

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

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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.



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).

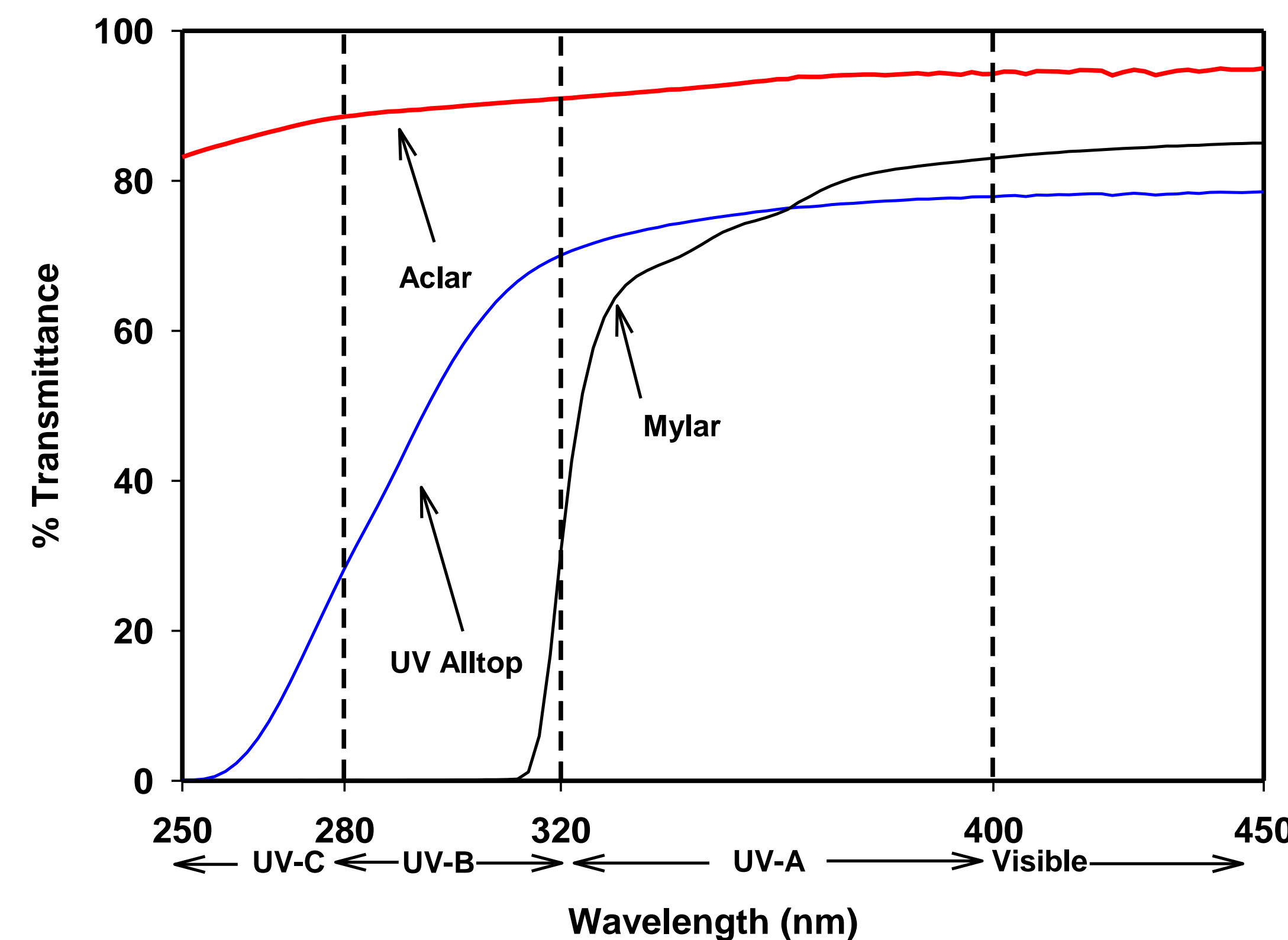


Figure 2: Spectral transmittance through the MNSU greenhouse Polycarbonate ("UV Alltop") and the UV-transmitting ("Aclar") and UV-attenuating ("Mylar") treatment films. The greenhouse Polycarbonate transmits >91% of ambient visible radiation, and 76% and 53% of UV-A and UV-B radiation, respectively.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

