Reflectance-based Nitrogen Fertilizer Management for Irrigated Cotton

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Objectives

- To compare two active spectroradiometers for in-season N status assessment of Subsurface Drip Irrigation (SDI) cotton

- To assess lint yields and N fertilizer use efficiency with two spectral reflectance based N management strategies compared to soil test-based N management in a SDI cotton system.

Materials & Methods

Nitrogen requirements for high-yielding cotton

Yield goal	Nitrogen requirement[1]
bales/ac	lb N/ac
1.5	75
2.0	100
2.5	125
3.0	150
3.5	175

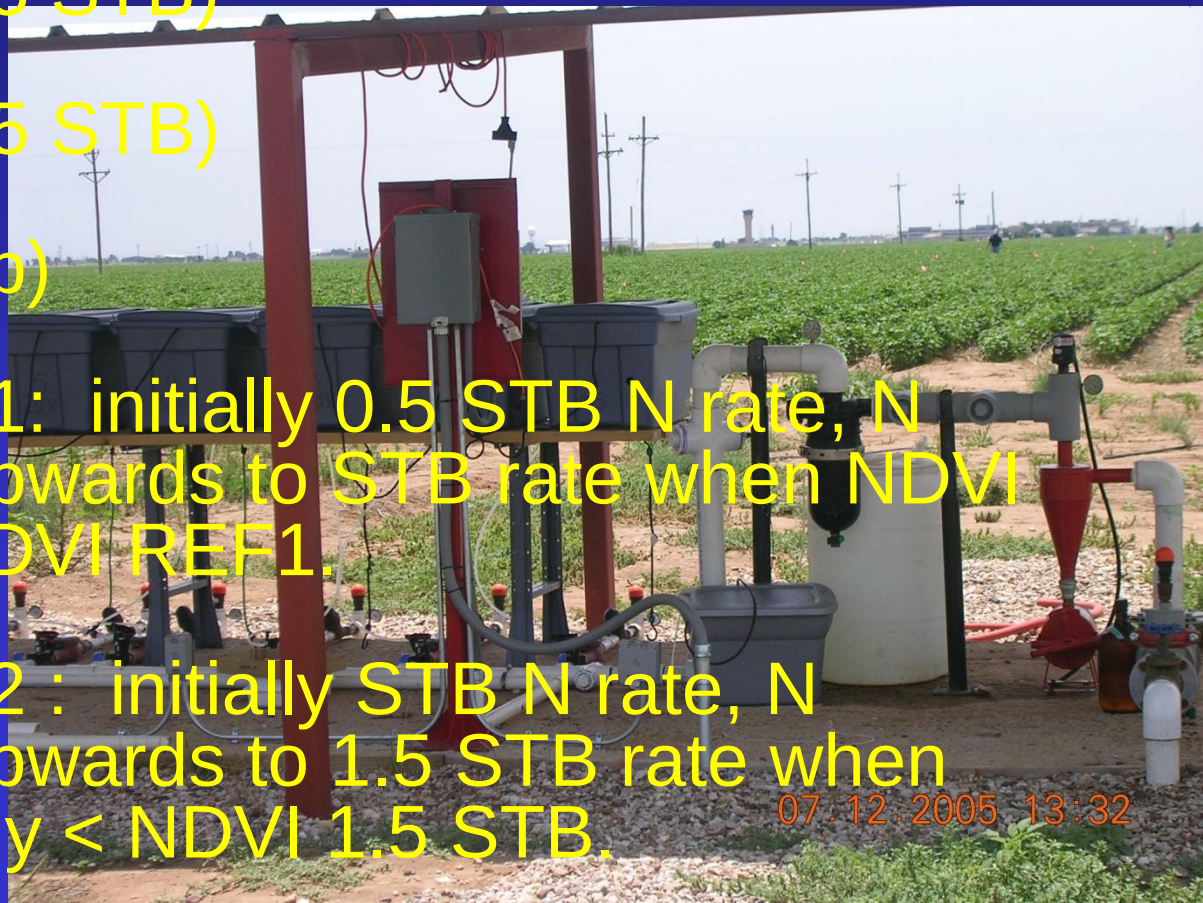
[1]Nitrogen fertilizer plus 0-24 inch NO_3-N

