Influence of irrigation nitrate crediting on cotton production and residual soil nitrate in the Texas Rolling Plains

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Introduction

Groundwater nitrate contamination is a major water quality concern in the Texas Rolling Plains. Leaching of nitrate-nitrogen (NO_3-N) is the primary route by which groundwater is contaminated (Spalding et al., 2001). While leaching may be minimal in properly managed, fine-textured soils, it is a problem with most irrigated sandy soils (Hergert, 1986). In the Rolling Plains, NO_3-N in irrigation water is a plant-available source that can be credited towards crop nitrogen (N) requirements. Adjusting fertilizer N rates for irrigation NO_3-N facilitates greater precision in N management, substantially reducing soil NO_3-N available for leaching.

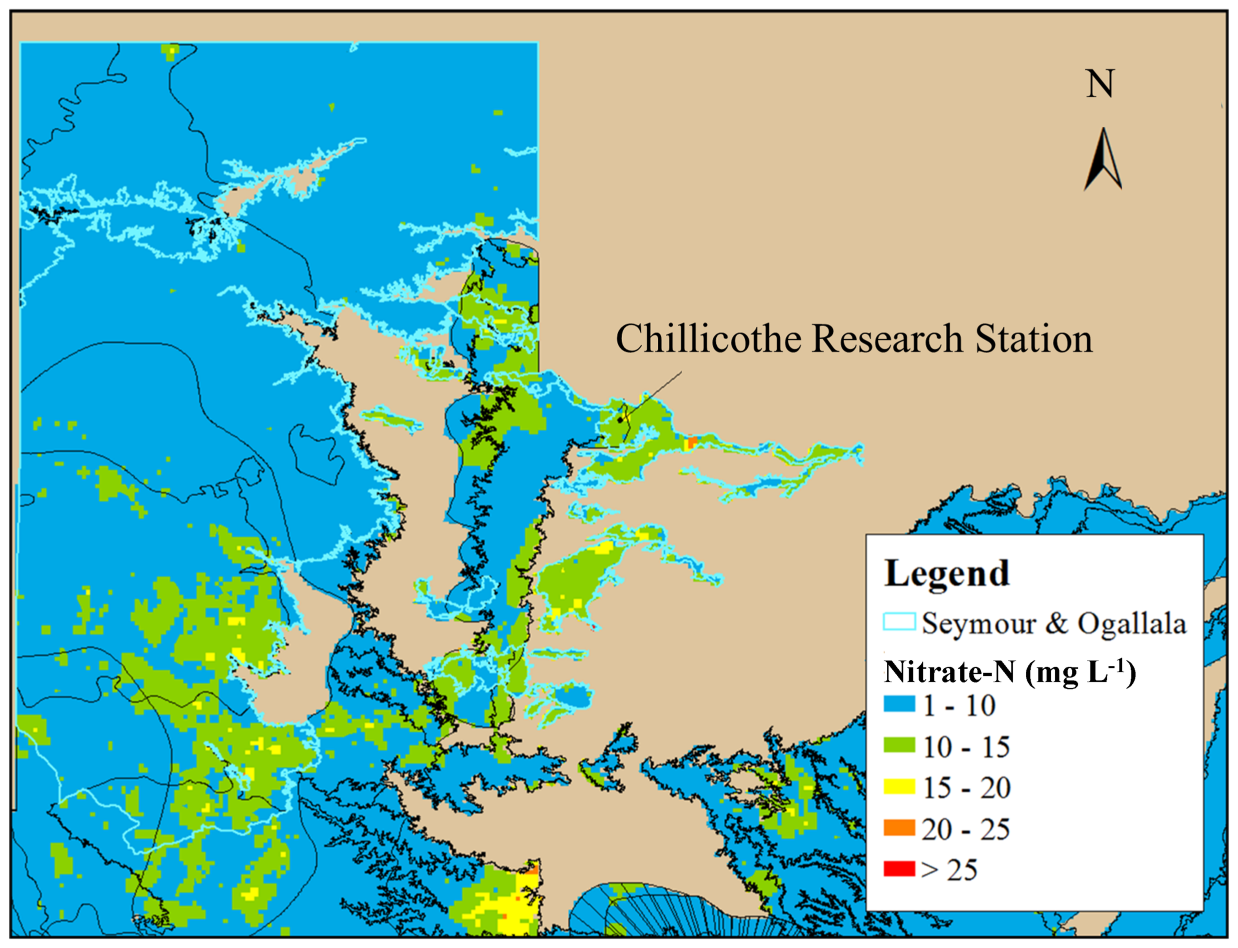

Figure 1. Study site location and groundwater NO_3-N in Texas High Plains and Rolling Plains

