Nitrogen Management in Cotton: West Texas, Irrigated

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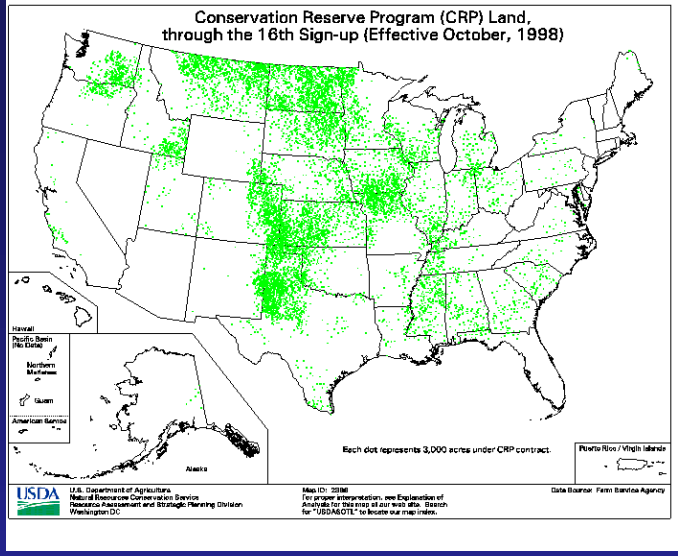
Introduction

- This is an update of Nitrogen (N) management of cotton, with special reference to the Southern High Plains.
- Second to water, N limits cotton production in the Southern High Plains.
- However, N requirements are not known for new production practices such as drip irrigation and conservation-till cotton.
- New N management strategies are needed to reduce soil nitrate buildup and possible leaching to the groundwater.

Outline

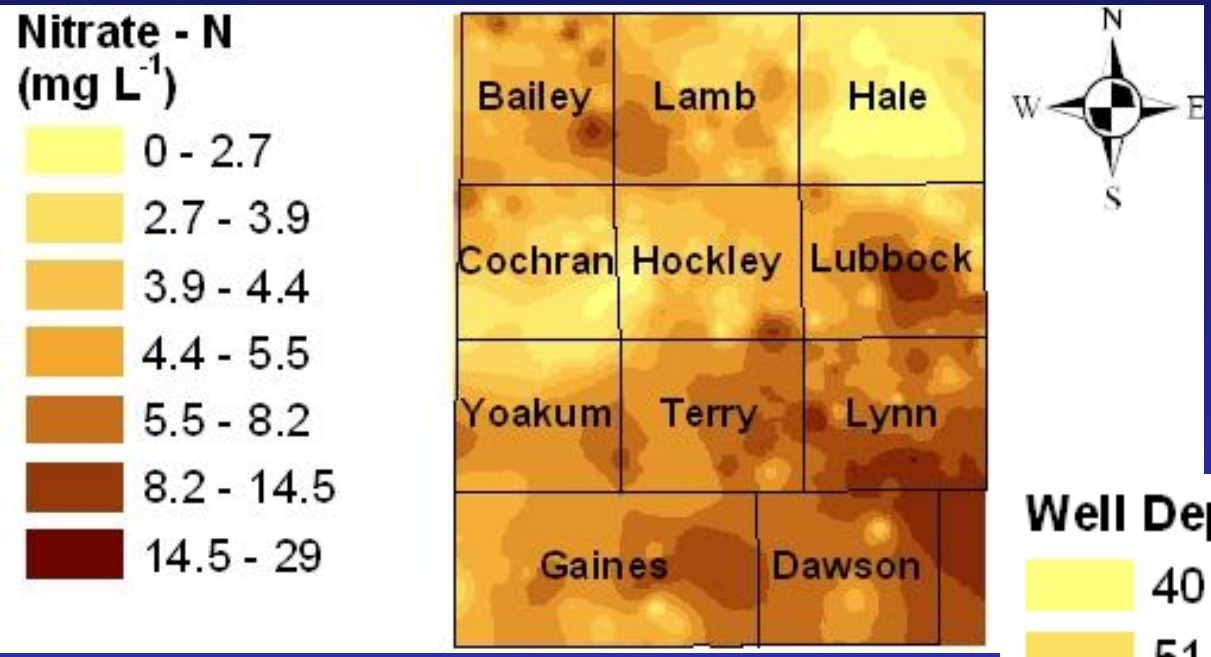
- Introduction
- Nitrogen response in different cotton systems
- Variable-rate N fertilization
- Nitrogen management for subsurface drip
- Nitrate soil test → cotton N requirements.

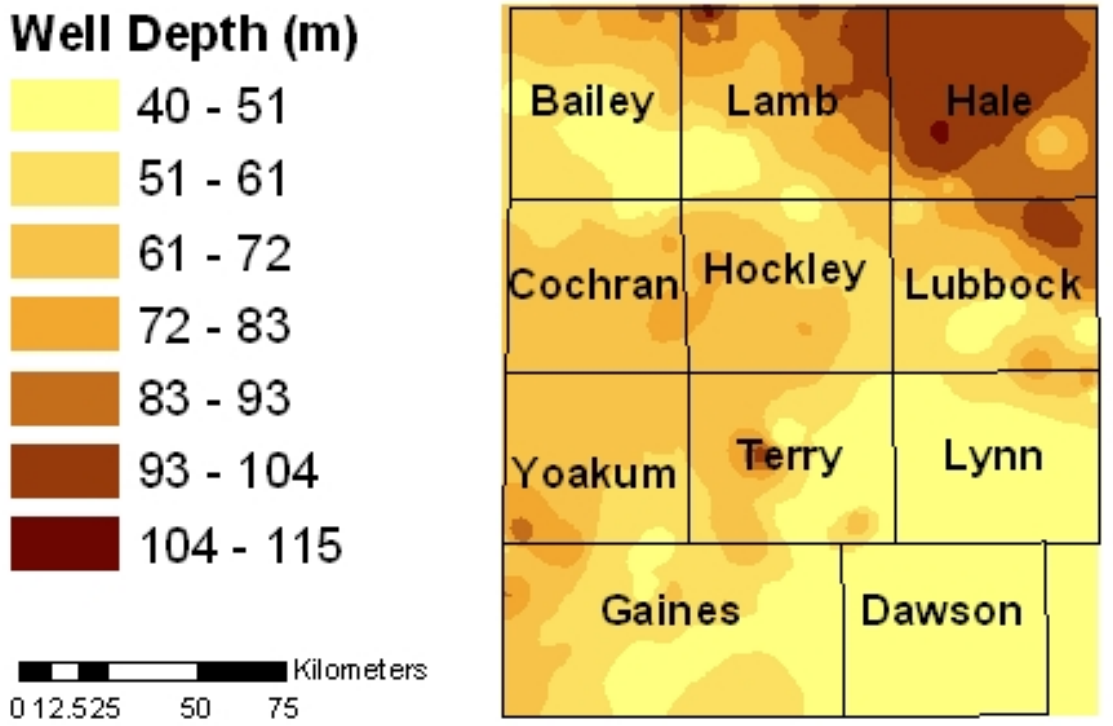
Introduction cont.