Methods

- AFD 5065 B2FRR
- Five N mgt treatments in RCB
- Three replicates
- Hand-picking (1/000 ac) and yield mapping

Treatments

- Soil test based N mgt (STB) 32-0-0 injected early square to mid bloom for 2.5 bale/ac yield goal (125 lb N/ac – 0-24 in soil test NO_3-N – irrigation water NO_3)
- 0.5 X Soil test based (0.5 STB)
- 1.5 X Soil test based (1.5 STB)
- Zero-N (1 plot/station/rep)
- Reflectance-based mgt 1: initially 0.5 STB N rate, N injection rate adjusted upwards to STB rate when NDVI REF1 is statistically < NDVI REF1.
- Reflectance-based mgt 2 : initially STB N rate, N injection rate adjusted upwards to 1.5 STB rate when NDVI REF2 is statistically < NDVI 1.5 STB.

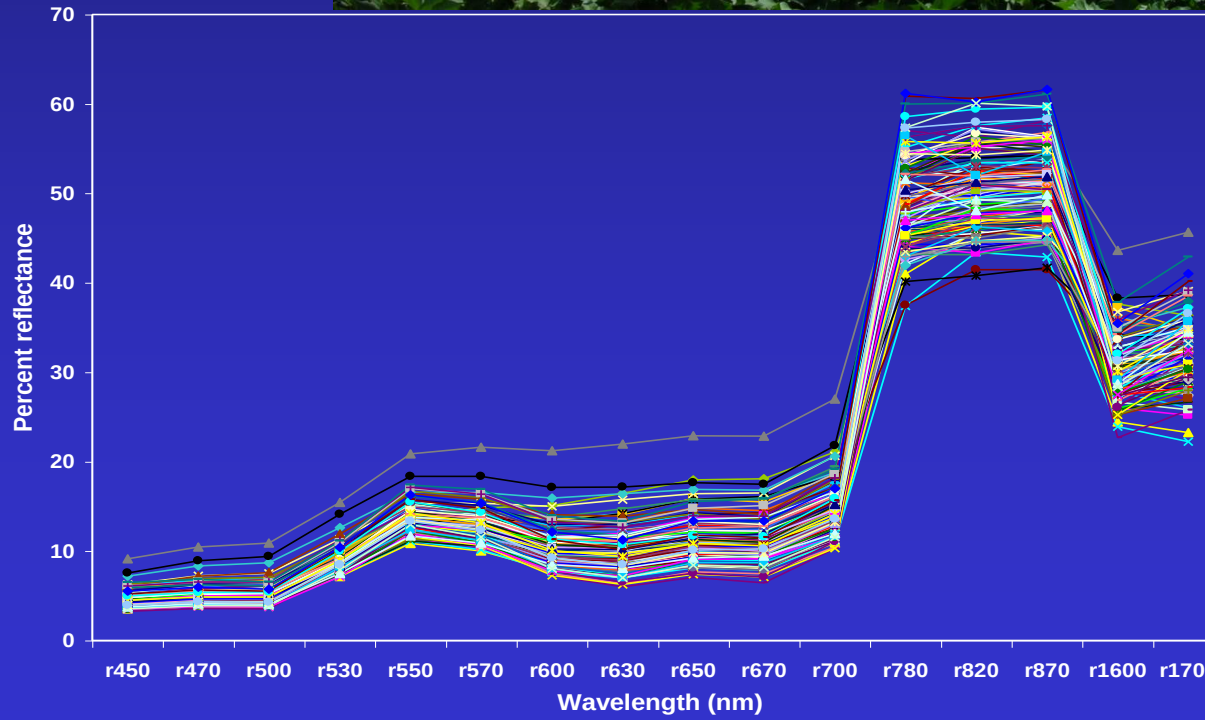


Cropscan MSR 16

- Passive sensor (natural light)
- 16 wavebands
- Percent reflectance =

  Refltd irrad @ λ /

  Incoming irrad @ λ



GreenSeeker

- Active sensor
- 2 wavebands, red (660 nm) and NIR (770 nm)
- 40 inches above canopy
- Percent reflectance =

