DEVELOPING NITROGEN AND PHOSPHORUS FERTIGATION STRATEGIES IN COTTON

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ABSTRACT

The objective of this research was to develop nitrogen (N) and phosphorus (P) fertigation strategies using subsurface drip irrigation (SDI) that increase nutrient use efficiency, cotton lint yield, and fertilizer return on investment. More specifically, we determined the number of fertilizer applications that result in optimized uptake and yield when using SDI. The research was conducted on a recently installed 67-zone SDI field at the Texas A&M AgriLife Research and Extension Center, Lubbock, TX, in 2021 - 2023. Results indicated less concern to greater application frequency with N; however, a greater return on investment was determined with fewer applications of P throughout the growing cotton (*Gossypium hirsutum*).

INTRODUCTION

Subsurface drip irrigation (SDI) is becoming a popular option for maximizing the water use efficiency of cotton (*Gossypium hirsutum*), especially in semi-arid environments of the Midsouth and Western United States. In the Texas High Plains where underground water resources from the Ogallala Aquifer are rapidly declining, there is increased adoption of water conservation technologies like center pivot and drip irrigation. In addition to increased water efficiency, drip irrigation allows for more precise fertilization through fertigation with application directly in the plant root zone. Applying fertilizers through SDI provides an opportunity to prescriptively apply nutrients at peak nutrient demand, which could minimize loss and increase uptake. Still, the application frequency and timing are poorly understood. This research aimed to develop nitrogen (N) and phosphorous (P) fertigation strategies using SDI that increase cotton lint yield.

MATERIALS AND METHODS

Cotton was planted at the Texas A&M AgriLife Research and Extension Center in Lubbock, TX. The Center includes a recently installed SDI system with 67 zones that allows the flexibility and control to apply nutrients through fertigation to each zone precisely. Plots were 4 rows wide (40" spacing) by 68 ft long. Treatments were arranged as a split-plot design with four replications. Main plots were designated for variety and fertility treatments were assigned to split plots. Ginned lint samples were sent to the Fiber and Biopolymer Research Institute (Texas Tech University, Lubbock, TX) for high-volume instrument analysis.

2021

Cotton (DP 2143 and DP 2020) was planted on 13 May 2021 then replanted on 7 June 2021. Fertilizer was applied via fertigation on 10, 28 May, 18 June, 20 July, and 2, 11, 20, 30 August 2021. Cotton lint yield was determined from mechanical harvesting on 18 November 2021. Harvested samples were ginned on a scaled gin at Texas A&M AgriLife Research and Extension in Lubbock, TX.

2022

Cotton (DP 2143 and DP 2020) was planted on 27 May 2022. Fertilizer was applied via fertigation on 7, 16, 24 June, 8, 15, 18, 29 July, and 12, 26 August 2022. Cotton lint yield was determined from mechanical harvesting on 12 December 2022. Harvested samples were ginned on a scaled gin at Texas A&M AgriLife Research and Extension in Lubbock, TX.

2023

Cotton (DP 2143 and DP 2020) was planted on 10 May 2023. Fertilizer was applied via fertigation on 17, 25 May, 2, 12, 21, 30 June, 10, 20 July, 8 August 2023. Cotton lint yield was determined from mechanical harvesting on 3 November 2023. Harvested samples were ginned on a scaled gin at Texas A&M AgriLife Research and Extension in Lubbock, TX.

RESULTS

2021

With DP 2020 and three nitrogen fertilizer applications, cotton lint yield was greater with one phosphorous application than with zero and nine (Figure 1). Differences were not determined for DP 2143 in 2021; however, similar trends to DP 2020 were observed.

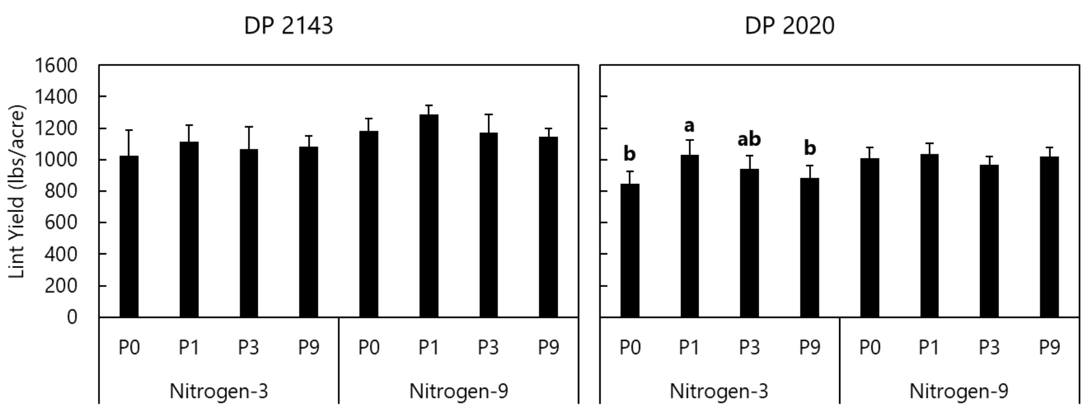

Figure 1. Cotton lint yields for two varieties, two nitrogen fertilization timings, and four phosphorous (P) fertilization timings at the Texas A&M AgriLife Research and Extension Center in Lubbock, TX. Letters represent significant differences between phosphorous fertilization frequency within cotton variety and nitrogen application frequency. Error bars represent standard deviation of the mean. Differences were only determined for DP 2020 B3XF.