- Nitrate levels in groundwater are increasing, but transport time > 20 yr
- Soils are Mollisols Lubbock north and Alfisols Lubbock south. ~ 15 % calcareous
- Constraints to crop production are water, wind/blowing sand/hail, N, P, weeds/pests.
- 60 % cotton land is highly erodible land (only 3% no-till, and only 11% in conserv-till).
- CRP on 4 million acres
- Conservation compliance on highly erodible land –soil roughening

Nitrate concentration and depths of wells in Texas Southern High Plains 1995-2005



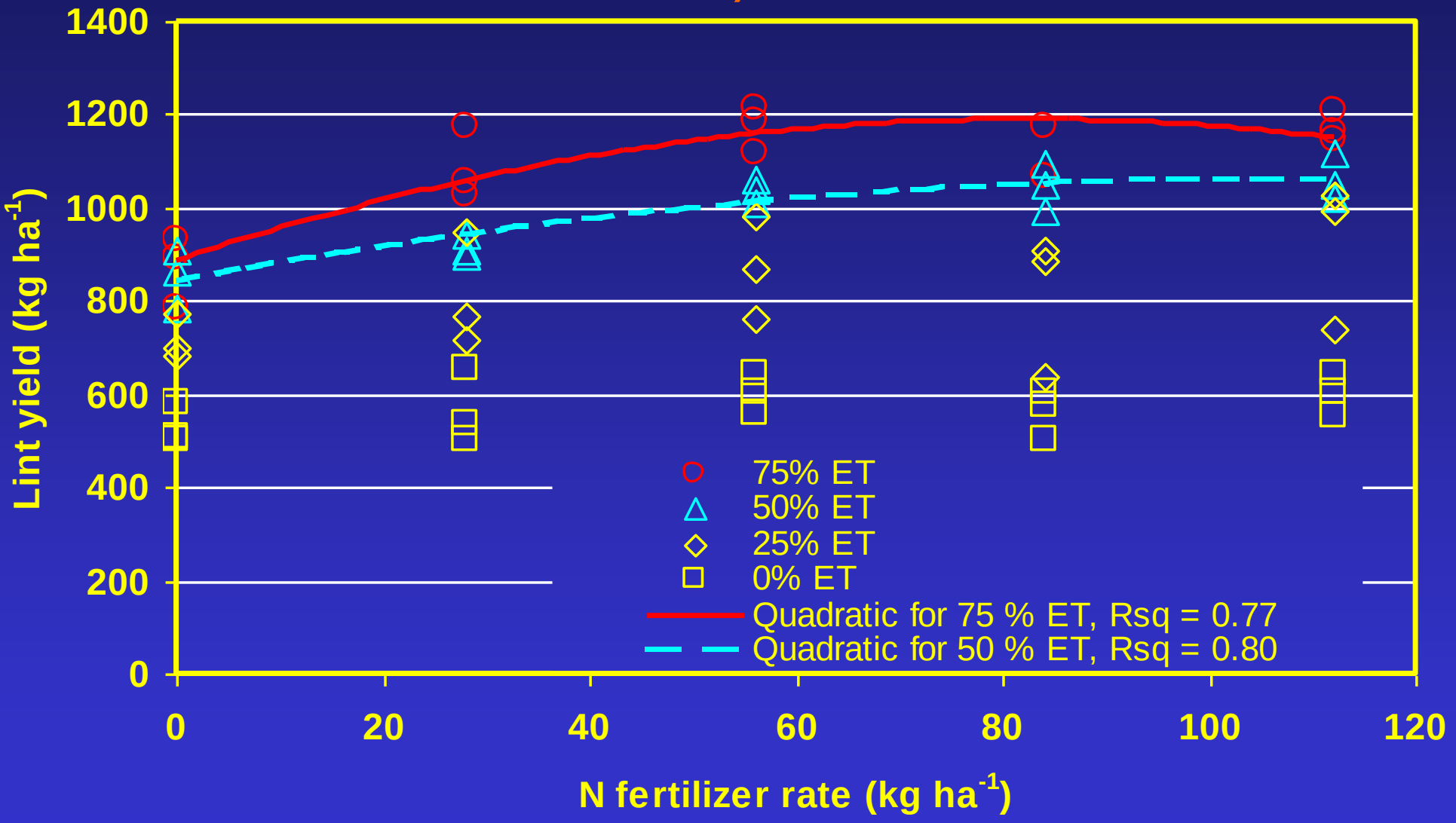


Price of UAN (32-0-0) in W. Texas 1999-2008

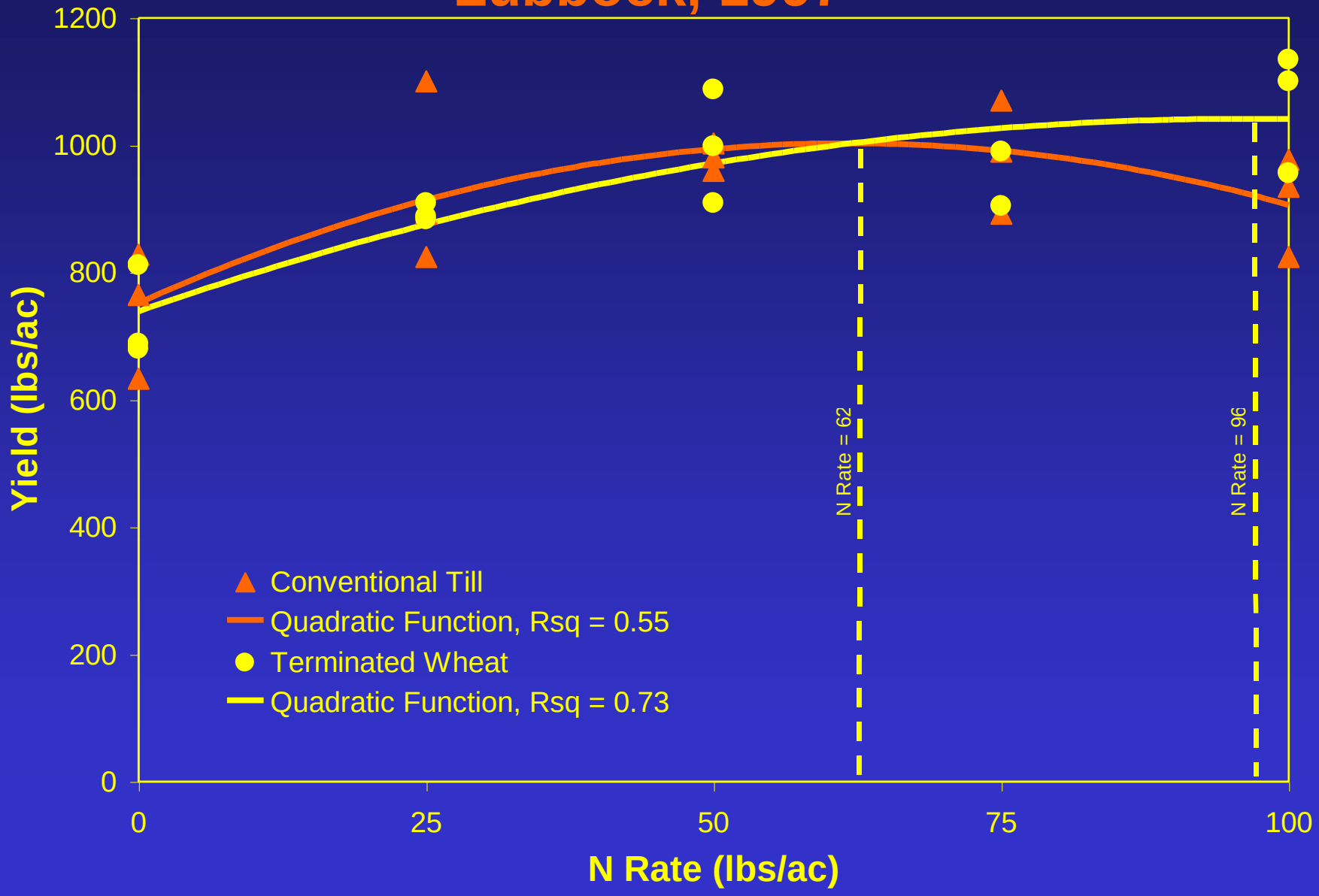
Should I cut back on N fertilizer?