  Refltd irrad @ λ /

  Incoming irrad @ λ

CropCircle

- Active sensor
- 2 wavebands, amber (590 nm) and NIR (880 nm)
- 40 inches above canopy
- Percent reflectance =

  Refltd irrad @ λ /

  Incoming irrad @ λ

Vegetative indices

- Red NDVI = $(R_{770}-R_{660})/(R_{770}+R_{660})$
- Amber NDVI = $(R_{880}-R_{590})/(R_{880}+R_{590})$

R = percent reflectance at λ (nm)

Plot plan

8, 40-in rows

600 ft

Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10	Station 11	Station 12	Station 13	Station 14	Station 15
0.5 STB	REF1	STB	REF2	1.5 STB	1.5 STB	REF1	REF2	Zero	STB	0.5 STB	REF1	STB	REF2	1.5STB
Rep 1	Rep 1	Rep 1	Rep 1	Rep 1	Rep 2	Rep 2	Rep2	Rep 2	Rep 2	Rep 2	Rep3	Rep 3	Rep 3	Rep 3
101	105	109	113	117	201	205	209	001	213	217	301	305	309	313
102	106	110	114	118	202	206	210	002	214	218	302	306	310	314
103	107	111	115	119	203	207	211	003	215	219	303	307	311	315
104	108	112	116	120	204	208	212	004	216	220	304	308	312	316

