ABSTRACT

Detailed spatial information of crop growth variability is essential to implement field management practices. High spatial resolution QuickBird satellite imagery data have provided new opportunities to estimate variations in crop conditions within a field. To evaluate the feasibility and reliability of QuickBird data, a three-year field campaign was conducted in a corn field and potato treatment plots to provide ground-based measurements of canopy biophysical and biochemical characteristics. Image-based algorithms for atmospheric correction were evaluated on QuickBird imagery and improved to retrieve surface reflectance of corn and potato canopies. Based on retrieved canopy reflectance, the potential for determining biophysical properties (e.g., leaf area index (LAI)) and biochemical properties (e.g., canopy nitrogen (N) content) using QuickBird data was investigated. The commonly used spectral vegetation indices (VIs) based on broadband reflectance were evaluated to identify the best VI for retrieving LAI. High resolution LAI was retrieved with identified VI from QuickBird imagery and validated with ground measurements. The effectiveness of QuickBird data in detecting variability in plant N status was compared with the petiole sampling method and the leaf chlorophyll meter (SPAD-502) in potato canopies.

The results indicated that the image-based model was most effective for the visible bands, but not for the near infrared (NIR) band since atmospheric transmittance was substantially overestimated on humid days. A contour map was developed to interpolate appropriate atmospheric transmittance for clear days under average atmospheric aerosol conditions and as a function of precipitable water content and solar zenith angle or

satellite view angle. With the interpolated atmospheric transmittance, the accuracy of NIR band reflectance was significantly improved and acceptable for agricultural applications. All selected VIs were well correlated with LAI, but with different efficiencies in estimating LAI as a result of the differences in dynamic ranges, the sensitivities to the variation of LAI, and the stabilities given other perturbing factors. The modified soil-adjusted vegetation index (MSAVI) proved to be the best LAI estimator for both crop types. QuickBird-derived LAI with MSAVI-LAI relationships agreed well with ground-measured LAI in both absolute values and spatial variability. QuickBird images acquired about one month after emergence were able to detect the same N treatment variations detected with petiole NO_3-N concentrations and SPAD meter readings, and helpful in mapping and monitoring N deficiency. However, treatment differences in VI value were minimal and insignificant when LAI reached large values.

Based on high-frequency measurements of two-stage evaporation and thermal infrared surface temperature in another field campaign, different methods were compared for estimating evaporation coefficient and quantifying soil evaporation. The results indicated that the evaporation coefficient provides an alternative means for evaluating soil moisture status. The proposed method greatly improved the accuracy of estimation by integrating remotely sensed surface temperature into physically based algorithms.

In summary, high spatial resolution QuickBird satellite imagery had great potential to be incorporated into image-based remote sensing approaches for site-specific crop management, and remotely sensed high-frequency thermal infrared data could be integrated into evaporation estimation for soil moisture assessment.