Phosphorus Fertility Evaluation in Graham County

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Abstract

A field study was implemented in 2002 in the Upper Gila River Valley of Safford to investigate the effects of varying phosphorus (P) fertilization rates on yield and quality of Upland cotton. This study is a continuation of work performed in this valley that began in 1998. This study was organized in a randomized complete block design with four treatments including four rates of 10-34-0 fertilizer, 0, 15, 30, and 45 gallons per acre (gpa) replicated 4 times. Lint yield results indicate a positive response to the application of 10-34-0 fertilizer with yield increasing linearly up to 30 gpa. The 45 gpa treatment resulted in a slightly lower yield than the 30 gpa treatment. This was likely due to the high level of nitrogen (N) fertilizer and excessive vegetative growth at the expense of reproductive growth (yield) that occurred in treatment 4.

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, 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, $NaHCO_3$ 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 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 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).

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Materials and Methods

The study in 2002 was established with 12, 38-inch row plots extending the full length of the irrigation run of approximately 1280 feet. Plots were planted on April 24th to the cultivars Deltapine DP655BR and DP5690RR. Four of the 12 rows in each plot were DP5690RR as an in field refuge for Bt resistance management. Treatments consisted of applications of liquid 10-34-0, which was applied in a sidedress application placing the liquid approximately 6 inches deep and approximately 6 inches to either side of the seed line when the plants had two-three true leaves. Treatments consisted of a control (0 gpa 10-34-0, Treatment 1) and a one time application of 15, 30, and 45 gpa for treatments 2, 3, and 4 respectively. In order to minimize the effect of the added N from the application of 10-34-0 an additional application of UAN32 was made to treatments 1, 2, and 3 in order to bring them to the level of treatment 4 in terms of N applied. Table 1 shows treatments and rates of 10-34-0 applied to each treatment. Plots were arranged in a randomized complete block design with four replications.

Yield estimates were made on October 14th 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).

Results and Discussion

Plant measurements collected two times (data not included) over the course of the season revealed no differences among treatments with respect to plant vigor or fruit load, with the exception of treatment number 4 which showed some vegetative tendencies toward the end of the season. Lint yield results are shown in Table 2 and Figure 1. Statistical separations are shown in Table 1 while Figure 1 is a graphical representation of the same data. Lint yields were significantly different at the $\alpha=0.01$ level with an OSL of 0.0696. Means separations indicate that the control was significantly different than treatments three and four but not treatment two. A linear trend in increasing yield with increasing amounts of P applied was observed with the exception of treatment number 4, the high rate of N fertilizer applied. This high fertilizer N resulted in an increase in vegetative growth that occurred at the expense of reproductive growth (yield).

Summary

The results from the 2002 P fertility evaluation tend to strengthen the recommendation of P fertilization, particularly on fields that have seen exclusively UAN32 application in recent years. This work is consistent with earlier work done in P fertility in this valley (Norton et al., 2002). A movement away from small grains as a rotation crop and into more cotton production year after year has all but eliminated the use of 16-20-0, or other P fertilizers, as a starter fertilizer for small grains. Cotton fertilization has been accomplished almost exclusively with UAN32 thus reducing the overall level of soil P available for crop use. These conditions provide an environment that has significant potential for a response to P fertilization.

This work will continue in the 2003 cotton growing season including an expansion in the rates and forms of P fertilizers used 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

Corey, R.B. 1987. Soil test procedures:correlation. p. 15-22. In J.R. Brown (Ed.) Soil Testing: Sampling, Correlation, Calibration, and Interpretation. SSSA, Special Publication Number 21, Madison, Wisconsin 1987.

Gomez, K.A. and A.G. Gomez. 1984. Statistical Procedures for Agricultural Research. (2nd ed.) John Wiley & Sons. New York.

Norton, E.R, J.C. Silvertooth, and L.J. Clark. 2002. Phosphorus fertility evaluation in Graham County. In Cotton A College of Agriculture Report. University of Arizona. Series P-130. pp. 123-127.

SAS Institute. 1999. SAS/STAT: Procedures. Release 8.0 ed. SAS Inst., Cary, NC.

Silvertooth, J.C. and E.R. Norton. 1998. Cotton Monitoring and Management System. Publication No. AZ 1049, Cooperative Extension, College of Agriculture, University of Arizona. (publication contains crop monitoring software and crop management recommendations).

