

# Effects of Banded Phosphorus Fertilizer on Cotton

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## ABSTRACT

Four field experiments were established in 1988 in Arizona to evaluate the effects of banded phosphorus (P) fertilizers on cotton. 2 sites involved upland cotton (*Gossypium hirsutum* L.) and 2 sites with pima (*G. barbadense* L. var Pima S-6), with 1 of each located near Marana, AZ (Vinton-Anthony sandy loam). A site with 1 of each kinds was also located near Coolidge, AZ (Mohall sandy loam). At the Marana studies, P was applied 6 inches directly below the zone of seed placement at the time of listing and at the Coolidge sites, P was applied 6 inches below and 2 inches to the side of the zone of seed placement after listing, but before planting. In all cases, the P source was 10-34-0 at rates of 0, 30, and 65 lb.  $P_2O_5$  acre<sup>-1</sup>. At the Marana location, a treatment of banded 10-34-0 at 30 lb.  $P_2O_5$  acre<sup>-1</sup> plus a foliar application of 10 lb.  $P_2O_5$  acre<sup>-1</sup> (early bloom) as 10-34-0 was included in both the upland and the pima experiments. Plant measurements for plant height, flower numbers, node numbers, boll numbers, and nodes to first fruiting branch were taken to evaluate plant response throughout the season. Plant tissue samples were also taken for leaf petiole  $PO_4$ -P and leaf blade total P analysis. Lint yield measurements were also taken. No statistically significant ( $P \leq 0.05$ ) differences were found among any of the treatments for any of the measured parameters, except in the petiole  $PO_4$ -P levels from the upland study at Coolidge on the second sampling date.

## INTRODUCTION

In cotton (*Gossypium* spp.) there have been a number of experiments which have shown some benefit associated with the use of banded applications of P fertilizers (2, 4, 5, 6) in soil conditions with low available P levels. In experiments conducted in Arizona, upland cotton (*G. hirsutum* L.) has not shown a positive yield response to broadcast applications of P fertilizer when tested under various conditions (1, 3, 8, 11). However, that is not entirely unexpected, even in soils with rather low levels of available P (NaHCO<sub>3</sub> extractable P), primarily due to the high pH and calcareous nature of most soils of Arizona and their associated P fixing tendencies, as shown by Silvertooth and Gardner (10). In recent years, however, there has been an increasing interest among Arizona cotton growers concerning the potential merits of banded pre-plant applications of P fertilizers.

Currently, very little information is available concerning the use of banded P fertilizers with upland or American pima (*G. barbadense* L.) cotton grown in soil and climatic conditions similar to Arizona's. Therefore, the objective of the experiments was to study the effectiveness of different rates of fertilizer P applied as ammonium polyphosphate (APP, 10-34-0) in a concentrated band pre-plant on both upland and pima cotton, with and without additional applications of foliar applied P fertilizer.

## METHODS

Four field experiments were initiated at 2 locations in Arizona in 1988 to measure the effects of banded P fertilization on both upland and pima cotton (Table 1). The initial soil test analyses are presented in Table 2 and the treatments imposed are described in Table 3. For all 4 experiments, treatments were arranged in the field in a randomized complete block design with 4 replications. All soil applied treatments of 10-34-0 fertilizer

were made by use of knife-shank applications in a pre-plant operation. At the Marana location, soil applied treatments were made at listing with knife applications being made for placement of the concentrated fertilizer band approximately 6 inches below the z1 of seed placement. At the Coolidge location, the soil applied treatments were made after listing by use of a knife-shank applicator placing the fertilizer in a concentrated band approximately 6 inches below and 2 inches to the side of the zone of seed placement. The experiments at Marana included a treatment consisting of a pre-plant soil application of 10-34-0, plus a foliar application of 10-34-0 at early bloom. Foliar applications were made with a ground rig applicator providing 23 gal acre<sup>-1</sup> total output. Dates of actual treatment applications are shown in Table 4 for each experiment. Heat unit accumulation from planting to date of foliar treatment application at Marana was 1964 H.U. (86/55 thresholds).

Plant measurements were initiated at all sites early in the season to monitor crop growth and development. Multiple, 1-meter samples were taken within each plot at approximately 14 day intervals. Measurements included number of plants m<sup>-1</sup>, plant heights, mainstem nodes plant<sup>-1</sup>, flower m<sup>-1</sup>, and total bolls m<sup>-1</sup>. The purpose for those measurements was to possibly detect any differences in plant growth and development that may have resulted from fertilizer treatments (particularly early-season responses).

