INFLUENCE OF ULTRAVIOLET RADIATION ON CELL WALL CONSTITUENTS IN REDUCED-LIGNIN MUTANTS OF CORN AND SORGHUM

Brock J. Bermel and Christopher T. Ruhland

Introduction

- Brown midrib mutants (BMR) of corn (*Zea mays*) and sorghum (*Sorghum bicolor*) have recently gained popularity in Southern Minnesota as forage material for grazing animals.
- These mutants have lowered expression of cinnamyl alcohol dehydrogenase and caffeic O-methyltransferase enzymes in the phenylpropanoid pathway responsible for the construction of the cinnamyl alcohol subunits of lignin.
- Reduced lignin increases livestock digestibility of these plants, but may also increase susceptibility to pathogen attack, lodging and environmental stress.
- In addition, phenylpropanoids are important attenuators of ultraviolet radiation (UV; Ruhland & Day 2000) and reductions in lignin concentrations during development may influence concentrations of cell wall constituents.
- We examined how UV influenced the cell-wall composition over a 50-day experiment in BMR corn and sorghum under greenhouse conditions.

Methods

- The experiment was held in a greenhouse which transmits nearly all ambient UV. Plants were grown under filters that either transmit ("Aclar") or attenuate ("Mylar") UV-B (Figure 2).
- Plants were harvested three times (days 20, 35 and 50) over the length of the experiment.
- The concentrations of cellulose, hemicellulose and lignin were determined using the filter-bag detergent technique using neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) in combination with a fiber analyzer (A200, ANKOM Technology).

Figure 1: The BMR mutation in sorghum makes for an excellent forage material for livestock due to low lignin concentrations (top; photo by King's Agriseeds). The BMR mutation is named after the brown coloration of the mid-vein and associated with reduced lignin content (lower left). We manipulated UV levels around corn and sorghum during a 50-d experiment using filters that modify incoming ambient radiation (lower right).

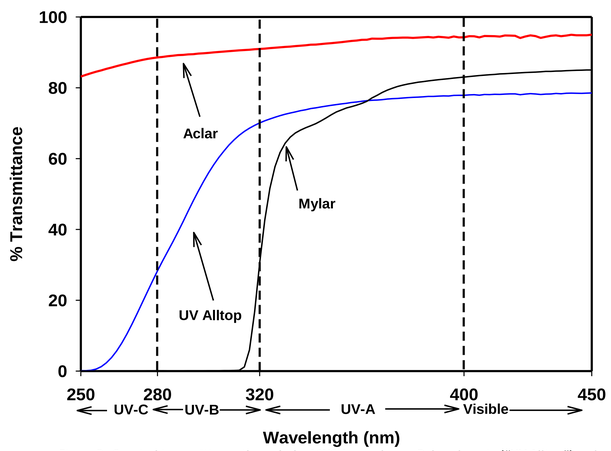

Figure 2: Spectral transmittance through the MNSU greenhouse Polycarbonate ("UV Alltop") and the UV-transmitting ("Aclar") and UV-attenuating ("Mylar") treatment films. The greenhouse Polycarbonate transmits >91% of ambient visible radiation, and 76% and 53% of UV-A and UV-B radiation, respectively. The Aclar film transmits >90% of UV-A and UV-B radiation while the Mylar film transmits >74% of UV-A and <3% of UV-B radiation.

