Use of Spectroradiometers to Guide In-season Nitrogen Fertilizer Applications in Irrigated Cotton in West Texas

Following water, nitrogen (N) is the most important constraint to upland cotton production. Most of the cotton in the semiarid western U.S.A. is irrigated, and in areas like the Southern High Plains, center pivots are the preferred irrigation method. Nitrogen fertilizer management is convenient with center pivots since liquid N can be injected into the irrigation system, and this mode of application is efficient as well. The timing of N fertilizer injections then becomes a management question producers need guidance on. Traditionally, spring, pre-plant soil nitrate tests have been the basis for N fertilizer recommendations for cotton in the semiarid western USA (Zhang et al., 1998). Soil nitrate-N measured in early spring, however, may be leached or lost as gases before crop N uptake is appreciable.

Decomposition of organic matter, on the other hand, can increase the supply of N to the crop. In-season monitoring of plant N status may be an approach that can complement soil testing and ensure that N is applied on an as-needed basis for the growing conditions of each particular season, field, and cotton variety.

Spectroradiometers provides a rapid and nondestructive in-season diagnosis of cotton N status and cotton biomass (Chua et al., 2003; Bronson et al., 2005, Yabaji et al., 2009). The approach for using the spectroradiometer that we have tested for 10 years in West Texas is the sufficiency index approach (Varvel, 1997).

$$\textbf{Sufficiency index} = \frac{\textbf{average NDVI sensor readings of unknown area}}{\textbf{average NDVI sensor meter readings of well-fertilized area}} \times 100\ \%$$

NDVI is a ratio of the near infrared and visible reflectance bands called normalized difference vegetative index that the sensors output. In-season N fertilizer is applied when the sufficiency index falls below 95%. The sufficiency index approach allows the spectroradiometer to be used in different environments and with different varieties, as these factors affect raw chlorophyll meter readings (Peterson et al., 1993).

For producers who want to use the spectroradiometer to guide the timing of liquid N fertilizer injections to center-pivot or drip irrigated cotton, a well-fertilized reference area needs to be established prior to planting or near planting. The simplest approach is to use an 8-row ground rig to apply 90 to 120 lb N/ac in a strip. The length of the well-fertilized area/strip can vary but could be from 100 to 1000 yards long. If solid urea is used (46-0-0), then it should be applied shortly before an irrigation.

We recommend sensing the well-fertilized strip plot and one to two representative passes of the bulk irrigated area of the field every 2 weeks starting at early squaring and ending at peak bloom. Active spectroradiometers need to be hand held or tool bar mounted at a 3 foot height above the cotton.

Table 1 shows results from two site-years of testing of activespectroradiometer-based N management in subsurface drip irrigated cotton at Lubbock Texas (Nusz et al., 2009). The soil test – based treatment consisted of a target N supply of 120 lb N/ac for a 2 ½ bale/ac yield goal. The nitrate-N in a 0-24 inch pre-plant, spring soil test was subtracted from 120 lb N/ac to give the seasonal N fertilizer amount to be applied/injected. In 2007 and 2008, 18 and 16 lb N/ac, respectively, was saved using reflectance-based N management, compared to the soil test based treatment. This was achieved without yield reductions.

Table 1. First open boll biomass, N accumulation, N fertilizer recovery efficiency, seed and lint yields as affected by nitrogen management, Lubbock, TX, 2007.

N treatment	N fertilizer injected[1]	Total N uptake	Recovery efficiency	Biomass	Seed yield	Lint yield
	--------- lb N/ac ------		%	--------------- lb/ac ------------------		
1.5*Soil test-based	120	-	-	-	2379 a	1347 a
Soil test-based	80	128 a	65 a	7704 a	2241 a	1326 a
Reflectance strategy	62	120 a	72 a	7561 a	2350 a	1372 a
0.5*Soil test-based	40	-	-	-	2270 a	1365 a
Zero-N	0	76	-	5362	1692	1062

[1] Injected from 11 July to 11 August

Table 2. First open boll biomass, N accumulation, N fertilizer recovery efficiency, seed and lint yields as affected by nitrogen management, Lubbock, TX, 2008.

N treatment	N fertilizer injected[1]	Total N uptake	Recovery efficiency	Biomass	Seed yield	Lint yield
	--------- lb N/ac ------		%	--------------- lb/ac ------------------		
1.5*Soil test-based	94	138 a	75 a	7993 a	2553 a	1532 a
Soil test-based	62	130 a	101 a	7546 a	2455 a	1495 a
Reflectance strategy	46	110 b	94 a	6587 b	2542 a	1538 a
0.5*Soil test-based	31	-	-	-	2129 b	1283 b
Zero-N	0	67	-	4968	1640	1006

[1] Injected from 26 June to 16 July and 5 to 8 August

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