

Phosphorus Fertility Evaluation in Graham County

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Abstract

A series of three phosphorus (P) fertility experiments were conducted in 2001 in Graham County. These studies follow similar experiments conducted over the past three seasons. Results from 2001 were consistent with previous results indicating a positive relationship between yield and P fertilizer applications in relation to soil test indices. Modest yield increases were observed from a minimum of 25 to 80 lbs. lint per acre with an application of approximately 70 lbs. of P as P₂O₅ per acre. Yield differences from previous years have been as great as 170 lbs. of lint per acre. With the increased use of UAN-32 as a primary fertilizer source and a reduction in the application of P fertilizers, which is typically associated with a rotation of small grains, a depletion of soil P is a potential result. A continuation of this research with varying rates of P fertilizer will take place in 2002 in an attempt to relate soil test P levels to yield increases observed in recent years. The results of this research demonstrate the possible need for a return to use of fertilizers with supplemental P for optimum yields that would be predictable based on soil test results.

Introduction

Fertility management in desert cotton production is a critical component in an economically, environmentally, and agronomically sustainable system. Fertility management and the efficient use of fertilizers has become increasingly important in recent years due to a rise in the cost of fertilizer. With increasing costs of production and the continued depressed cotton prices, it will become even more important to scrutinize each input to determine whether that particular input contributes to the overall profitability of the crop.

Nitrogen (N), P, and potassium (K) are the nutrients most commonly applied to Arizona cotton crops. Management of these nutrients is important to optimize plant response and yield and should be based upon established guidelines. These guidelines are typically developed through soil testing and plant tissue testing correlation and calibration. The development of appropriate soil testing guidelines are based upon a three-step process (Corey, 1987). Step one involves selecting an extractant that is appropriate for the chemical characteristics of the soil being tested. In the case of P fertility in high pH soils, NaHCO₃ has been shown to be an effective extractant. The second step involves correlating the amount of nutrient extracted from the soil to the amount taken up by the crop. The third step involves calibrating the test value in terms of its effect on some marketable characteristic of the crop being evaluated (commonly yield). Fertilizer recommendations are then made based upon the results of the calibration procedure. A critical level is then developed for a particular crop. In the case of cotton production in the desert soils of Arizona, a NaHCO₃ extractable level of P greater than 5 ppm is usually considered sufficient, and a level below 5 ppm is indicative of possible deficiencies of P (Silvertooth et al., 1991). Other research done around the state has shown little positive yield response to P fertilization (Silvertooth et al., 1989, 1990, 1991 and Thelander and Silvertooth, 2000).

The Pima and Grabe soil series dominate most of the agricultural soils in the upper Gila River Valley and the dominant soil texture is a clay loam. These soils typically have both a high electrical conductivity of the soil extract (EC_e) and high pH. Samples collected out of this valley over recent years have indicated

several areas where soil P levels are near or below the 5 ppm NaHCO_3 extractable P that is recommended as the critical level for optimum cotton production. Due to the increased potential for yield response to P fertilization with low P soil test levels, a series of experiments were initiated in 1998. The basic materials and methods for the experiments conducted in 1998-2000 can be found in other reports (Thelander and Silvertooth, 2000).

Materials and Methods

In 2001 three similar experiments were conducted at three different locations. Each of the three experimental sites consisted of two treatments: 1) a control receiving 0 P fertilizer and 2) a treated block receiving one application of approximately 70 lbs. P/acre as P_2O_5 applied early in the season at the 3 – 4 leaf stage. In all cases the treatments were arranged in a randomized complete block design with four replications in each of the three experimental sites. Treated blocks were 12, 36" rows wide and extended the full length of the irrigation run (1250 feet). The control blocks each contained 48 untreated rows. Plant measurements were collected on a regular basis from each of the three sites from all plots. Plant measurements included plant height, number of mainstem nodes, number of aborted or missing sites, and nodes above the top (first position) white flower. Leaf tissue was also collected on a regular basis in an effort to assess the P fertility status of the crop throughout the season. Yield estimates were made by harvesting the entire 12 row treated block and 12 rows from the control blocks and then weighed with a boll buggy equipped with load cells. Data was subjected to analysis of variance in accordance with procedures outlined by the SAS Institute (1999) and Gomez and Gomez (1984).