2022

With DP 2020 and three N fertilizer applications, cotton lint yield was greater with zero, one, and three P applications than with nine applications. When N was applied in nine equal applications, lint yields were greater with one P application compared to the no P control and three applications. Regardless of variety, fewer P applications generally generated more cotton lint than three or nine applications.

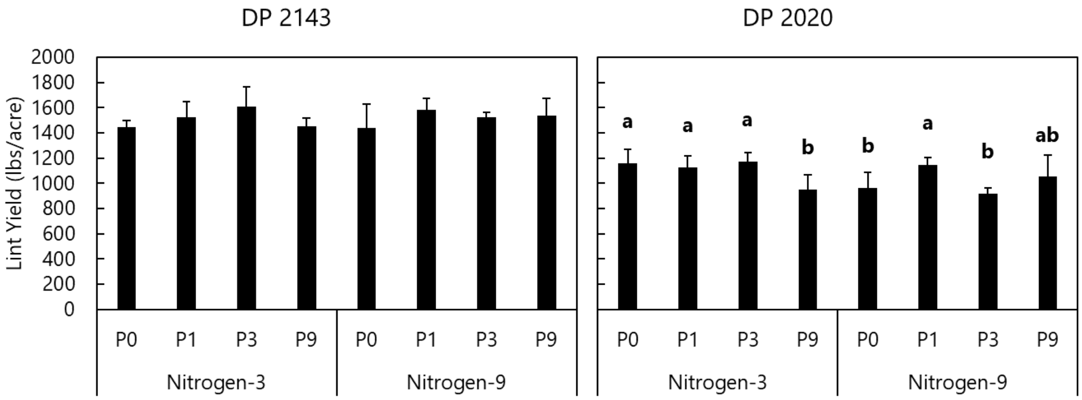

Figure 2. Cotton lint yields for two varieties, two nitrogen fertilization timings, and four phosphorous (P) fertilization timings at the Texas A&M AgriLife Research and Extension Center in Lubbock, TX. Letters represent significant differences between phosphorous fertilization frequency within cotton variety and nitrogen application frequency. Error bars represent standard deviation of the mean. Differences were only determined for DP 2020 B3XF.

2023

With DP 2143 and three nitrogen fertilizer applications, cotton lint yield was greater with three phosphorus applications than with zero, one, and nine applications (Figure 3).

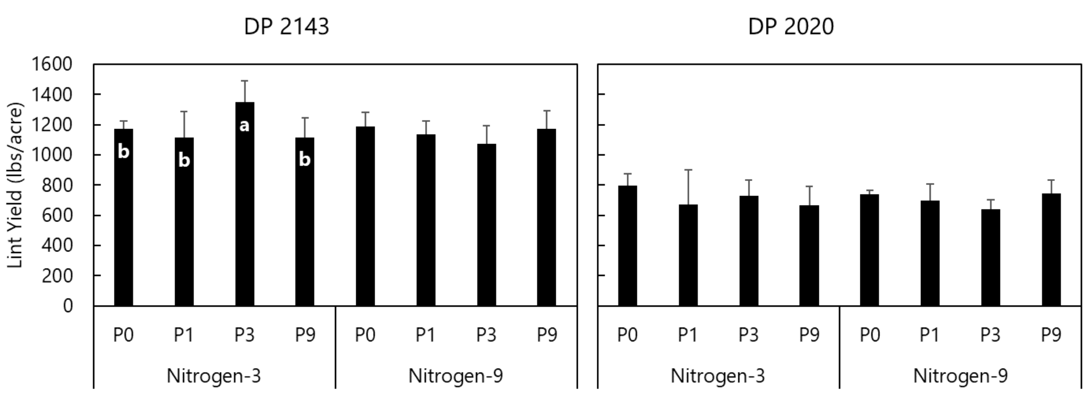

Figure 3. Cotton lint yields for two varieties, two nitrogen fertilization timings, and four phosphorous (P) fertilization timings at the Texas A&M AgriLife Research and Extension Center in Lubbock, TX. Letters represent significant differences between phosphorous fertilization frequency within cotton variety and nitrogen application frequency. Error bars represent standard deviation of the mean. Differences were only determined for

DP 2143 B3XF.

Preliminary data suggest different management approaches needed for N and P when fertigating using SDI. Nitrogen resulted in generally greater yield response with greater frequency of applications. Greater applications of N likely minimized losses from denitrification and immobilization. Results demonstrate that prescriptive N fertilizer applications produce greater lint yield and reduce nutrient losses compared to greater quantities applied at fewer frequencies. Phosphorous did not result in a greater yield response when applied at a greater frequency. We believe that nine P applications may be causing antagonistic effects with zinc and possibly other micronutrients. Past work has demonstrated greater P uptake with nine applications even though lint yield was reduced. This leads us to hypothesize an antagonistic effect of increased P uptake reducing the uptake of other essential elements. Future work should explore the potential antagonistic effects that could potentially be taking place.