Quantification of Soybean Canopy Development and Weed Competition Using LiDAR-Based UAV Imaging

Matt Fallis[1], Kristen MacMillan[1], Dilshan Benaragma[1]

[1]Department of Plant Science, Faculty of Agricultural and Food Sciences, University of Manitoba, 66 Dafoe Road, Winnipeg, MB, R3T 2N2, Canada

Quantifying soybean canopy development and weed competition across agronomic practices is challenging due to spatial variability and the labour required for repeated ground measurements. A factorial field experiment in Carman, Manitoba, tested combinations of three seeding rates (80,000, 160,000, 240,000 seeds ac^{-1}), three row spacings (7.5, 15, 22.5 in), and weedy versus weed-free conditions, with weekly UAV multispectral and LiDAR flights. Ground data included crop height, biomass, and yield to evaluate remote sensing metrics.

LiDAR point clouds were processed to derive 90th-percentile canopy height and volume for each plot, and these traits were related to ground measurements over the early growing season. Ground height and LiDAR height showed a strong, significant non-linear relationship described by a four-parameter log-logistic model, indicating that LiDAR height reliably tracked soybean canopy growth. LiDAR volume trajectories over six weeks clearly separated row spacing × seeding rate treatments, while early-season crop biomass was consistently reduced under weedy conditions, with narrow 7.5-inch rows partially mitigating losses.

These results demonstrate that LiDAR-based UAV imaging can capture treatment-driven differences in soybean canopy development and early weed competition, supporting its use as a high-throughput tool to evaluate cultural weed management strategies.