Objectives

Determine effects of irrigation NO_3-N crediting on cotton N fertilizer requirement, cotton lint yield, and residual soil NO_3-N.

Materials & Methods

Apr	Analysis of soil NO_3-N, NH_4-N, and MIII-P
May	Fertilizer input, broadcast and incorporated
May	Planting cotton (FM 1740)
June	Begin sampling well water
Oct	Subsampling cotton plants (10 plot^{-1})
Nov	Mechanical lint harvest

Experimental design

- Randomized complete block design within subsurface drip (SDI) and center-pivot (LESA) irrigation systems
- Five fertilizer treatments, replicated 4 times
- Abilene clay loam in SDI; Grandfield fine sandy loam in LESA
- 8-row x 15 m plots

Treatment	Description
Control	Unfertilized
Credited N	N rate based soil & water testing
Credited N + P	N rate based soil & water testing plus P
Uncredited N	N rate based on soil testing only
Uncredited N + P	N rate based soil testing plus P

- N application as 10-34-0 and 28-0-0 was based on soil NO_3-N to 61 cm
- Irrigation NO_3-N crediting was 62 kg NO_3-N ha^{-1} (represents NO_3-N in 30.5 cm irrigation water at 20 mg NO_3-N L^{-1})

Data analyzed by ANOVA in SAS

Results

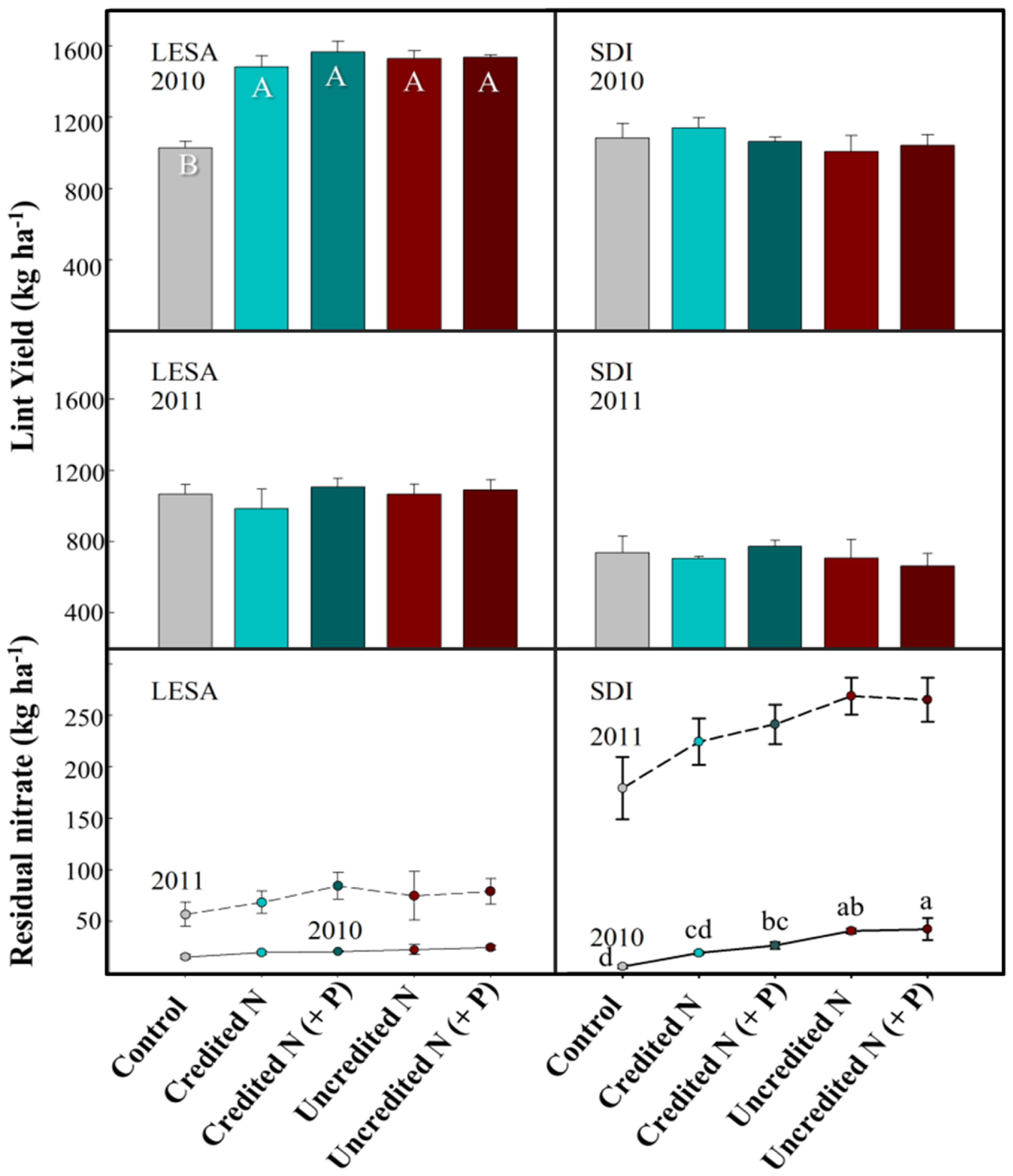

Figure 2. Lint yield (top) and residual soil NO_3-N to 91 cm (bottom). Means with same letter were not different (lint yield: $p < .0001$; residual NO_3-N: $p < .05$).

In 2011, drought conditions led to high irrigation input, resulting in 170 kg NO_3-N ha^{-1} applied through irrigation alone in LESA and SDI. Residual soil NO_3-N increased by a factor of three or more from 2010 to 2011.

Even with high input of NO_3-N, irrigation nitrate crediting led to reductions in soil nitrate accumulation.