Results and Discussion

This series of large, field scale P fertility experiments were begun in 1998 with Layton Farms in Thatcher, AZ. In 1998, 48 row blocks were treated with approximately 114 lbs. P/acre as applied as 11-52-0 in a pre-plant injected treatment. Soil test results for this field are found in Table 1. This study was planted 21 April 1998 to the cultivar Pima HTO. It was harvested on 23 October 1998. Yield results for this particular experiment are found in Table 2. Differences in yield were not statistically significant but trends revealed increased yield with P fertilization.

This project was repeated in 1999 in a different location with the same cooperator. The 1999 location was planted on 25 April 1999 to Pima HTO and harvested on 11 November 1999. Plots were again 48 row blocks each and were treated with 84 lbs. P/acre with an application of 10-34-0 injected preplant. Soil test results for this location are also found in Table 1. Yield results for this location are found in Table 2. A statistically significant yield response was not obtained but trends toward higher yield with P fertilization were observed again. Visual differences in plant vigor and plant height were also observed at this location particularly on the upper (south) end of the field where the soil is dominated by a higher percentage of sand and silt.

During the 2000 season a P rate study was not established at this location. However, observations were made during the growing season in the residual plots and distinct visual differences remained in the same field where the P fertilizer had been applied the previous season. Therefore, the decision was made to harvest the original 1999 plots again in 2000 and yield results are presented in Table 3. Soil samples were not collected from this location in 2000. Another item to note is the fact that in the 2000 season the cultivar planted was an Upland cotton cultivar (DP655BR), which produced significantly higher yields than the previous two seasons. Once again a statistically significant yield increase was not observed but an average increase of 167 lbs. lint/acre was obtained in the plots that had been fertilized the previous year. Yield estimates for all three years are shown graphically in Figure 1.

In 2001 the test location was moved to another area of the valley that had a lower NaHCO_3 extractable soil P level. All three fields used in the 2001 evaluation had levels of less than 5 ppm (Table 1) which is the standard critical level established for Arizona cotton production (Silvertooth and Norton, 1998). Plant measurements taken during the season revealed no differences in plant growth and development. No visual differences in plant growth were observed at this location in 2001 as there had been in previous years at similar sites.

Yield differences were observed to be statistically significant in one of the three locations (Table 3). Results from all three locations indicated trends toward increased lint yield with P fertilization. Increases ranged from 25 to 80 lbs. lint/acre. Figure 2 shows how each of the three locations performed with respect to yield.

Summary

Results from this set of P fertility studies indicate the potential benefit of P fertilization in the upper Gila River Valley. Several factors could be contributing to the response observed in these experiments. Recent years have seen a change in production practices by many growers in the upper Gila River Valley. A change in the use pattern of fertilizer products has occurred over recent years from fertilizers containing a P component to almost exclusive use of UAN 32. A reduction in the use of 16-20-0 and other P based fertilizers as a starter fertilizer for small grains has also decreased due to a reduction in the use of small grains as a rotation crop for cotton. These factors could be contributing to an overall depletion of soil P available for cotton plant uptake, thus resulting in positive lint yield responses with the application of P.

This work will continue in the 2002 cotton growing season including an expansion in the rates and possibly timing of P fertilizers in an effort to optimize P fertilization with respect to yield and the overall economic return to the producer in relation to the established soil testing guidelines for cotton production in Arizona (Silvertooth and Norton, 1998).

References

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Table 1. Soil test results for each P fertility experimental locations in Graham County, 1998-2001.

Year	pH	EC dS/m	ESP¶	Ca*	Mg*	K*	Na*	Zn*	NO ₃ -N**	P§
1998	7.9	6.8	6.9	7200	580	530	720	--	212	6.8
1999	8.3	2.0	5.4	7700	820	620	620	--	25.4	7.1
2000					No samples collected					
2001					No samples collected					

*Exchangeable cations using neutral molar ammonium acetate.

**NO₃--N using specific ion electrode.

§NaHCO₃ extractable P.

¶Computed - exchangeable sodium percentage.

Table 2. Lint yield results and analysis of variance results for all P fertility evaluation sites 1998-2000.

Treatments	Year		
	1998	1999	2000
	-----Lint Yield (lbs lint/acre)-----		
Control	812	951	1497
Treated	868	976	1663
LSD*	NS	NS	NS
OSL§	0.3713	0.4435	0.2151
CV (%)¶	10.32	4.23	9.52

*Means followed by the same letter are not significantly different according to a Fisher's least significant difference (LSD) means separation test.

