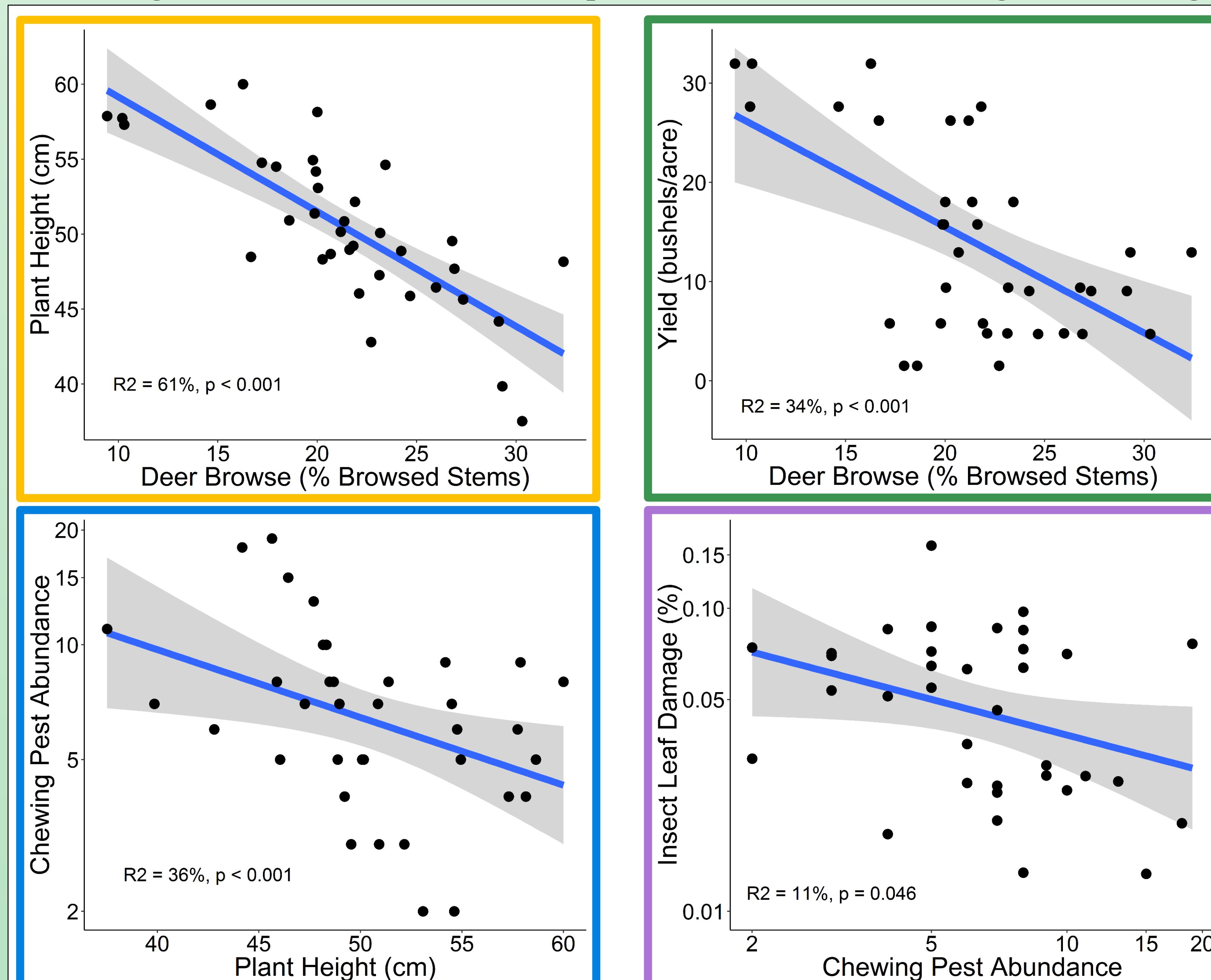


Figure 4. Relationships between deer browse and plant height (top left); deer browse and yield (top right); plant height and chewing insect abundance (bottom left); and, chewing insect abundance and insect leaf damage (bottom right).

Conclusions and Implications

- Deer browse moderately benefits pest insect abundance through changes to plant growth
 - Nutrient analysis of soybean leaves will shed light into drivers of this relationship
- Chewing insect pest abundance was lower than economic threshold levels
- Limiting deer browse in soybean fields may be an effective insect pest management technique
- Economic threshold of deer browse appears to be ~20% mean browsed stems



Figure 5. A. VanGorder (left) and G. Lloyd (right) measuring plant height and stem browse ratio.

Further Information

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Literature Cited

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- Shimazaki et al. 2002 Ecological Research 17:527-533.