

Phosphorus Fertility Evaluation in Graham County

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Abstract

This project is a continuation of an ongoing phosphorus (P) fertility evaluation that began in 1998, at Safford, AZ on a grower cooperated field. The field study conducted during the 2003 season consisted of five treatments of varying rates of P fertilizers from 0 through 165 lbs. of P_2O_5 per acre. Treatments were arranged in a randomized complete block design with three replications. Plot sizes were 12, 36 in. rows wide and extended the full length of the irrigation run of 1250 feet. Three of the five treatments (treatments 3, 4, and 5) consisted of varying rates of P fertilizer applied as a liquid blend (11-30-0-5S) proprietary to United Agri Products (UAP) injected in the soil at approximately the 4 leaf stage prior to the first post plant irrigation. An additional treatment (treatment 2) of calcium thiosulfate (CATS) proprietary to Tessengerlo-Kerley was also applied. In an effort to ensure uniform application of fertilizer nitrogen (N) across all treatments, a solution of urea-ammonium-nitrate (UAN) was applied to bring uniform the level of all treatments with respect to N fertilizer. Lint yield results indicate a strong positive response to applied P, consistent with the previous four years of P fertility work done in this area. The highest applied P treatments resulted in the highest lint yields with an increase of approximately 155 lbs. lint/acre above the control, an increase of about 12%. Fiber quality data did not indicate any significant differences among treatments for any of the fiber quality parameters measured. Compiling all yield data from the prior six years and plotting percent relative yield as a function of applied P fertilizer demonstrates a positive response to P fertilization. These results indicate the need for local growers to consider P fertilization as an important component of their fertility program. This is particularly true for cotton fields that have had very little or no rotation with small grain crops that are commonly fertilized with a P based fertilizer such as 16-20-0.

Introduction

Recent years have seen an increase in cost of fertilizers experienced by cotton producers throughout the cotton producing regions of the U.S. This increase in cost along with the ever increasing environmental scrutiny on the use of fertilizers and other agricultural products has driven producers to become even more critical of inputs used in the production of a cotton crop. Efficient use of fertilizers and other agricultural products will benefit the producer from an agronomic, economic, and environmental perspective. Nutrient management is a critical component of a successful crop production system. Deficient levels of nutrients can lead to reduced yields and quality. Application of nutrients over and above what the crop can utilize also reduces the efficiency of the system and may lead to an environmental concern. Providing sufficient levels of nutrients then become critical to realizing the full potential of the crop.

Nitrogen, 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 is 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, sodium

bicarbonate (NaHCO_3) 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 NaHCO_3 extractable level of P greater than 5 ppm is usually considered sufficient, and a level below 5 ppm is indicative of possible P deficiencies (Silvertooth et al., 1991). Other research done around the state has shown little positive yield response to P fertilization in soils with extractable levels of P greater than 5 ppm (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 (EC_e) and high pH. Samples collected out of this valley over recent years have indicated 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). Results from other P fertilizer work performed in the Safford valley have indicated consistent positive yield responses to P fertilization (Norton et. al., 2002).

The objectives of the current study are to continue to evaluate the response of cotton to P fertilization and refine recommendations for P fertilizer applications.

Materials and Methods

The 2003 evaluation was constructed as a 5 treatment experiment arranged in a randomized complete block design with three replications. Each treatment consisted of approximately one acre blocks of 12, 36" rows wide extending the full length of the irrigation run of 1250 feet. Treatments consisted of a control (Treatment 1), a calcium thiosulfate (CATS) treatment (treatment 2), and three rates of a liquid P fertilizer (11-30-0-5S, treatments 3, 4, and 5). Treatments were applied on May 27 when the crop was approaching the 4-5 leaf stage. This occurred just prior to the first in-season irrigation. In order to ensure that the varying N levels were not a factor in the experiment, a urea-ammonium-nitrate solution (UAN) was used to bring all treatments to the same level with respect to fertilizer N. Table 1 outlines all treatments with their associated materials that were applied.

Yield estimates were made on 24 November by harvesting the center 8 rows from each 12-row plot and then weighing with a boll buggy equipped with load cells. Sub samples were collected for lint turnout determination. Lint samples were then sent to the USDA fiber classing office in Phoenix, AZ for high volume instrument (HVI) analysis providing fiber quality data. All data was subjected to analysis of variance in accordance with procedures outlined by the SAS Institute (1999) and Gomez and Gomez (1984).