			Applied			
		Need	Credited	Fertilizer	Irrigation	Uptake
		kg N ha^{-1}				
	LEPA	168	84	84	39	128
2010	SDI		84	84	55	170
	LEPA		79	90	170	149
2011	SDI		96	78	170	89
	LEPA		121	48	75	TBA
2012	SDI		168	0	75	TBA

Figure 3. 2010 - 2012 Applied N in Credited-N treatments. Need = cotton N need for 1615 kg lint ha^{-1}; Credited = NO_3-N credited from irrigation and soil; Fertilizer = N rate after applying N-credits. Uptake = total cotton N uptake

Effects of irrigation nitrate crediting

- Lint yield was not affected in either irrigation system in 2010 or 2011
- N uptake was negatively affected only in LESA 2010 in Credited-N treatment
- Reduction in soil NO_3-N was significant, though relatively small, in SDI 2010. In SDI 2011, residual soil NO_3-N was reduced by 15%, yet differences were not significant at the 5% probability level
- In all 5 treatments in SDI 2012, preplant soil nitrate met 100% of crop N demand

Conclusions

- Cotton N requirement in SDI 2012 was fully satisfied by soil NO_3-N accumulated over the 2011 season. Even though soil N loss was very high in LESA 2011, enough NO_3-N remained in soil to meet 30 to 47% of crop N requirement the following season.
- Crediting of irrigation and soil NO_3-N to 61 cm led to savings in fertilizer costs of \$85 to \$172 ha^{-1} yr^{-1} in LESA and \$85 to \$224 ha^{-1} yr^{-1} in SDI.
- Overall, irrigation nitrate crediting did not influence lint yield.
- Patterns of estimated N loss indicate the impact of soil texture on NO_3-N movement. From a water quality standpoint, nitrate crediting may have the greatest impact in systems with coarse-textured soils.

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