Tillage, Water, and Nitrogen Response of Cotton

Lint Yield vs. N Rate for varying irrigation levels
Lubbock, TX 1997



N Response in Cotton for Conven-till and Conserv-Till, Lubbock, 1997

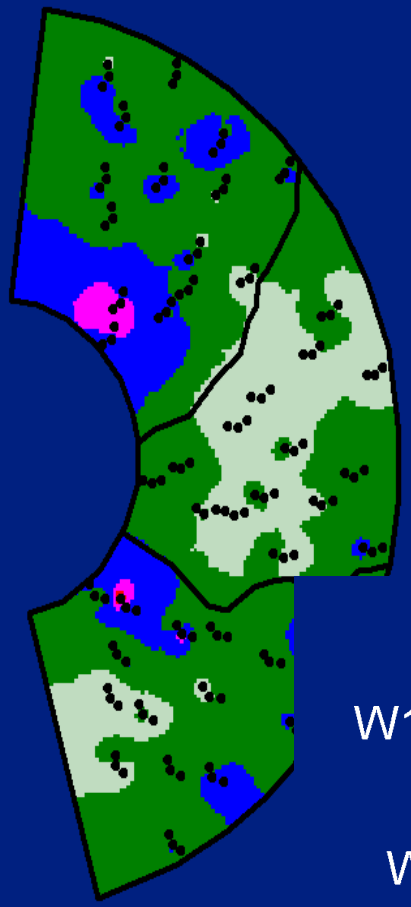


Net returns to N fertilizer for irrigated conservation-till cotton, Lubbock, TX

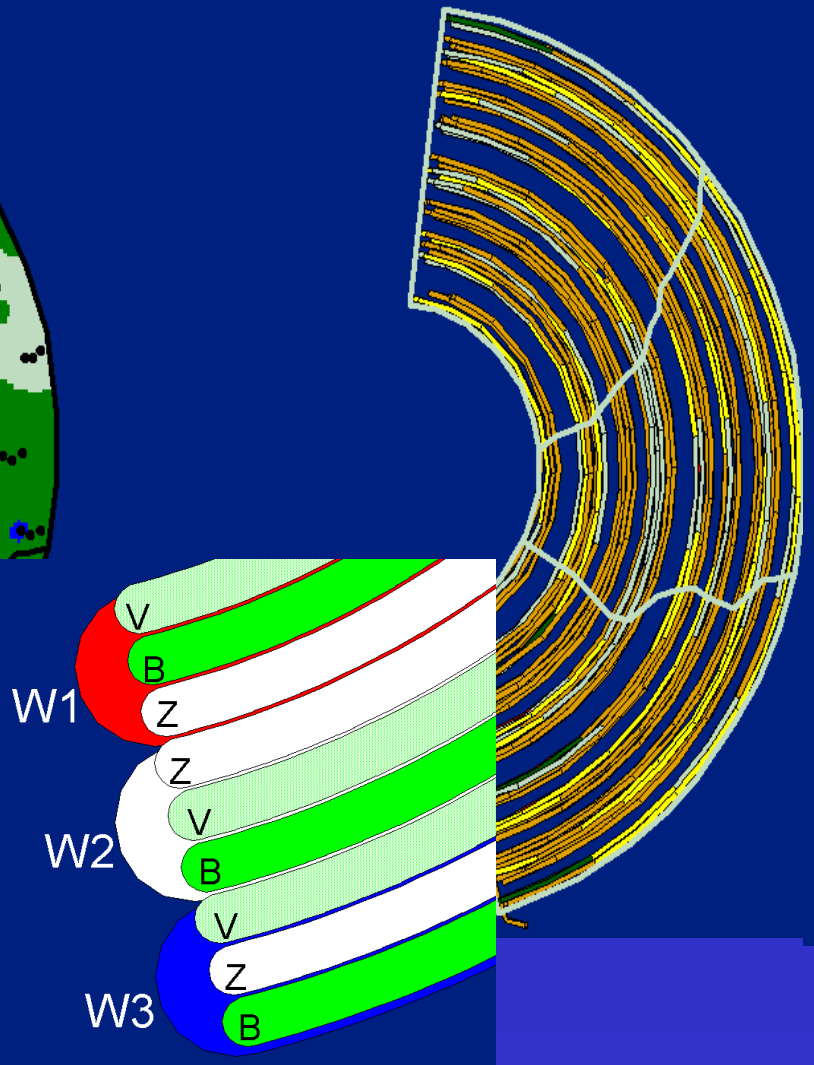
N fertilizer price	Econ. opt. N fert. rate	$0.50/lb lint	$0.52/lb lint	$0.54/lb lint
$ per lb N	lb N/ac	----------Net returns to N fertilizer ($/ac) -------		
0.25	90	99	104	109
0.30	90	94	99	104
0.35	80	90	95	100
0.40	80	86	91	96
0.45	80	82	87	92
0.50	80	78	83	88
0.55	80	74	79	84

