TRACKING SPATIOTEMPORAL PARAMETERS FOR IN-SEASON NITROGEN MANAGEMENT AND YIELD PREDICTION IN COTTON

Vaishali Swaminathan
Texas A&M University
College Station, TX
J. Alex Thomasson
Mississippi State University
Starkville, MS
Nithya Rajan
Amrit Shrestha
Jeffrey Siegfried
Karem Meza Capcha
Texas A&M University
College Station, TX
Xiongzhe Han
Kangwon National University
Chuncheon, Republic of Korea (South)

Abstract

Nitrogen (N) availability and uptake, during the early growth stages in cotton, affect chlorophyll health, canopy development, maturity rate, and yield potential. Some of the visible symptoms of N stress include leaf chlorosis, stunted vertical growth, low canopy area, and early onset of senescence. Therefore, early detection of N stress is important for effective in-season N management, achieving yield goals and minimizing losses. The objectives of this study were (1) early prediction of N stress in cotton, and (2) yield prediction by tracking maturity rates. In this study, unmanned aerial vehicle (UAV) based multi-spectral images were used to capture spatiotemporal variabilities in a trial with four N application rates (0 lb./ac, 50 lb./ac, 100 lb./ac, 150 lb./ac). Normalized difference vegetation index (NDVI), normalized difference red edge index (NDRE), leaf area index (LAI), and canopy height were derived from the orthomosaic and digital elevation models. Early in the season, NDRE had the strongest correlation with total biomass N ($R2 = 0.80$), followed by LAI and NDVI ($R2 = -0.46$). Results for early detection of N stress indicated that K-Means classification based on weekly changes in two parameters (Δweekly NDRE and Δweekly LAI) was able to distinctly separate the high and low treatment zones (silhouette score = 0.56), offering better clustering than absolute daily values of the parameters (silhouette score = 0.37). The harvested yield had a linear relationship with Δweekly NDRE ($R2 = 0.86$), which was obtained around the time of flowering. The clustering algorithm based on Δweekly NDRE and Δweekly LAI during flowering stage was able to distinctly identify the different yield groups. Lastly, the K-Means classification algorithm was tested on an image dataset obtained at early boll opening to identify individual bolls visible on the canopy. The derived boll counts had a linear relationship with harvested yield, indicating the potential of early boll counts in predicting yield. The results showed that transforming the observed parameters to indicate growth rate (Δweekly) improved early season N stress prediction, as N availability is crucial for canopy expansion. Also, tracking maturity based on parameters obtained at the time of flowering improved yield prediction.

References

Ballester, C., Hornbuckle, J., Brinkhoff, J., Smith, J., & Quayle, W. (2017). Assessment of in-season cotton nitrogen status and lint yield prediction from unmanned aerial system imagery. Remote Sensing, 9(11), 1149.

Silvertooth, J. C., Bronson, K. F., Norton, E. R., & Mikkelsen, R. (2011). Nitrogen utilization by Western US cotton. Better Crops Plant Food, 95(2), 21-23.