Data from the previous five years of P fertility work was compiled in an effort to look at trends over recent years. Percent relative yield with respect to the control was calculated and plotted as a function of applied fertilizer P. Regression analysis was performed on this data to determine the strength of the relationship between yield and applied P.

Results and Discussion

Results from the 2003 project were consistent with the results from previous work done in this valley with respect to P fertility (Norton et. al., 2002). An increase in lint yield was observed with increasing rates of P fertilizer applied. Table 2 outlines the lint yield and the associated analysis of variance. Significant differences were observed between the highest rate of P applied and the control and treatment 2 neither of

which received any P fertilizer applied. No significant differences were observed with respect to fiber quality parameters measured among any of the P treatments. (Table 3). Figure 1 shows lint yield as a function of treatment on the left vertical axis. The right vertical axis shows the percent relative (relative to the control) yield for each of the treatments. The highest rate of P fertilizer applied resulted in approximately a 13% yield increase over the control. Percent relative yield was calculated for results from the previous five years of data collected on P fertility projects conducted in this valley. Percent relative yield as a function of applied P is shown in Figure 2. Regression of the data produced an equation with a slope of 0.07 indicating an increase in lint yield of 0.07 lbs for every pound of fertilizer P applied. This regression equation accounts for only 34% ($r^2=0.3375$) of the variation contained in this data indicating a moderately strong relationship.

Summary

This work will continue in the 2004 cotton growing season 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). The 2004 project will also involve investigating the effects of variable rate or prescription application of P fertilizers based upon yield maps and soil sampling from the 2003 season.

References

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Table 1. Rates of both P and N for each of the four treatments, P fertility study, Safford, AZ, 2003.

	Treatments				
	1	2	3	4	5
Primary Application – 27 May					
Product	---	CATS	11-30-0-5S	11-30-0-5S	11-30-0-5S
Rate (gpa)	0	15	10	20	30
P Applied (lbs/acre)	0	0	31	63	94
N Applied (lbs/acre)	0	0	12	24	36
Secondary Application – 3 June					
Product	UAN	UAN	UAN	UAN	UAN
Rate (gpa)	10	10	7	7	0
P Applied (lbs/acre)	0	0	0	0	0
N Applied (lbs/acre)	35	35	25	25	0
Total P (lbs/acre)	0	0	31	63	94
Total N (lbs/acre)	35	35	36	48	35

Table 2. Analysis of variance for lint yield estimates for each of the four treatments, P fertility study, Safford, AZ, 2003.

Treatment	Lint Yield lbs lint per acre
5	1311 a*
4	1231 ab
3	1227 ab
1	1163 b
2	1156 b
LSD* (lbs lint/acre)	85
OSL§	0.0178
C.V.(%)†	3.7

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

§Observed Significance Level

†Coefficient of Variation

Table 3. Fiber quality data for each of the four treatments, P fertility study, Safford, AZ, 2003.

Treatment	Grade	Staple 32nds	Micronaire	Strength grams/tex	Leaf Grade	Length 100ths	Uniformity
1	31	34.3	4.9	31.7	2	1.08	80.3
2	21	35.3	5.0	31.7	3	1.10	81.0
3	21	34.7	5.0	31.8	2	1.08	80.7
4	21	35.0	4.9	32.0	2	1.09	80.3
5	21	35.0	4.9	31.8	2	1.09	80.3