Variable-rate N fertilization for Cotton

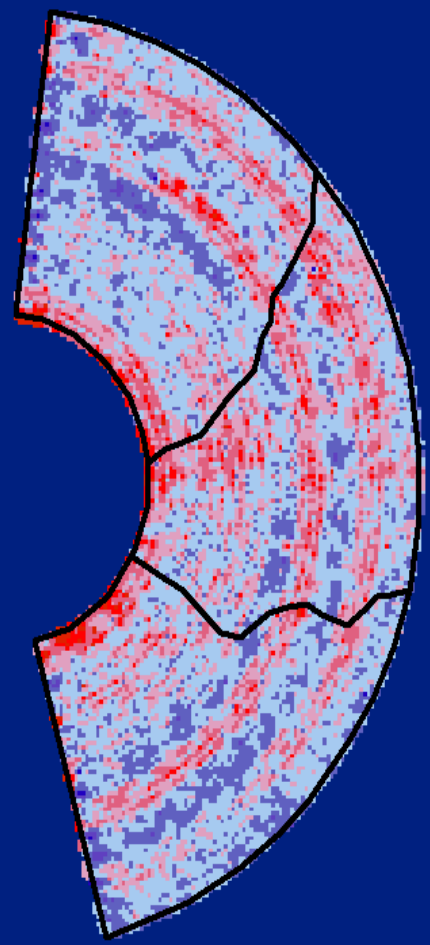
0-24 in. lb NO_3-N/ac,
Lamesa, 2002



As applied lb N/ac
Lamesa, 2002



Lint yields
Lamesa, 002

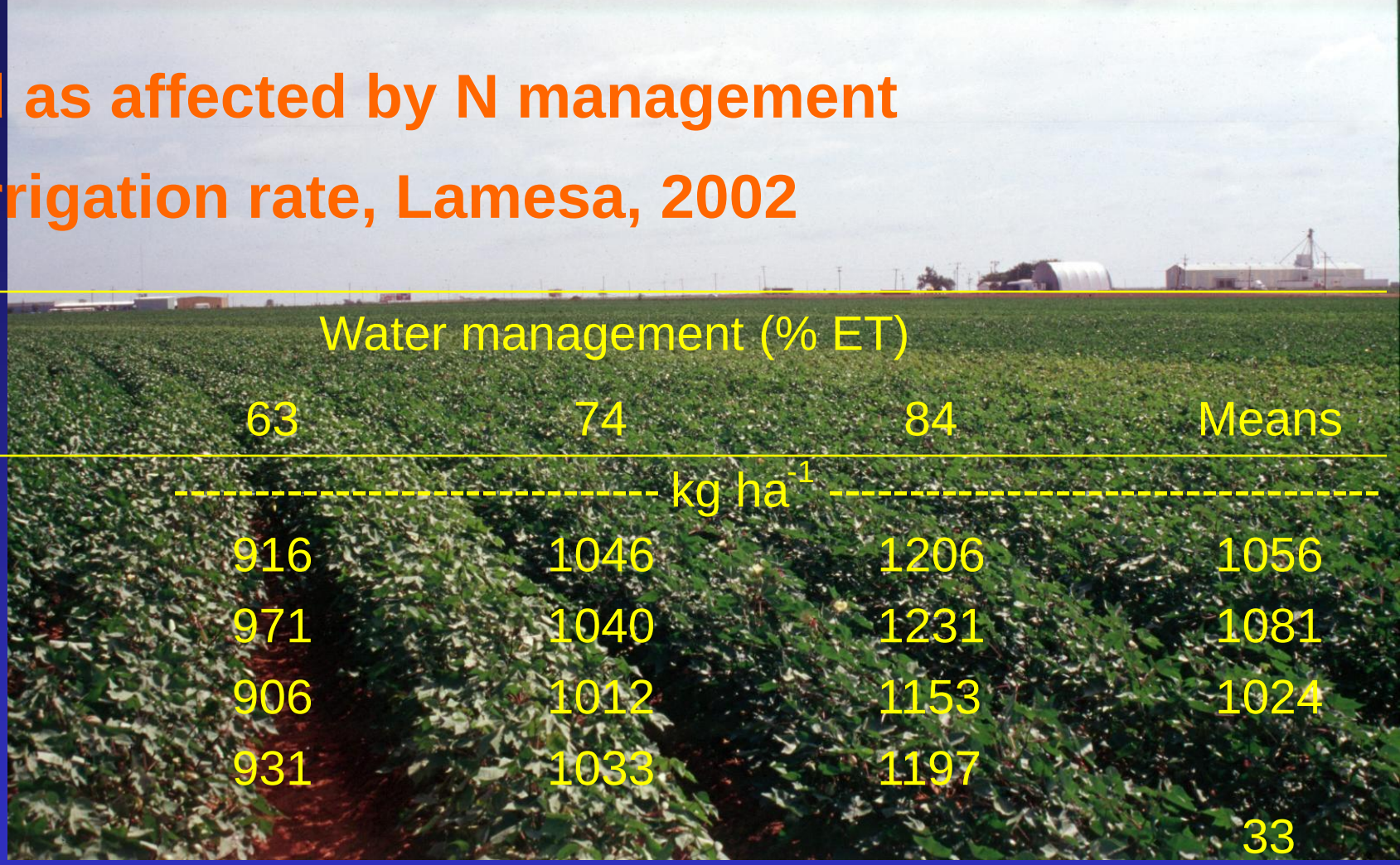


Nitrogen fertilizer rates applied to cotton, (average across 64,75, 85 % ET LEPA) Lamesa, 2002 and 2003

	Min	Max	Mean
		2002	
	---------- lb N/ac ----------		
Blanket rate	50	53	52
Variable rate	14	89	55
		2003	
Blanket rate	89	92	91
Variable rate	39	122	88

Note: N fertilizer is applied at 120 lb N/ac – 24 in. NO_3-N for 2 bale/ac yield goal

Lint yield as affected by N management and irrigation rate, Lamesa, 2002



	Water management (% ET)			
N mgt	63	74	84	Means
	---------- kg ha^{-1} ----------			
Blanket-rate	916	1046	1206	1056
Variable-rate	971	1040	1231	1081
Zero-N	906	1012	1153	1024
Means	931	1033	1197	
LSD (*P*=0.05)				33
Nitrogen		**		
Water – linear		**		
Water – quadratic		NS		
Water x N		NS		
^{o}15 pie		**		

Lint yield as affected by N management and irrigation rate, Lamesa, 2003

	Water management (% ET)			
N mgt	76	82	89	Means
	----------	kg ha^{-1}	----------	
Blanket-rate	646	862	971	827
Variable -rate	720	846	1019	862
Zero-N	661	770	870	767
Means	676	826	953	
LSD (*P*=0.05)	58	58	58	33
Nitrogen		**		
Water – linear		**		
Water – quadratic		NS		
Water x N		NS		
^{o}15 pie		**		

Lint yield as affected by N management and irrigation rate, Lamesa, 2004

	Water management (% ET)			
N mgt	73	83	93	Means
	---------- kg ha^{-1} ----------			
Blanket-rate	1052	1141	1169	1120
Variable-rate	1144	1301	1290	1245
Zero-N	1023	1092	1073	1067
Means	1073	1178	1177	
LSD (*P*=0.05)				45
Nitrogen		**		
Water – linear		NS		
Water – quadratic		NS		
Water x N		NS		
^{o}15 pie		**		

In-season sensing of N status for Cotton

Correlations with chlorophyll meter (SPAD) and spectral reflectance (GVI)[1], early bloom Lubbock, 2000

