WITHIN-CANOPY DIFFERENCES IN COTTON TISSUE NITROGEN STATUS AND GAS EXCHANGE ACROSS NITROGEN TREATMENTS

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Abstract

Cotton plants were grown under subsurface drip irrigation and received 0, 60, 120 or 180 lbs N/acre during the period from about main stem node number nine through early boll filling in a three-year study of cotton growth, yield and physiological responses to rates of applied nitrogen. The leaves sampled for gas exchange and nitrogen status were the third, fifth, eighth and eleventh down from the main stem terminal leaf. Gas exchange measurements were made at 5 to 9 day intervals, and measurements to be reported were only made on leaves exposed to 1200 umoles m^{-2} s^{-1} photosynthetic photon flux density (PPFD). Under conditions with high residual soil N (> 10 mg NO3-N/kg soil), reductions in applied N even to 60 lbs N/acre resulted in no significant reductions in photosynthetic rates or leaf conductance. Under these conditions, petiole NO3-N levels and leaf N percent were close to sufficient levels established by the University of CA even in 0 and 60 lbs N/acre treatments.

Under conditions with lower residual soil N in 1995 and 1996, average leaf conductance from peak bloom on was 16 % lower in the 0 N treatment, and 11 % lower in the 60 lbs N/acre treatment when compared to the average across higher N treatments. Under low residual soil N conditions, leaf N percent in 0 and 60 lbs/acre treatements was reduced more significantly in lower canopy main stem leaves and sympodial leaves than in upper canopy leaves. For example, average leaf N % at flowering of the 7^{th} fruiting branch was 3.3%, 3.55%, 4.1% and 4.2% in the 0, 60, 120 and 180 lbs N/acre treatments, respectively. The reduction in leaf photosynthetic rates and conductance was correlated both with leaf age and with reductions in leaf N content. In younger leaves (15 to 30 days age), leaf N levels at which photosynthetic rates declined at least 15% varied from about 3.4% (fruiting branch 1 through 6), about 3.1% (fruiting branch 7 through 11), to about 2.9% (cutout through 2 weeks post-cutout). Effects of aging on leaf photosynthetic rates were accelerated more with low N treatments particularly after leaves reached 30 days of age. Leaf conductance levels were often not well-correlated with observed changes in leaf photosynthetic rates. Leaf conductance was more related to leaf age than with leaf N levels. It should be noted that deficiencies in N that were correlated with reduced photosynthesis were also associated with 15 to 20% reductions in average leaf size, and with reductions in number of fruiting sites and sympodial leaf number. This results in reductions in photosynthetic area at the canopy level in low N treatments under low residual soil N conditions. At PPFD levels less than 400 umol, photosynthetic rates of lower canopy main stem and symprodial leaves were 5 to 31% of upper canopy rates at full PPFD, while leaf conductance levels ranged from 18 to 43%. Results in general indicate that deficient N applications can result in leaf level impacts on photosynthesis and leaf conductance, but signficant reductions in applied N and low residual soil N are required to produce these effects.

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