Silvertooth, J.C., T.A. Doerge, G.W. Thacker, S.W. Stedman, and J.E. Malcuit. 1989. Effects of banded phosphorus fertilizer on cotton. 1989. p. 19-21. In J.C. Silvertooth (ed.) Cotton, A College of Agric Rep. Univ. of Arizona, Series P-89.

Silvertooth, J.C., J.E. Malcuit, T.A. Doerge, G.W. Thacker and S.W. Stedman. 1990. Upland and pima cotton response to banded phosphate fertilization. 1990. p. 181-182. In J.C. Silvertooth (ed.) Cotton, A College of Agric Rep. Univ. of Arizona, Series P-90.

Silvertooth, J.C., G. W. Thacker, J.E. Malcuit, T.A. Doerge, and S.H. Husman. 1991. Upland and pima cotton response to banded fertilizer applications, 1990. 1991. p. 222-226. A College of Agric. Rep. Univ. of Arizona, Series, P-91.

Thelander, A.S. and J.C. Silvertooth. 2000. Fertility management and calibration evaluations on upland and pima cotton. In Cotton A College of Agriculture Report. University of Arizona. P-121. pp. 189-223.

Table 1. Rates of both P and N for each of the four treatments, P fertility study, Safford, AZ, 2002.

Treatment	Applied 10-34-0	Total Applied P	Total Applied N	Total Applied UAN32
	gallons per acre	lbs P_2O_5 per acre	lbs N per acre	gallons per acre
1	0	0	0	15
2	15	56	17	10
3	30	112	33	5
4	45	168	50	0

Table 2. Analysis of variance for lint yield estimates for each of the four treatments, P fertility study, Safford, AZ, 2002.

Treatment	Lint Yield
	lbs lint per acre
1	1496 b
2	1586 ab
3	1649 a
4	1637 a*
LSD* (lbs lint/acre)	124
OSL§	0.0696
C.V.(%)†	4.6

*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, 2002.

Treatment	Grade	Staple	Micronaire	Strength	Leaf Grade	Length	Uniformity
		32nds		grams/tex		100ths	
1	21	36	46	30.9	3	1.12	82
2	21	36	49	30.2	2	1.11	83
3	21	36	46	31.5	2	1.13	82
4	21	36	50	30.6	3	1.12	82

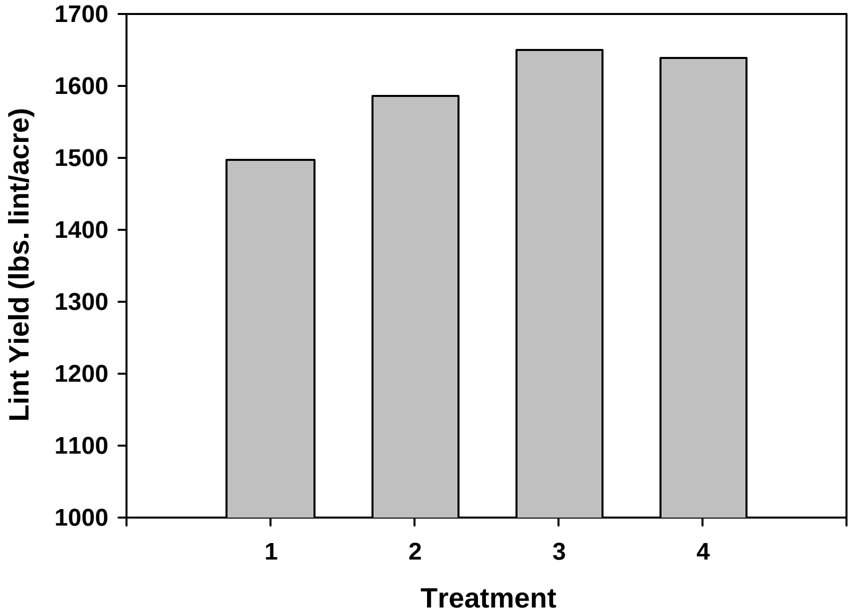

Figure 1. Graphical representation of lint yield results for each of four P fertility treatments, P fertility study, Safford, AZ, 2002.