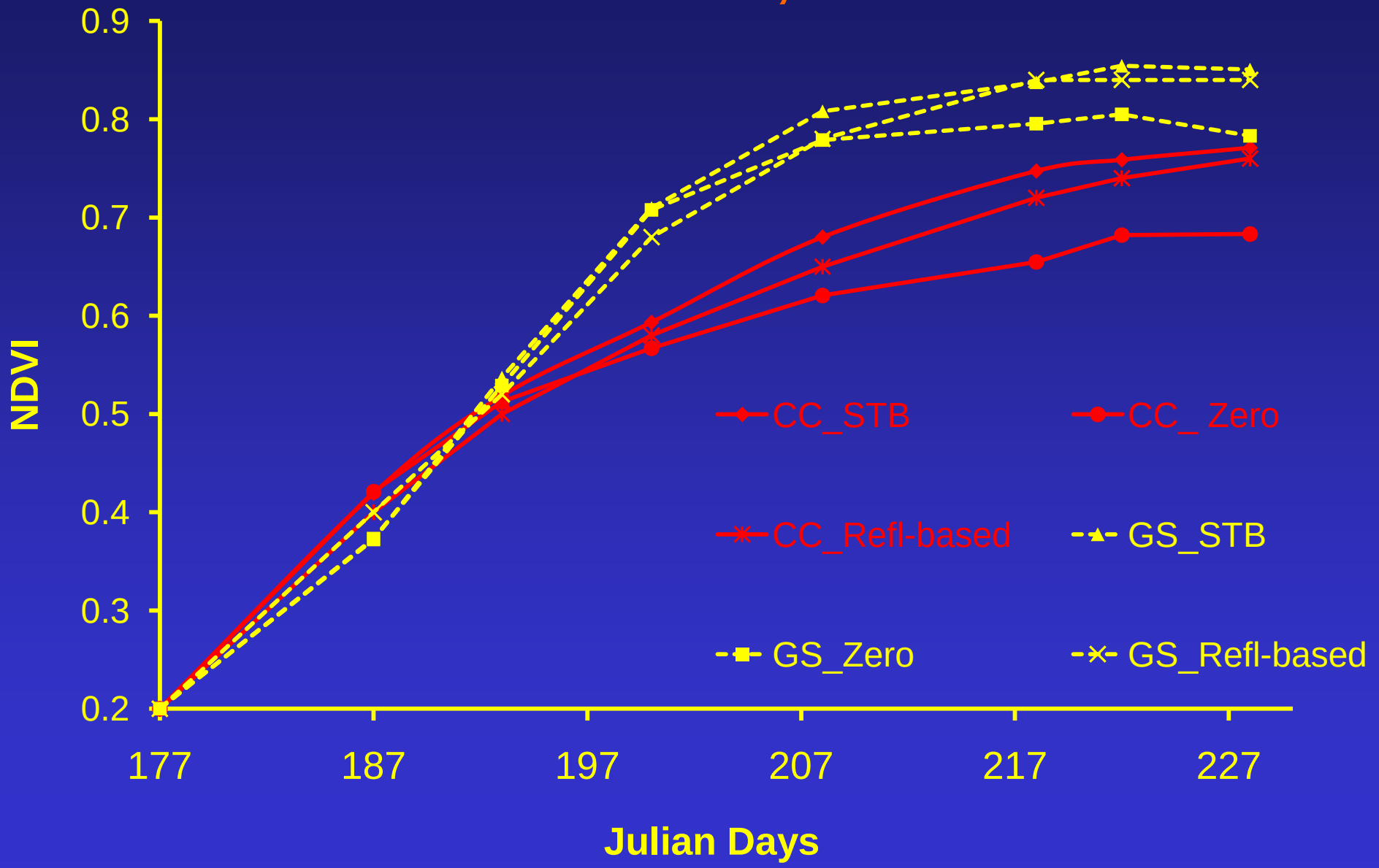
Results

Correlation of Crop Circle (CC) and Green Seeker (GS) NDVI, Biomass, Leaf N, Chlorophyll meter at mid-bloom sampling and Lint yields, Lubbock, TX 2007.