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

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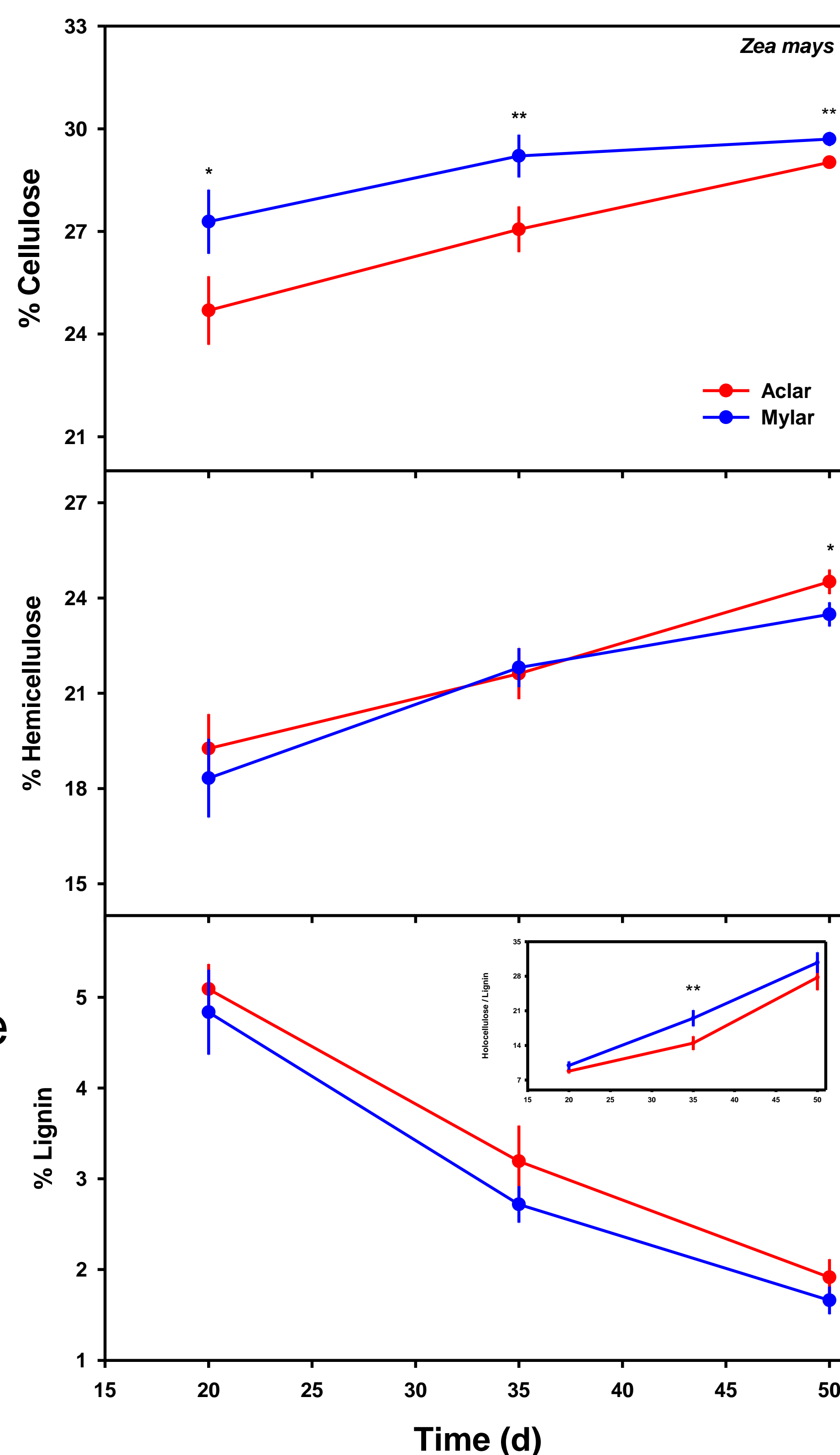


Figure 3: The cell wall concentrations of Cellulose (top), Hemicellulose (middle), and Lignin (bottom) under the filters in corn. *Insert*: Concentration of Holocellulose/Lignin ratio. Values are means (n=7) and vertical bars represent 1SE and ** and * indicate a treatment effect ($P < 0.05$ and 0.10,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