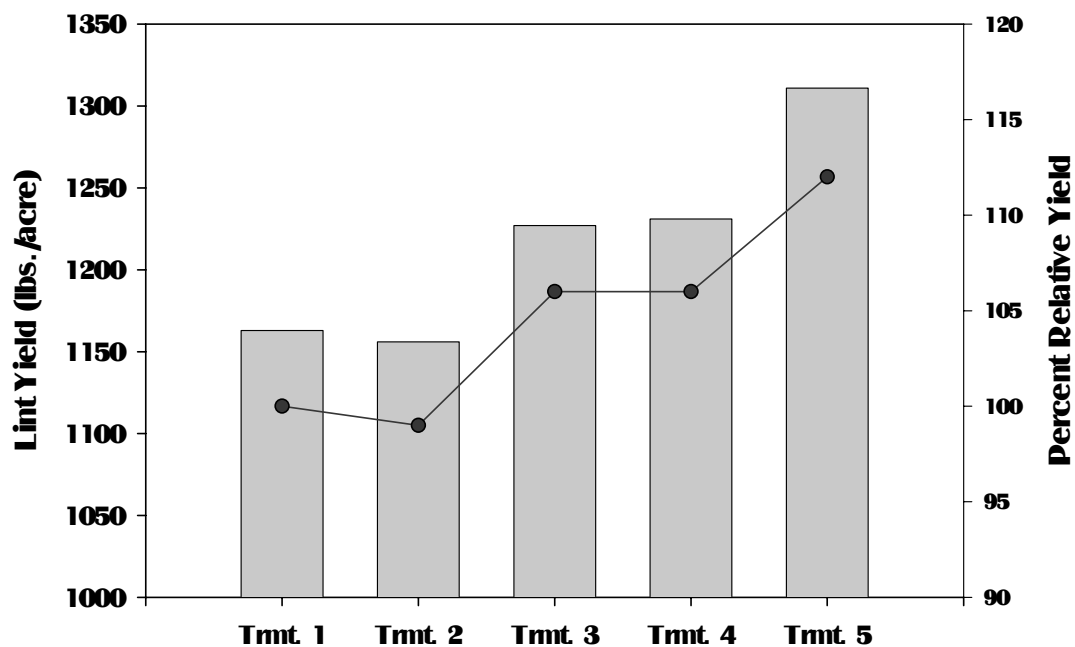


Figure 1. Graphical representation of lint yield results for each of four P fertility treatments, P fertility study, Safford, AZ, 2003.

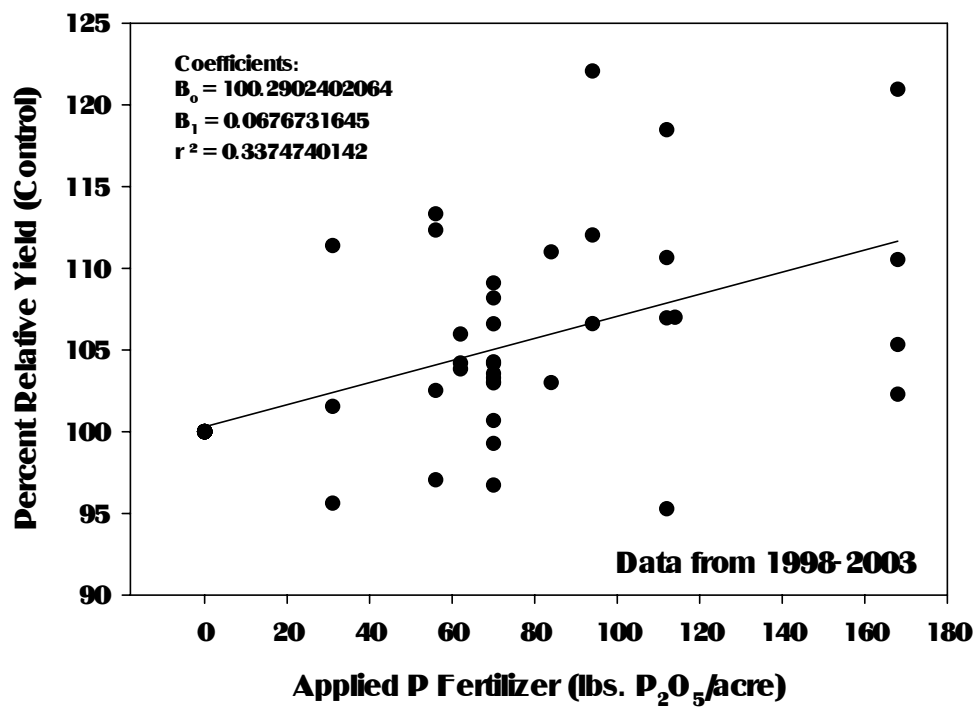


Figure 2. Percent relative yield (relative to the control) for the past five years of P fertility research performed in the Safford valley.