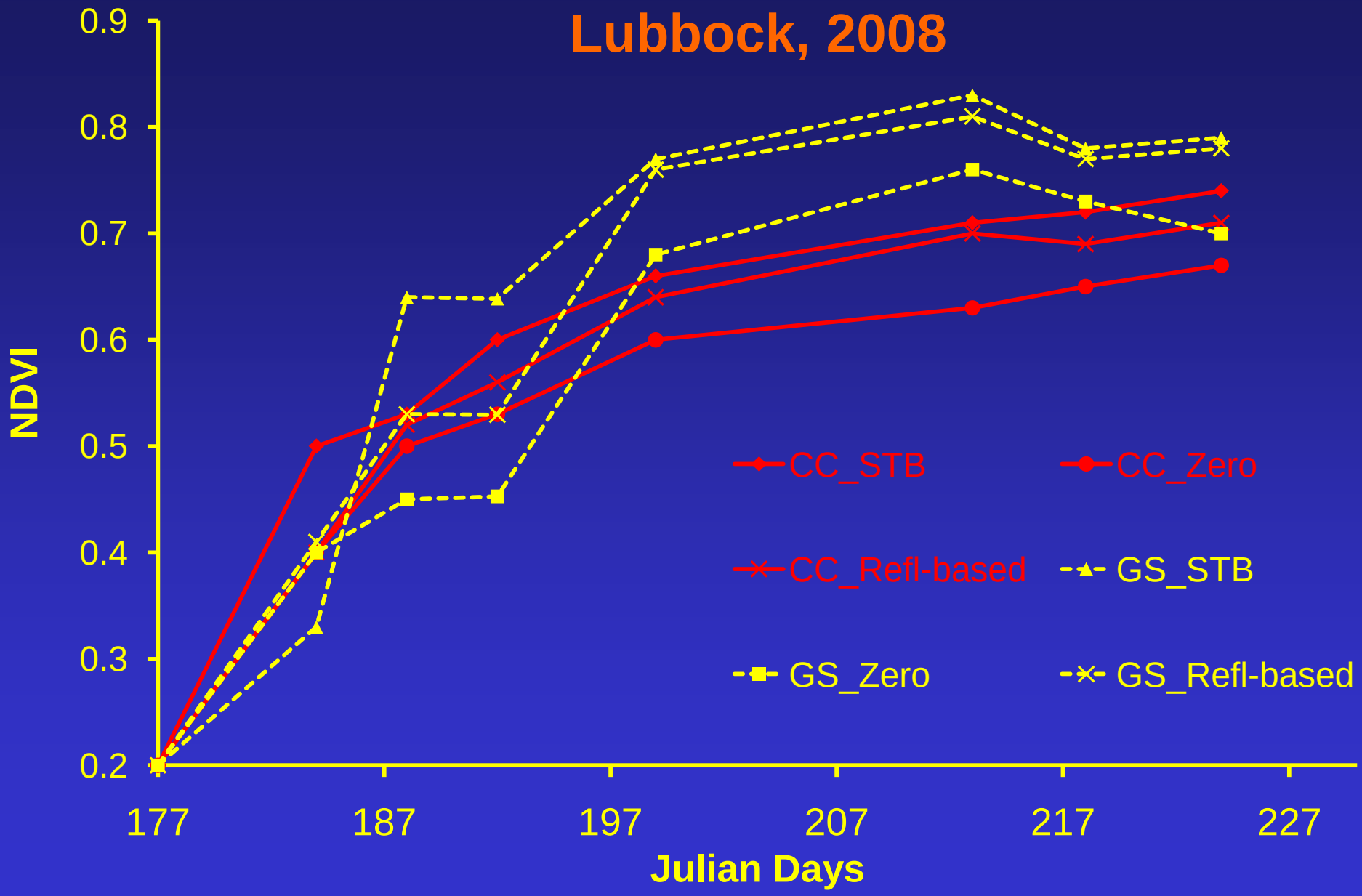
	N Rate	CC NDVI	GS NDVI	Biomass	Leaf N	Chlor. Meter	Lint Yield
N rate		0.60**	0.69**	0.53**	0.63**	0.71**	0.23*
CC NDVI	0.60**		0.57**	0.44*	0.55**	0.50**	0.48**
GS NDVI	0.69**	0.57**		0.36*	0.62**	0.65**	0.27*
Biomass	0.53**	0.44*	0.36*		0.46**	0.35*	0.33*
Leaf N	0.63**	0.55**	0.62**	0.46**		0.65**	0.32*
Chlor. Meter	0.71**	0.50**	0.65**	0.35*	0.65**		
Lint yield	0.23*	0.48**	0.27*	0.33*	0.32*		

