

Author:  [ADVANCED](#)Volume  Page Keyword:   
[TOP](#) > [Available Issues](#) > [Table of Contents](#) > [Abstract](#)

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[\[PDF \(579K\)\]](#) [\[References\]](#)

## Estimating the Mean Leaf Inclination Angle of Wheat Canopies Using Reflected Polarized Light

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**Abstract:** In this study, we extended previous work linking the polarization of reflected light from crop canopies with characteristics of the canopy structure, such as the leaf inclination angle. We obtained reflectance and polarized reflectance in 8 spectral bands from the canopies of two varieties of wheat, planted in plots fertilized with a basal dressing and topdressed at the jointing and booting stages. The optical measurements were carried out on 3 clear-sky days when the plants were at the stem-elongation, heading and ripening stages, respectively. On each measurement date, we assessed the leaf orientation geometry of the plants using a Plant Canopy Analyzer (LAI-2000), measured the leaf greenness (an indicator of leaf chlorophyll content) using a handheld SPAD-502 (SPAD) optical sensor, and also measured plant height. Both polarization and leaf greenness observations at the heading stage were able to distinguish the canopies that had received topdressing from those without topdressing. However, no significant correlation was observed between the polarization in the blue, green and red bands and the SPAD ( $r=0.425-0.456$ ,  $n=12$  observations,  $p>0.05$ ). On the other hand, the mean leaf inclination angle (= mean tip angle: MTA) measured by the LAI-2000 was inversely correlated with the polarization in the 3 visible bands ( $r=-0.85-0.88$ ,  $n=12$ ,  $p<0.001$ ). Adjusting the view zenith angle according to the solar position at the time of measurement improved the accuracy. We tested a linear regression model to predict the MTA of the two wheat varieties based on polarized reflectance in the red band centered at 660 nm ( $r^2=0.73$ ,  $n=12$ ,  $p<0.001$ ). Validation of this model obtained in the subsequent cropping season confirmed that polarization

measurements were potentially useful for estimating the MTA of wheat stands in which the panicles were located below the topmost leaf layer of the canopy.

**Keywords:** [Jointing-stage topdressing](#), [LAI-2000](#), [Mean tip angle](#), [Polarization](#), [Remote sensing](#), [SPAD-502](#), [Wheat](#)

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