	Leaf N	Leaf N Acc.	Biomass	Lint yield	SPAD	GVI
N Rate	0.64**	0.54**	0.42*	0.42*	0.66**	0.48**
Leaf N		0.82**	0.60**		0.83**	0.77**
Leaf N Acc.			0.94**	0.61**	0.63**	0.88**
Biomass				0.71**	0.43*	0.82**
Lint yield						0.69**

[1]Percent reflectance at 820 nm/percent reflectance at 550 nm

Lint yields as affected by in-season sensing of N status

Treatment	Ropesville 2000	Lubbock 2000	Lubbock 2001
	Lint Yield (lb/ac)		
Well-fertilized	609 (180)	946 (180)	1326 (120)
Soil Test	629 (120)	953 (120)	1276 (90)
Reflectance	613 (45)	916 (45)	1200 (90)
Chlorophyll meter	556 (30)	922 (75)	1246 (75)
Zero	631 (0)	792 (0)	1038 (0)
LSD (*P*=0.05)	NS	80	123

Nitrogen applied is in parentheses

Nitrogen management for subsurface drip irrigated cotton

Spring soil nitrate, N fertilizer amounts injected, well water nitrate, and total N supply, Lubbock, TX, 2005

N source	N timing	Spring soil NO_3[1]	Starter N fertilizer	N fertilizer injected	Well water-NO_3	Total N supply
		lb N/ac				
28-0-0-5S	Early bloom[2]	8	22	90	23	143
28-0-0-5S	Peak bloom[3]	7	22	90	23	142
32-0-0	Early bloom[2]	8	22	90	23	143
32-0-0	Peak bloom[3]	8	22	90	23	143
32-0-0	Reflectance-based[3]	7	22	65	23	117
Zero-N	N/A	7	22	0	23	52

[1] 0-24 inches
[2] Injected from 20 June to 22 July
[3] Injected from 20 June to 12 Aug

First open boll biomass, N uptake, seed and lint yields as affected by N management, Lubbock, TX, 2005

N source	N timing	N fertilizer injected	Total N uptake	Recovery efficiency	Biomass	Seed yield	Lint yield
		------- lb N/ac ------		%	---------- lb/ac ----------		
28-0-0-5S	Early bloom[1]	90	-	-	-	2611 a	1865 a
28-0-0-5S	Peak bloom[2]	90	-	-	-	2598 a	1829 a
32-0-0	Early bloom[1]	90	-	-	-	2629 a	1879 a
32-0-0	Peak bloom[2]	90	160 a	63 a	9647 a	2549 a	1812 a
32-0-0	Reflectance -based[2]	65	143 a	62 a	9164 a	2511 a	1817 a
Zero-N	N/A	0	103 b	-	8047 b	2072 b	1620 b