**P<0.0001, *P<0.05

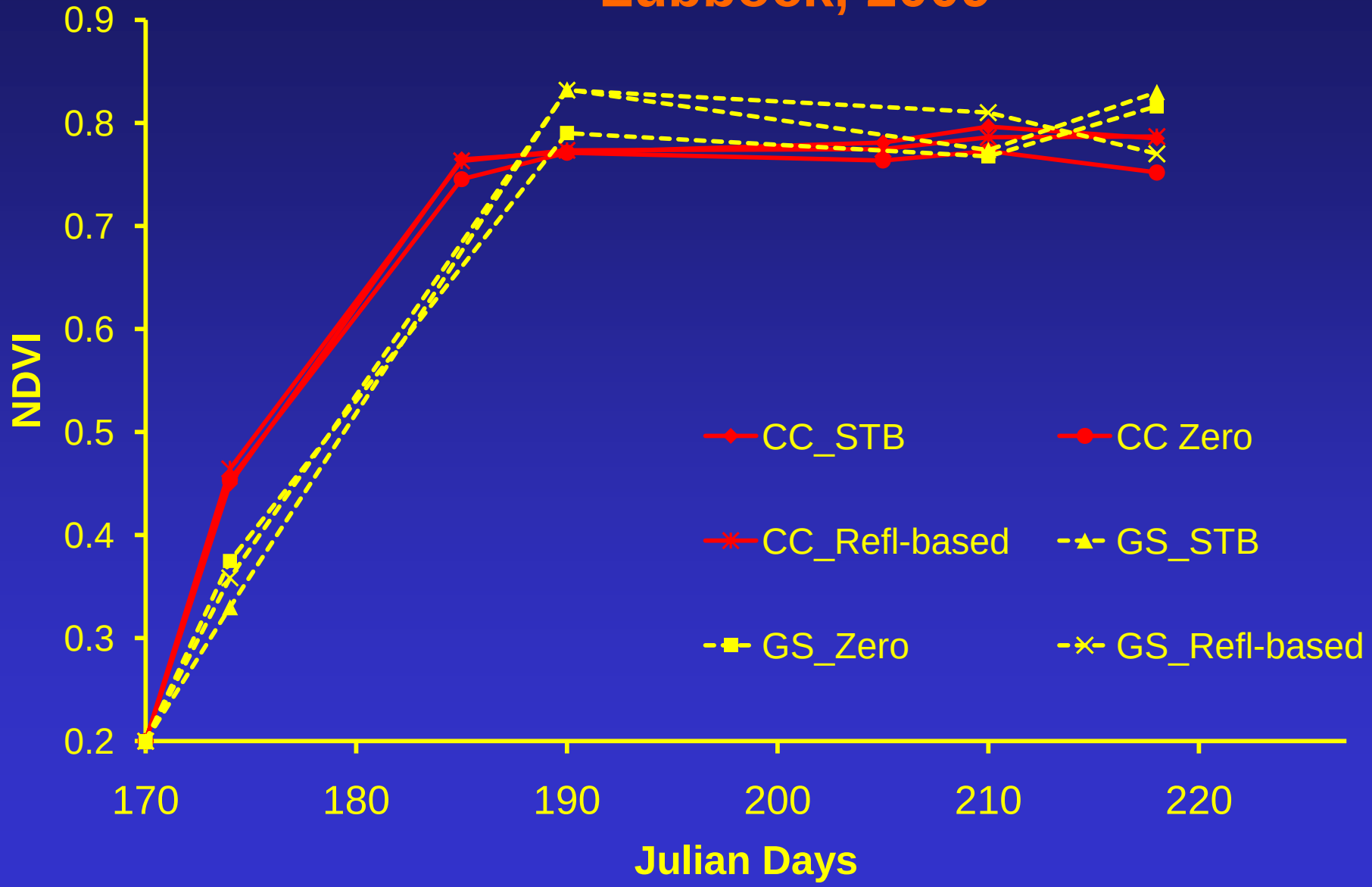
Crop Circle and Green Seeker NDVI SDI cotton Lubbock, 2007



Crop Circle and Green Seeker NDVI SDI cotton Lubbock, 2008



Crop Circle and Green Seeker NDVI SDI cotton Lubbock, 2009



Spring soil nitrate, N fertilizer amounts injected, well water nitrate, and total N supply, Lubbock, TX, 2007

N treatment	Spring soil NO_3[1]	N fertilizer injected[2]	Well water-NO_3	Total N supply
	---------- lb N/ac ----------			
1.5*Soil test-based	18 a	120	20	158
Reflectance strategy 2	22 a	90	20	132
Soil test-based	24 a	80	20	124
Reflectance strategy 1	17 a	62	20	99
0.5*Soil test-based	18 a	40	20	78
Zero-N	18 a	0	20	38

[1] 0-24 inches
[2] Injected from 11 July to 11 August

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[a]	Total N uptake	Recovery efficiency	Biomass	Seed yield	Lint yield
	---- lb N/ac -----		%	---------- lb/ac ----------		
1.5*STB	120	-	-	-	2379 a	1347 a
Refl- strategy 2	90	131 a*	62 a	7666 a	2253 a	1330 a
STB	80	128 a	65 a	7704 a	2241 a	1326 a
Refl.strategy 1	62	120 a	72 a	7561 a	2350 a	1372 a
0.5*STB	40	-	-	-	2270 a	1365 a
Zero-N	0	76	-	5362	1692	1062