§OSL – Observed Significance Level

¶CV – Coefficient of Variation

Table 3. Lint yield results and analysis of variance results for P fertility evaluation, 2001.

Treatments	Location		
	North	South	Central
	-----Lint Yield (lbs lint/acre)-----		
Control	1592 a*	1411 b	1445 a*
Treated	1670 a*	1467 a*	1468 a
LSD*	NS	55	NS
OSL§	0.1191	0.0487	0.04071
CV (%)¶	3.12	1.70	2.28

*Means followed by the same letter are not significantly different according to a Fisher's least significant difference (LSD) means separation test.

§OSL – Observed Significance Level

¶CV – Coefficient of Variation

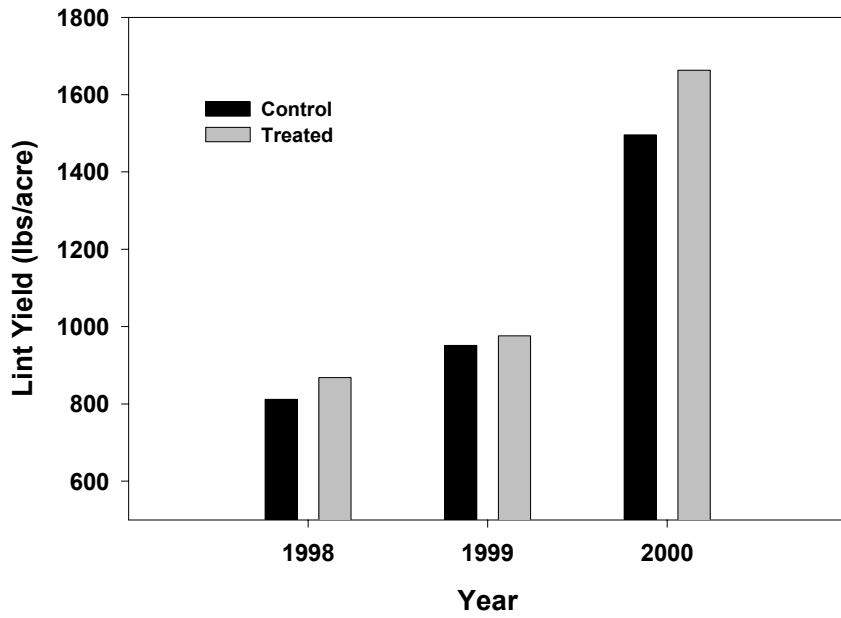


Figure 1. Yield results for P fertility studies conducted in Graham County, 1998-2000.

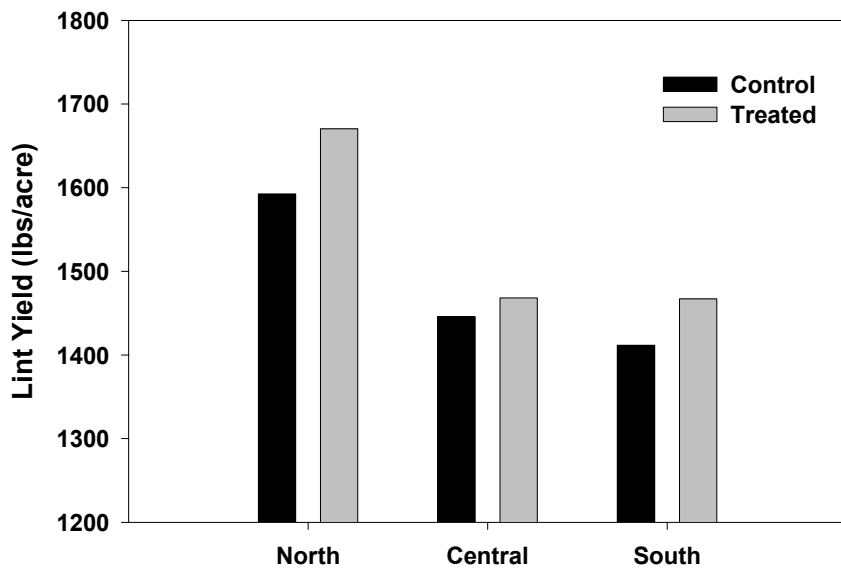


Figure 2. Yield results for P fertility experiments conducted in Graham County, 2001