CANOPY REFLECTANCE-BASED NITROGEN MANAGEMENT STRATEGIES FOR SUBSURFACE DRIP IRRIGATED COTTON

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ABSTRACT

Nitrogen (N) fertigation in subsurface drip irrigated (SDI) cotton (*Gossypium hirsutum* L.) can be very efficient. Determining the amounts and timing of the N fertigation, however are questions that weekly canopy reflectance measurements may answer.

The main objective of this 3-yr. study was to assess two canopy reflectance strategies for adjusting near-daily urea ammonium nitrate (UAN) fertilizer in-season injections between squaring and early to mid bloom. Additionally, we evaluated three fixed N rates; 50, 100, and 150 % of a soil test-based N recommendation for a 1400 kg lint ha^{-1} yield goal.

This three-year study was conducted at on Acuff sandy clay loam (fine-loamy, mixed, superactive, thermic Aridic Paleustolls) near Lubbock, Texas. Cotton cultivar ‘AFD 5065 B2F Roundup Ready’ was planted at a 16 kg ha^{-1} in early June in 2007, and in mid May in 2008 and 2009. Irrigation was targeted at 85 % replacement of evapotranspiration.

Based on the yield goal, the soil test-based N treatment rate was an N requirement of 140 kg N ha^{-1} minus 0- 0.6 m soil NO_3-N, and minus an estimate of seasonal irrigation water NO_3. For the reflectance-based N strategy-1, UAN was injected starting at first square at 50 % of the rate of the soil test-based N treatment. Normalized difference vegetative index (NDVI) was calculated from weekly canopy reflectance measurements at 1 m height. The spectroradiometers used were active (i.e. use built-in light sources) instruments, the GreenSeeker^{TM} and the Crop Circle^{TM}. If NDVI in the reflectance strategy-1 plots fell significantly below NDVI in the soil test-based plots, the N injection rate was increased to match the injection rate of the soil test plots. The reflectance-based N strategy-2 had an initial UAN injection rate equal to that of the soil test plots, and was raised to match the 150 % soil test plots when NDVI in the reflectance-2 plots < 1.5X soil test plots.

PROC MIXED was used to perform ANOVA, with N management, considered a fixed effect. PROC NLIN was used to estimate quadratic-plateau models of lint and seed vs. N fertilizer rate. The economic optimum N rate (EONR) was calculated by setting the N fertilizer/lint or seed price ratio equal to the first derivative of the quadratic-plateau model and solving for N rate.

Moderate correlations ($P < 0.05$) were observed between NDVI and leaf N at mid and peak bloom in 2007 and 2008. The chlorophyll meter had stronger correlations with leaf N than NDVI from active spectroradiometers in 2007 and in 2008, but correlations with lint yields were highest with NDVI. These were no correlations in 2009 between NDVI or the chlorophyll meters and leaf N, biomass, or lint yields. 2009 was the season with the least amount of N fertilizer response (i.e. delta yields) in lint and seed yields.

An average of 30 % less N fertilizer was used with reflectance-based strategy-1 over the 3 years, compared to the soil test-based N management, without lint or seed yield reductions. Our newer, second reflectance N management strategy N rates were higher than the soil test N rates by 11 kg N ha^{-1} in 2007, without any yield benefit. In 2008 and 2009, the N rate of the reflectance-2 plots was equal to the soil test plots.

Economic optimum N rates (EONRs) were 39 to 47 kg N ha^{-1} in 2007, 64 to 76 kg N ha^{-1} in 2008, and 22 to 32 kg N ha^{-1} in 2009. This compares with reflectance-1 N rates of 69, 52, and 27 kg N ha^{-1} for 2007, 2008, and 2009, respectively. The small N fertilizer rates used in 2009 were a result of NDVI in reflectance-1 never falling less than the NDVI in the soil test treatments. Lack of in-season N deficiency in reflectance-1 led to the initial 0.5 x soil test N injection rates to be unchanged.

In summary, reflectance-based N management, where the approach is to reduce N rates without hurting cotton yields, showed high potential in this study. High cotton lint yields (i.e. 1500 kg lint ha^{-1}) were achieved with relatively low N inputs, reflecting the high recovery and internal N use efficiency of fertigation in subsurface drip irrigation.

Keywords: fertigation, remote sensing, nitrogen use efficiency, economic optimum N rate.