AVAILABILITY OF WELL WATER NITRATES FOR COTTON IN VARIOUS IRRIGATION SYSTEMS

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Abstract

Groundwater containing elevated nitrate (NO_3-N) concentrations could potentially supply significant amounts of N to irrigated crops. The objective of this research was evaluate the practice of accounting for existing N in irrigation water toward crop needs and the subsequent impact on crop production and N levels in the soil profile. Five fertility treatments (1) control; 2) N needs and 3) N and P needs based on soil testing and yield goal; 4) N needs and 5) N and P needs accounting for NO_3-N in well water) and three irrigation systems (furrow, subsurface drip, and center pivot) were evaluated. Nitrogen applications were reduced by 42% to 73% when NO_3-N in irrigation water was accounted toward crop N needs. Initial results found that lint yields and N uptake were not significantly different among fertilized plots, indicating that crediting well water NO_3-N is a sound practice, from both an agronomic and economic viewpoint.

Introduction

Nitrate is the most pervasive contaminant in groundwater in Texas and in the U.S. (Nolan et al., 2002). The Seymour Aquifer has the highest median NO_3 concentration among nine major aquifers in Texas (13.5 mg NO_3-N L^{-1}, Hudak, 2000). The Seymour Aquifer is a shallow, unconfined aquifer formed by isolated pockets of alluvial deposits and underlies over 300,000 ac in parts of 23 counties in north central Texas (Ashworth and Hopkins, 1995). While this is an environmental concern due to exceeding EPA Safe Drinking Water Standards, it could also provide a savings to producers if NO_3-N in well water is accounted for and credited toward crop N needs. A two-year study in Colorado concluded that NO_3 crediting is a sound economic and agronomic practice (Bauder and Waskom, 1999). When properly used, growers can maintain yields, reduce fertilizer costs, and help “clean up” groundwater. The objective of this study is to evaluate the practice of accounting for existing N in irrigation water toward crop needs and the subsequent impact on crop production.

Materials and Methods

Fibermax 1740 cotton was planted 22 May 2010 on furrow, subsurface drip (SDI), and center pivot irrigation systems at the Texas AgriLife Research Chillicothe Research Station in Chillicothe, TX. Plots within SDI and pivot systems were 8 rows (40” row spacing) x 50 ft long and 8 row x 100 ft long for the furrow irrigation system. Fertility treatments included: 1) control (N from irrigation water only); 2) N applied based on soil testing and yield goal (N); 3) N and P application based on soil testing and yield goal (N&P); 4) N application accounting for NO_3-N in well water (N-credit); and 5) N and P application accounting for NO_3-N in well water (N&P-credit). Treatments were replicated four times within the SDI and pivot systems and three times within the furrow system in a randomized complete block design. Liquid fertilizer was applied over the entire plot area to achieve a uniform application and incorporated. All plots were irrigated with a goal to achieve 100% ET replacement based on data obtained from the High Plains ET network. Water samples were collected weekly and analyzed for NO_3-N. Plants were clipped from each plot, dissected, and analyzed for total N. Plots were machine-harvested and ginned to obtain lint yields. Data were analyzed using Proc GLM of SAS (SAS Institute, Version 9.2). Means were considered significantly different when $P < 0.05$.

Results and Discussion

Table 1 shows N application rates for each fertility treatment. Well water NO_3-N concentrations typically average about 20 mg L^{-1} at the Chillicothe Research Station. In determining N application rates, it was assumed that 12 inches of water would be applied during the growing season, thus providing approximately 55 lb N ac^{-1}. As a result of accounting for NO_3-N in the well water, N applications were reduced by 73% for the furrow system and 42% for the SDI and pivot systems. Calculated N applied through the well water during the growing season was 35 lb N ac^{-1} for furrow, 48.5 lb N ac^{-1} for SDI, and 39.5 lb N $ac^{-1}$for pivot.

Table 1. Resulting nitrogen application rates based on soil test, yield goal, and well water NO_3-N.

Treatment	Yield Goal (bale/ac)	Residual Soil NO_3 – top 24" (lb/ac)	Applied N (lb/ac)†	Applied N when accounting for Well Water N (lb/ac)
Furrow	2	25	75	20
Pivot	3	20	130	75
SDI	3	20	130	75

†All P treatments received 75 lb P_2O_5 ac^{-1}.

Lint yields were significantly higher for fertilized plots compared to the control in the pivot system (Figure 1). However, there were no significant differences in lint yield among fertilized plots for the pivot, although N applications were reduced by 55 lb N ac^{-1}. There were no significant differences observed among treatments within furrow and SDI systems. There were some pest issues late in the season leading to dropped bolls within the SDI system which may explain some of the variability. It should also be noted that almost 70 lb N ac^{-1} was available to the SDI control treatment through nitrates in well water and soil. While fertilized treatments resulted in greater yields that the control in the furrow system, differences were not significant.