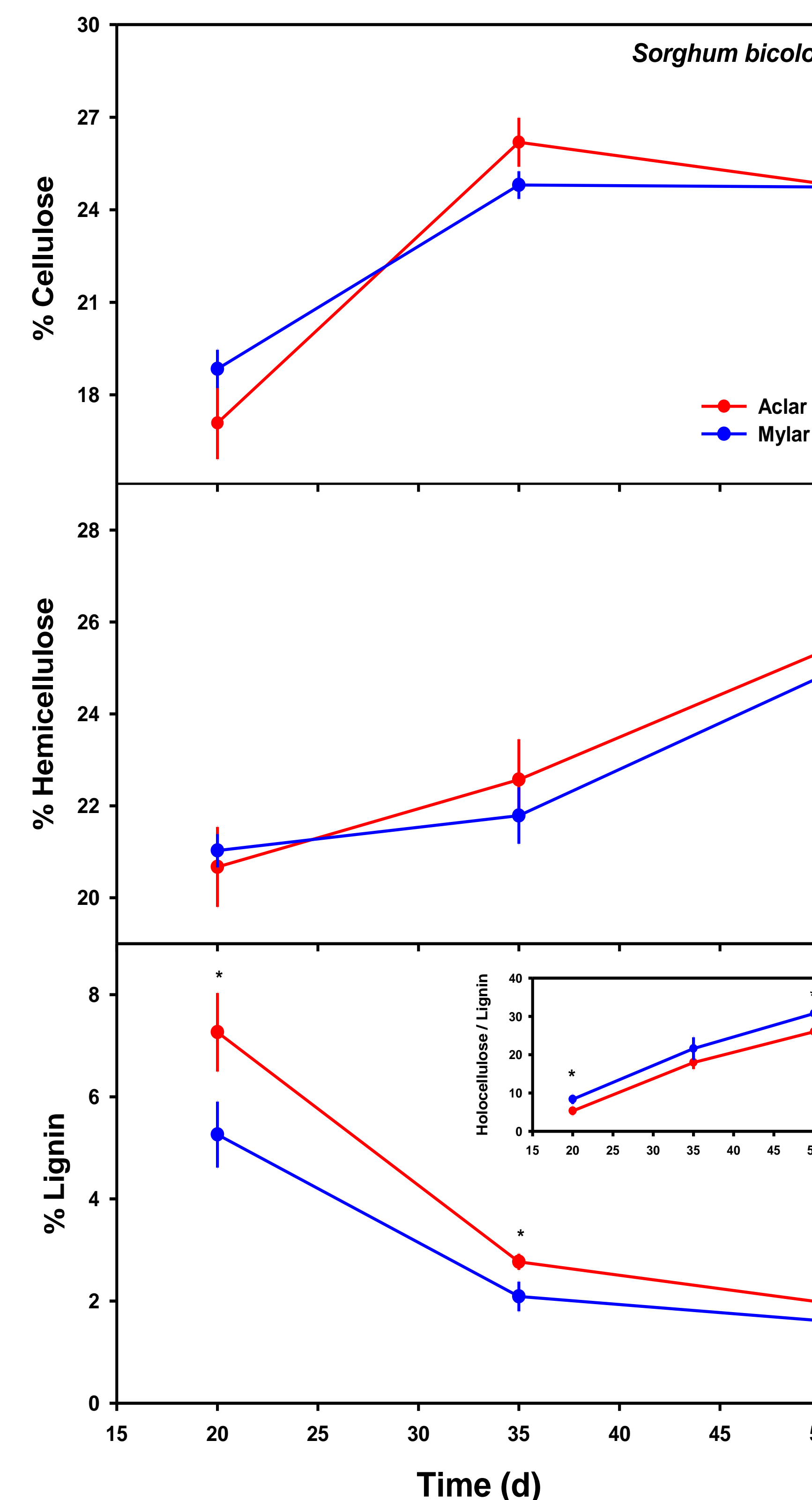


Figure 4: The cell wall concentrations of Cellulose (top), Hemicellulose (middle), and Lignin (bottom) under the filters in sorghum. *Insert*: Concentration of Holocellulose/Lignin ratio. Values are means (n=7) and vertical bars represent 1SE and ** and * indicate a treatment effect ($P < 0.05$ and 0.10,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