[a] Injected from 11 July to 11 August

*Means in a column followed by the same letter are not significantly different at *P* = 0.05

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*STB	94	138 a	75 a	7993 a	2553 a	1532 a
Refl.strategy 2	62	-	-	-	2572 a	1586 a
STB	62	130 a	101 a	7546 a	2455 a	1495 a
Refl.strategy 1	46	110 b	94 a	6587 b	2542 a	1538 a
0.5*STB	31	-	-	-	2129 b	1283 b
Zero-N	0	67	-	4968	1640	1006

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

*Means in a column followed by the same letter are not significantly different at *P* = 0.05

First open boll biomass, N accumulation, N fertilizer recovery efficiency, seed and lint yields as affected by nitrogen management, Lubbock, TX, 2009

N treatment	N fertilizer injected[1]	Total N uptake	Recovery Efficiency	Biomass	Seed yield	Lint yield
	---------- lb N/ac -------		%	---------- lb/ac ----------		
1.5*STB	72	124 a	47 a	7761 a	2526 a	1527 a
Refl.strategy 2	48	-	-	-	2487 ab	1509 a
STB	48	114 a	49 a	7670 a	2471 ab	1522 a
Refl.strategy 1	24	109 a	77a	8058 a	2581 a	1610 a
0.5*STB	24	-	-	-	2326 b	1487 a
Zero-N	0	90	-	6962	2029	1336

Lint yields as affected by cultivar and nitrogen management, Lubbock, TX, 2010

N management	Cultivar FM9180	Cultivar ST5458	Means
	---------- lb/ac ----------		
Reflectance-based (100 lb UAN-N/ac)	1435	1602	1519
Soil test-based (50 lb UAN-N/ac)	1351	1513	1432
Zero-N	1047	1136	1091
Means	1277	1417	
Cultivar		**	
Nitrogen		**	
Cultivar x Nitrogen		NS	

Summary of three years of Refl. Strategy 1 N fertilizer management in SDI cotton, Lubbock, TX, 2007-2009

	Units	2007	2008	2009
0-24 inch NO_3	lb /ac	17	30	18
Starter N fertilizer	lb N/ac	0	10	22
Irrigation NO_3	lb N/ac	20	30	22
Injected fertilizer	lb N/ac	62	46	24
Recovery efficiency	%	72	94	77
Lint yield	lb /ac	1372	1538	1610

Summary of three years of soil test based strategy for N fertilizer management in SDI cotton, Lubbock, TX, 2007-2009

	Units	2007	2008	2009
0-24 inch NO_3	lb /ac	24	35	21
Starter N fertilizer	lb N/ac	0	10	22
Irrigation NO_3	lb N/ac	20	30	22
Injected fertilizer	lb N/ac	80	62	48
Recovery efficiency	%	65	101	49
Lint yield	lb /ac	1326	1495	1522

Economic optimum nitrogen rate (EONR) for lint, seed and lint + seed, Lubbock, TX, 2007-09 ($0.50/lb lint, $0.55/lb N)

Quadratic-plateau for lint	Quadratic-plateau for seed	Quadratic-plateau for dollar value of lint + seed	Reflectance-1 N rate
lb N ac^{-1}			
2007			
35	41	38	62
2008			
68	57	71	46
2009			
22	29	23	24

Conclusions

- Recovery efficiency of daily injection of N between early square and mid bloom was 62 to 94 %.
- Reflectance-based N management strategy1 saved 22, 26, and 50 % N compared to soil test based management during 2007, 2008, and 2009, respectively.
- EONRs ranged from 22 to 68 lb N/ac for lint.
- Need to test for center pivots and furrow irrigation