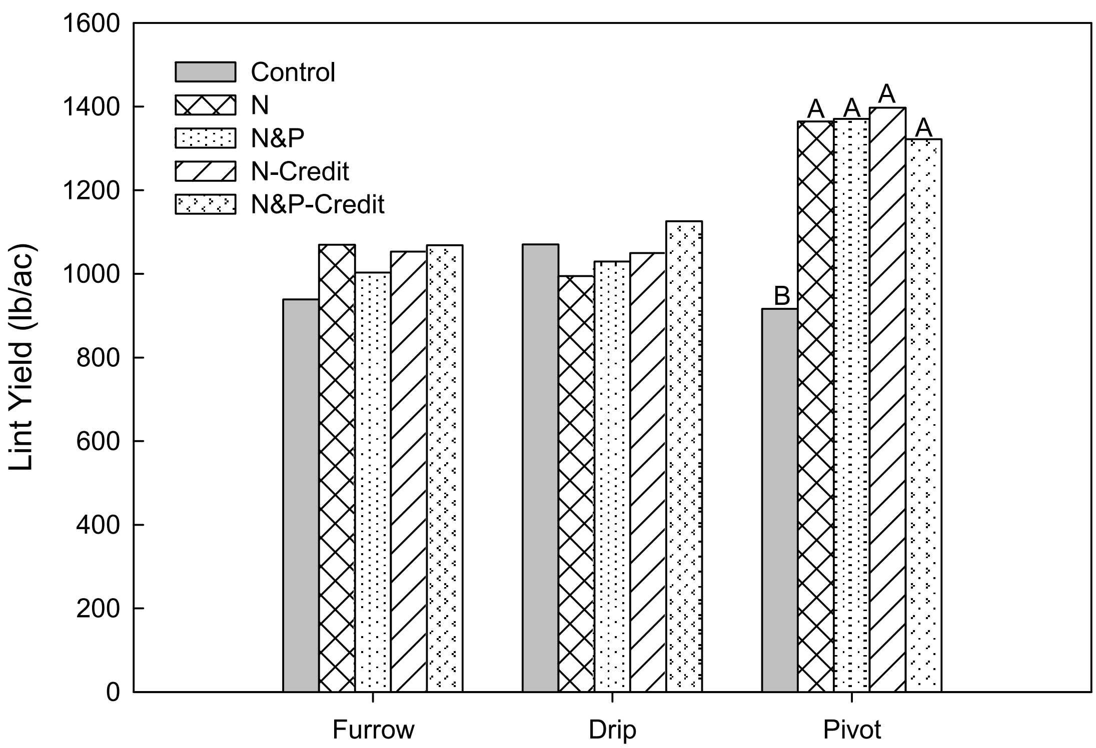

Figure 1. Lint yields as a function of N application treatment and irrigation system.

Nitrogen uptake levels were higher for all N treatments compared to the control within each irrigation system (Figure 2). For furrow and SDI systems, N uptake levels were similar among N treatments. For the pivot system, the N treatment had the highest N uptake level, significantly higher than the N&P and N-Credit treatments. This is assumed be due to variability among treatment replications. However, all N treatments resulted in significantly greater N uptake levels than the control for the pivot system.

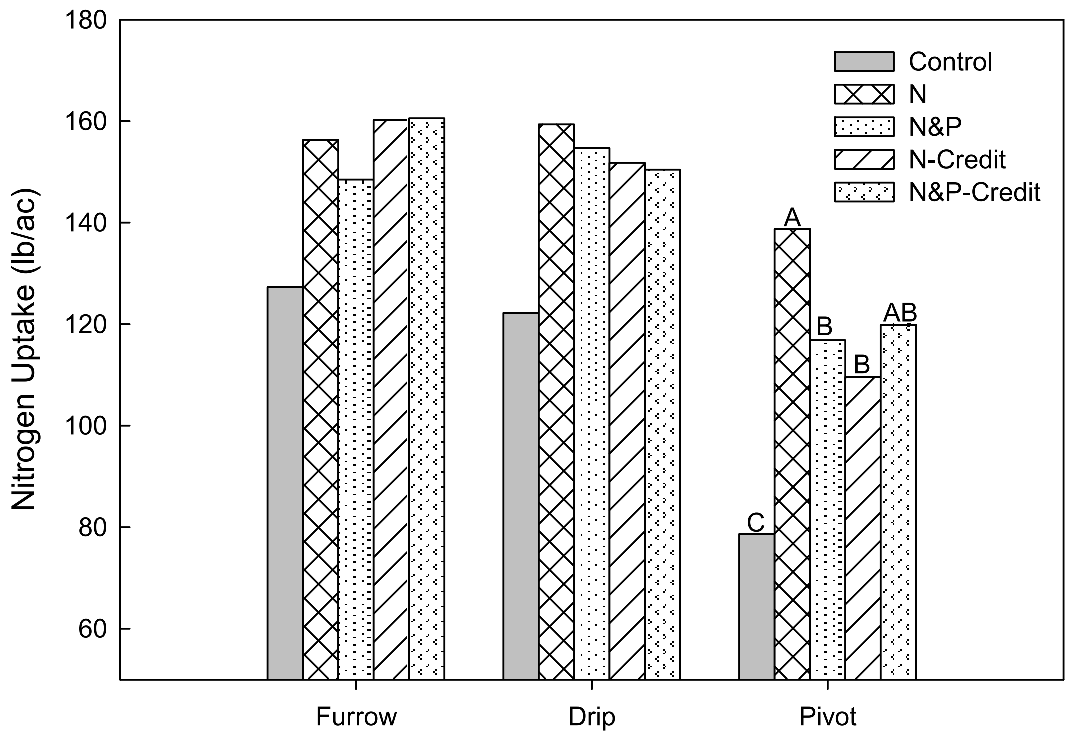

Figure 2. Nitrogen uptake as a function of N application treatment and irrigation system.

Summary

Initial results indicate that accounting for NO_3-N in irrigation water toward crop N requirements can maintain cotton lint yields. As N rates were reduced by 42 to 73%, significant savings could be realized by producers who test their well water and credit the NO_3-N levels in the water toward crop N needs. Two additional years of data will be collected (2011 and 2012) and compiled to better evaluate the practice of nitrate crediting. In addition, NO_3 concentrations in the soil profile are being measured and analyzed.

Acknowledgements

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