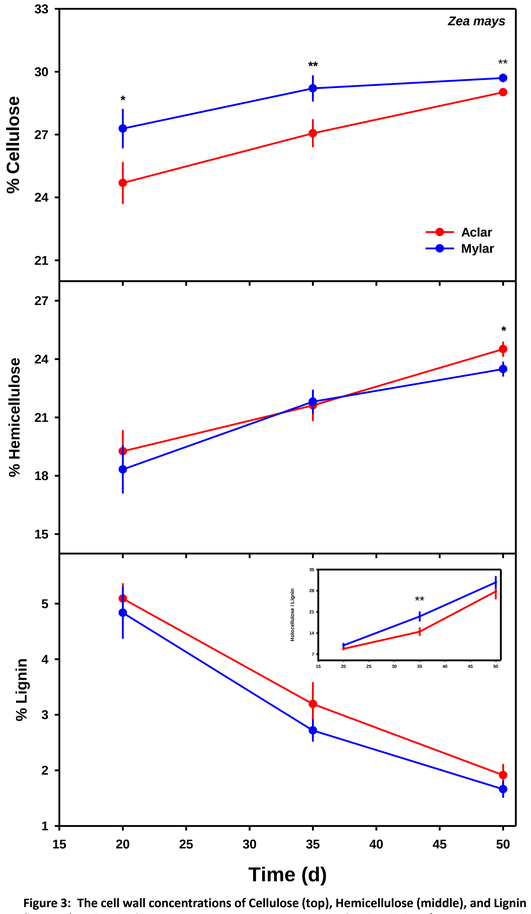

Figure 3: The cell wall concentrations of Cellulose (top), Hemicellulose (middle), and Lignin (bottom) under the filters in corn. *Insert:* Concentration of Holocellulose/Lignin ratio. Values are means (n=7) and vertical bars represent 1SE and ** and * indicate a treatment effect (P<0.05 and 0.10, respectively).

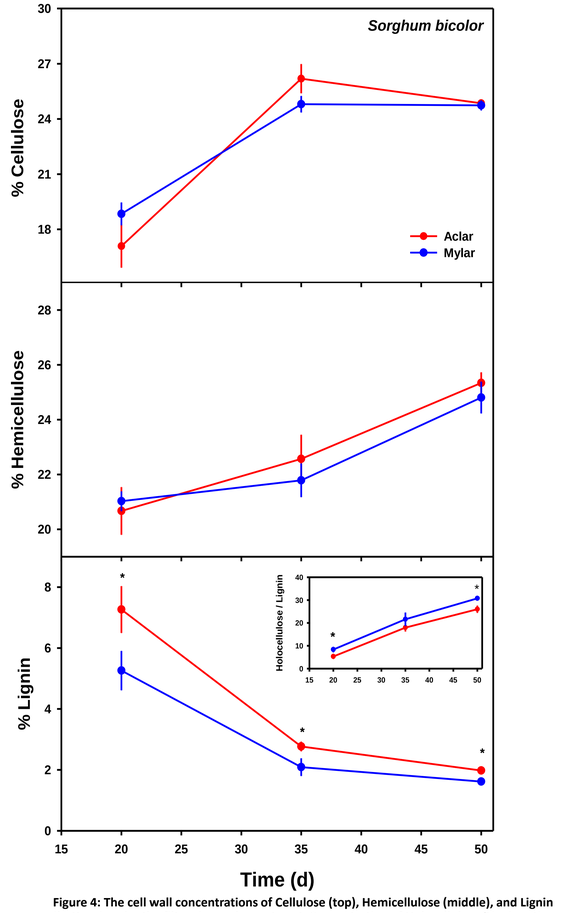

Figure 4: The cell wall concentrations of Cellulose (top), Hemicellulose (middle), and Lignin (bottom) under the filters in sorghum. *Insert:* Concentration of Holocellulose/Lignin ratio. Values are means (n=7) and vertical bars represent 1SE and ** and * indicate a treatment effect (P<0.05 and 0.10, respectively).

Results

- In BMR corn, cellulose concentrations were consistently higher in plants growing under Mylar than under Aclar on all sampling dates (Figure 3).
- In BMR sorghum, lignin concentrations tended to be higher under Aclar than Mylar (P<0.10; Figures 4).
- There were very few UV effects on hemicellulose concentrations in either species (Figures 3 & 4).
- Holocellulose/Lignin ratios in both species had slight higher ratios under Mylar than Aclar (*inserts;* Figures 3 & 4).

Conclusions

- Our results indicate that UV radiation may have a subtle influence on cell wall constituent concentrations in BMR corn and sorghum mutant varieties.
- The effects of UV radiation may be species dependent.
- Although UV radiation may have minimal effects on BMR cultivar crops, UV-stress coupled with other biotic and abiotic stresses may reduce potential yields and/or digestibility of these varieties by grazing animals.
- Future studies should address the sensitivity of BMR varieties to UV radiation under realistic outdoor spectral regimes.

References

Ruhland CT, Day TA. (2000). Effects of ultraviolet-B radiation on leaf elongation, production and phenylpropanoid concentrations of *Deschampsia antarctica* and *Colobanthus quitensis* in Antarctica. *Physiologia Plantarum* 109: 244-251.

Acknowledgements

We thank Maegan Eatwell for assistance with the UV-filter treatments. Financial support was provided by grants from the National Science Foundation(Grant # DEB1256129).

This document is available in alternative format to individuals with disabilities by calling Accessibility Resources at 507-389-2825 (V), 800-627-3529 or 711 (MRS/TTY).