[1] Injected from 20 June to 22 July
[2] Injected from 20 June to 12 Aug


Denitrification meaurements
(N_2O+N_2) surface flux
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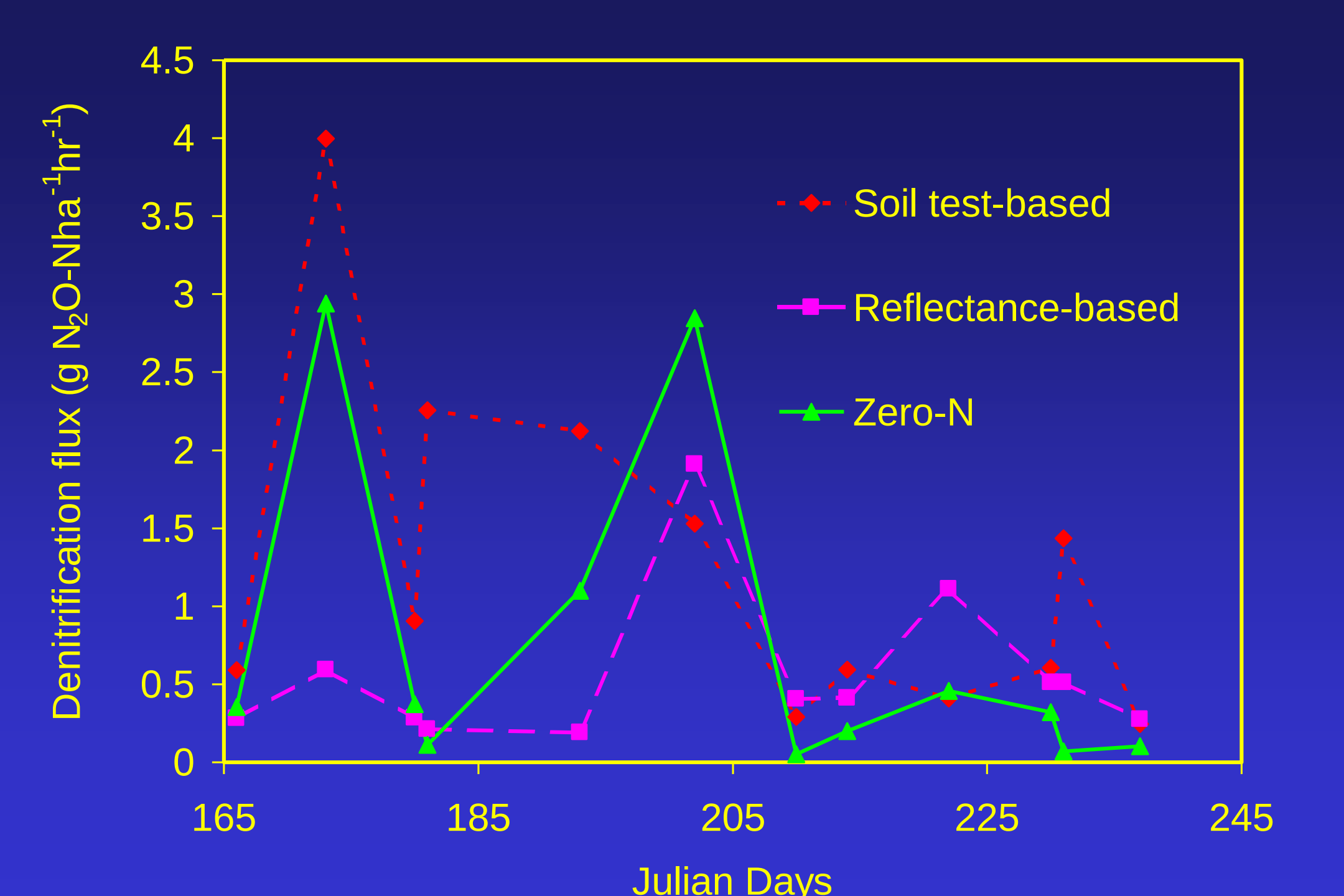
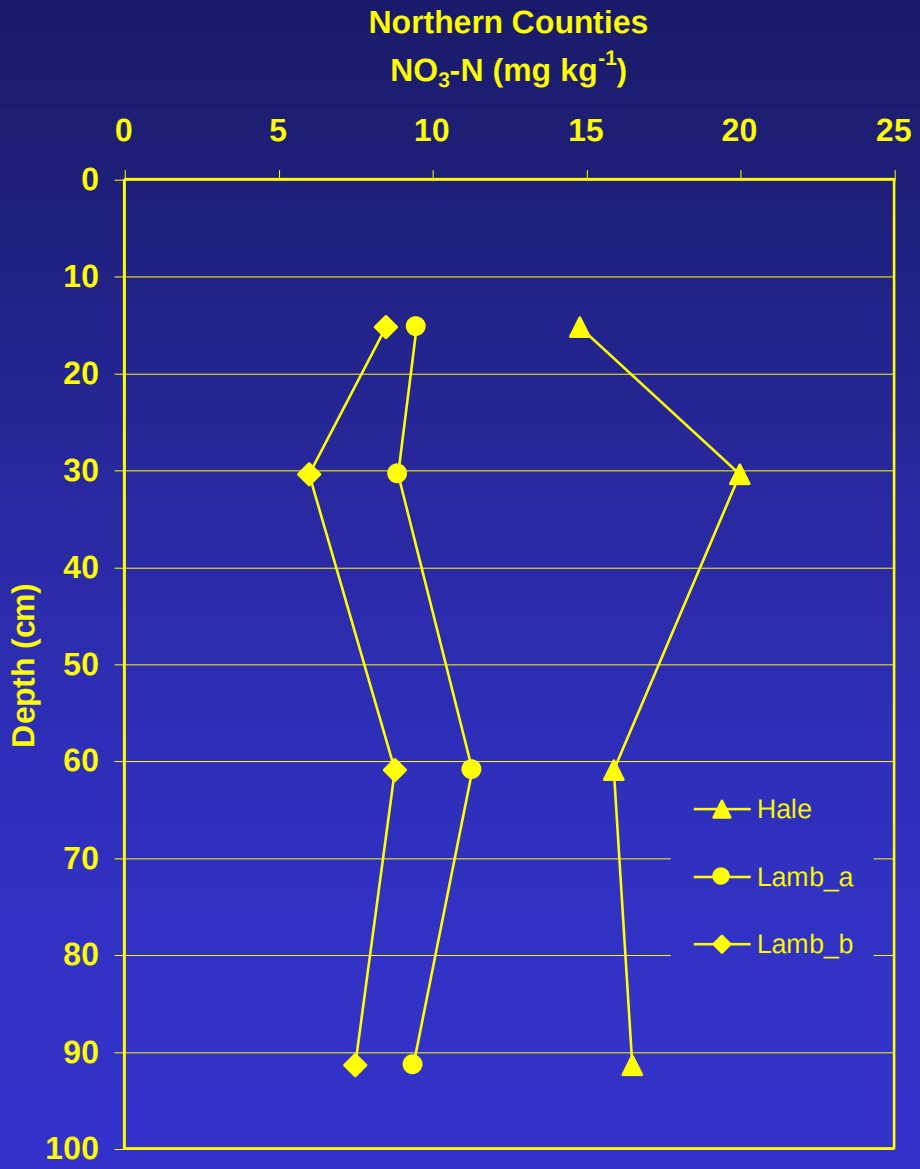
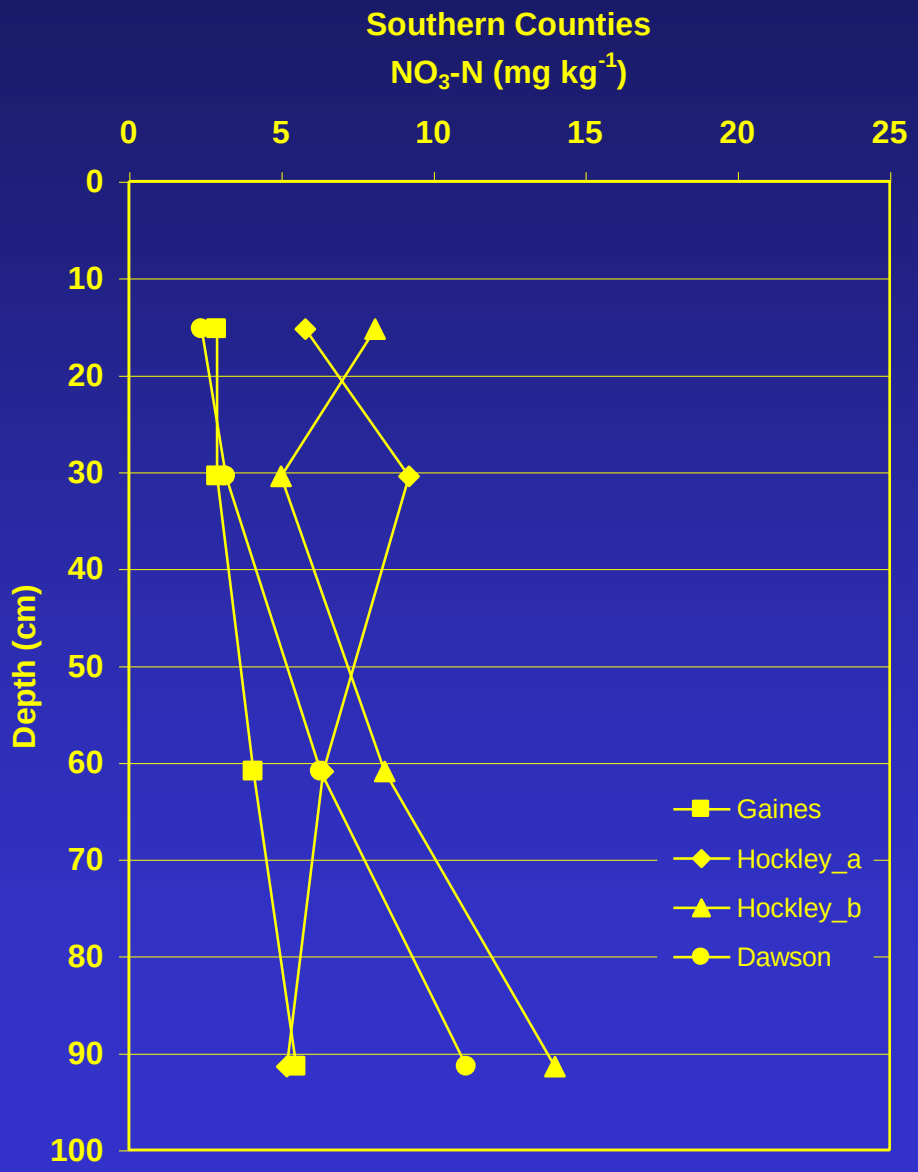

Denitrification flux (g N_2O-Nha^{-1}hr^{-1})
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
165
185
205
225
245
Julian Days
Soil test-based
Reflectance-based
Zero-N

Nitrate Soil Test for Cotton → N fertilizer recommendations

Soil profile NO_3-N concentrations in farmers' fields in Dawson, Gaines, Hale, Hockley, and Lamb counties, Texas, 1999-2004





Nitrate contents of 0-0.9 m soil profiles for eight cotton fields in Southern High Plains of Texas

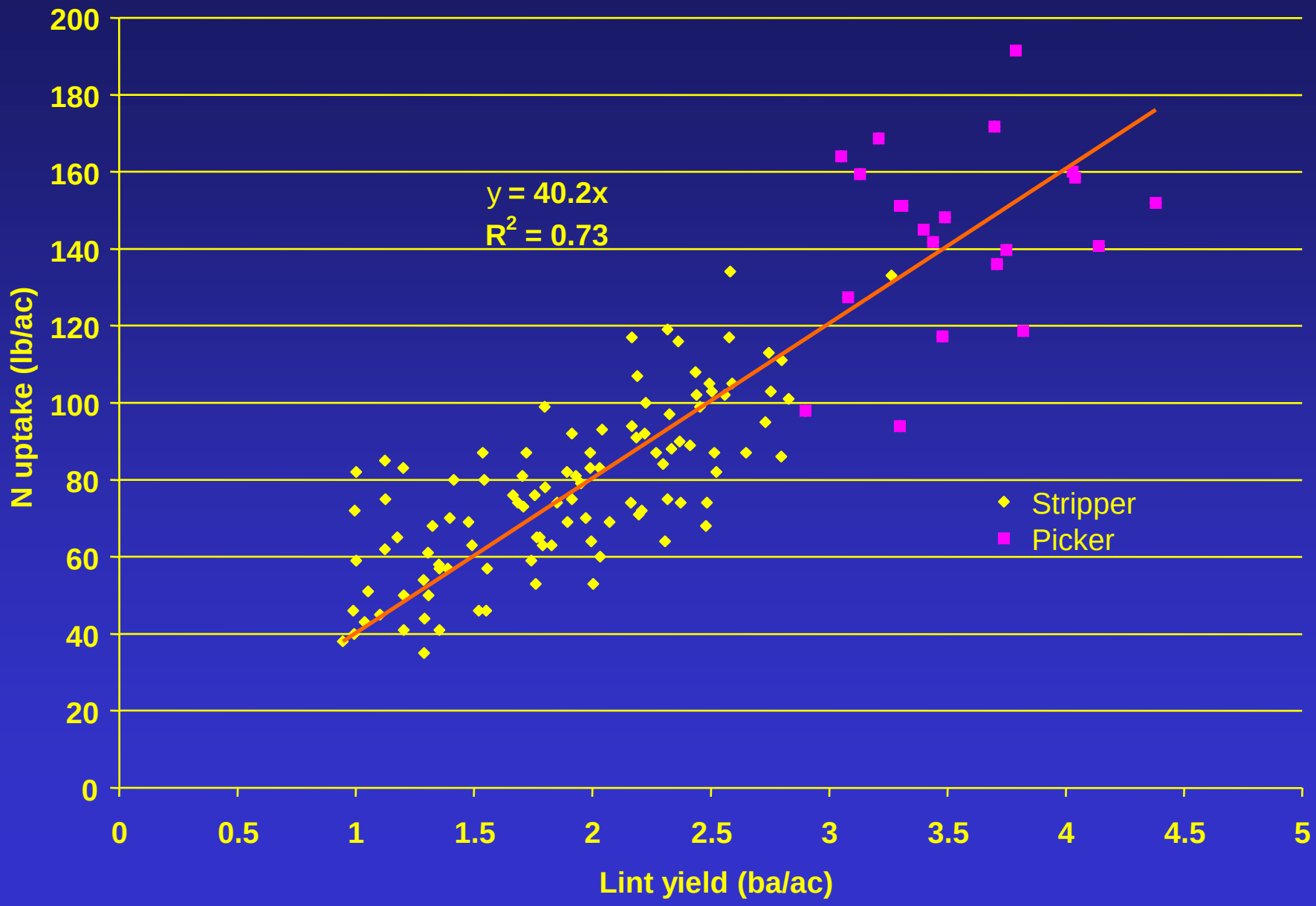
Field	N	Lower 95	Upper 95	Mean	Median
		kg NO_3-N ha^{-1}			
Dawson1	90	63	117	90 c	60
Gaines1	69	51	60	56 c	54
Hale1	53	207	250	228 a	214
Hale2	54	25	41	33 c	22
Hale3	47	98	120	109 b	111
Hockley1	53	114	146	129 b	114
Hockley2	60	51	60	56 b	51
Yoakum1	78	82	99	91 bc	85

Nitrogen requirements for irrigated 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

N Requirements (lb N/ac) vs. cotton lint yield (bale/ac)



Recovery efficiency of 90 lb fertilizer-N/ac in cotton plants, West Texas

Year	Irrigation	Lint yield	Recovery effcy-diff	Recovery effcy-15N	N application details
		lb/ac	--------- % ---------		
2001	Sub drip	1230	60	31	3 injections of 30 lb/N/ac
2001	LEPA	1321	42	37	3 injections of 30 lb/N/ac
2002	LEPA	1227	40	-	3 injections of 30 lb/N/ac
2005	Sub drip	1678	63	-	30 injections in 8 wks
2006	Sub drip	1407	71	-	31 injections in 8 wks
2006	Furrow	1220	20	-	Side-dress at 1st square

Mass balance approach to N fertilizer needs for 2.5 bale/ac cotton

N source	Pullman clay loam	Acuff loam	Amarillo sandy loam
	---------- lb N/ac ----------		
Critical 0-24 in NO_3-N	40	50	75
Net N mineralization	60	50	20
Irrigation NO_3-N	20	20	20
Sum	120	120	115

Texas A&M - West Texas cotton N fertilizer recommendations since early 2003

- **Soil test for nitrate (0-24 in.) is first step**
- **Nitrogen calculator: http://lubbock.tamu.edu/cotton/calcinstructions.html**
- **Nitrogen calculator needs: 1) soil test NO_3-N, 2) well water NO_3-N, 3) soil texture, 4) yield goal**

Conclusions

- **Similar Lint yield response to N for surface drip and subsurface drip irrigation at Lubbock. Terminated wheat cotton has 30 lb N/ac greater N fertilizer requirement than conventional cotton.**

- **0-24 in. spring NO_3-test appears effective in predicting N response in the Western US. Critical levels may be 50 and 75 lb N/ac for loamy/clayey and sandy surface soils respectively.**

Conclusions cont.

- **Forty lb N/ac is required in the cotton plant per bale of lint yield in the Southern High Plains. This reflects deficit irrigation and breeding for small plants.**
- **NUE (Rec. effcy) ranged from 20 % for furrow irrigation to 71 % fro drip.**
- **INUE is 40 lb N/bale for 3.8 bale picker cotton**

Conclusions cont.

- Chlorophyll meter and reflectance measurements positively related with N rate applied and in-season N status of cotton.

- Nitrogen applied with in-season sensing can reduce N applications in low-yielding seasons and reduce residual soil NO_3.

Questions?