Plant-tissue samples were also collected at 2 separate dates from each experiment (Table 5). Samples of both the leaf blade and petiole of the uppermost fully-developed leaf on a plant were taken from 40 to 50 plants within each plot. Petioles and leaf blades were separated, dried and ground to pass a 2mm sieve. Petioles were subjected to an acetic acid extraction, an aliquot of which was then used for PO<sub>4</sub> determination by a colorimetric procedure (Murphy and Riley, 1962). Leaf blades were analyzed for total P, determined colorimetrically from a nitric-perchloric acid digest (Murphy and Riley, 1962).

All plots were harvested by use of a 2-row mechanical picker in the center 4 rows of each plot. Plots were 8 and 12 rows wide at Coolidge and Marana respectively.

All experimental data were subjected to analysis of variance procedures and an LSD multiple comparison test, as outlined by the SAS Institute (1985).

## RESULTS AND DISCUSSION

Advocates of banded phosphate fertilizer applications on cotton often describe benefits in terms of early-season vigor. The data collected by use of the multiple, 1 meter samples from each plot taken during the months of June and July, revealed no differences among any of the treatments with regard to any of the measured parameters (see Materials and Methods section). From those measurements, no treatment benefit in terms of plant growth and development could be determined.

The only data from the analyses of the tissue samples taken at 2 separate dates for each study (Table 6 - 13) showing any statistically significant differences were the extractable PO<sub>4</sub> values from petioles sampled 16 August 1988 in the upland study at Coolidge (Table 9). In that case, there was a higher level of extractable PO<sub>4</sub> in petioles sampled from the 65 lb. P<sub>2</sub>O<sub>5</sub> acre<sup>-1</sup> treated area versus those from the check plots. All other plant nutrient parameters measured revealed no differences among treatments at any of the sampling dates.

In terms of harvestable lint, there were no differences detected among any of the treatments, at either location (Tables 14 and 15). The only location with a significant late crop warranting a second pick, was the upland experiment at Marana. Using the percent lint harvested at first pick and second pick and as response variables in an analysis of variance revealed no differences among any treatments. No benefit in terms of earliness was detected in any of the areas treated with band or foliar applications of P fertilizer.

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Table 1. Locations for banded phosphate experiments in Arizona, 1988.

<u>Location</u>	<u>Crop</u>	<u>Variety</u>	<u>Soil Type</u>	<u>Planting Date</u>
Coolidge	Upland	DPL-90	Mohall Sandy Loam	April 5
	Pima	S-6		April 5
Marana	Upland	DPL-20	Vinton-Anthony Sandy Loam	April 26
	Pima	S-6		April 26

Table 2. Initial soil test analyses from each phosphate experimental area used in 1988.

<u>Location</u>	<u>Crop</u>	<u>Ca§</u>	<u>Mg</u>	<u>Na</u>	<u>K NO<sub>3</sub>-N*</u>	<u>P**</u>	<u>pH</u>	<u>EC</u>	<u>ESP***</u>	
		----- $\mu\text{g g}^{-1}$ -----			(1:1 H <sub>2</sub> O) ds m <sup>-1</sup>		-%-			
Coolidge	Upland	4600	360	295	270	12	5	8.5	1.8	4.6
Coolidge	Pima	4530	360	290	400	13	6	8.5	1.5	4.5
Marana	Upland	4560	240	175	290	15	7	8.1	1.5	2.8
Marana	Pima	4570	225	162	292	16	9	8.2	1.5	2.7

§Exchangeable cations using neutral molar ammonium acetate.

\*NO<sub>3</sub>-N using specific ion electrode.

\*\*NaHCO<sub>3</sub> extractable P.

\*\*\*Computed - exchangeable sodium percentage.

Table 3. Treatments and rates used in phosphate experiments conducted in Arizona, 1988.\*

<u>Treatment</u>	<u>Soil Treatment</u> -----lb. P <sub>2</sub> O <sub>5</sub> acre <sup>-1</sup> -----	<u>Foliar Treatment**</u>
1	0	--
2	30	--
3	30	10***
4	65	--

\*P source was 10-34-0.

\*\*Marana location only.

\*\*\*Applied at early bloom, 23 gal acre<sup>-1</sup> total output.

Table 4. Dates of treatment applications for phosphate experiments conducted in Arizona, 1988.

<u>Location</u>	<u>Crop</u>	<u>Planting</u>	<u>Soil Treatment</u>	<u>Foliar Treatment</u>
Coolidge	Upland	April 5	March 28	--
	Pima	April 5	March 29	--
Marana	Upland	April 26	March 10	July 21
	Pima	April 26	March 9	July 21

Table 5. Heat units accumulated since planting, for each of the plant tissue sampling dates for each phosphate experiment in 1988.

<u>Location</u>	<u>Crop</u>	<u>1st</u>	<u>Date</u>	<u>2nd</u>	<u>Date</u>
Coolidge	Upland	1670*	6/30	2937	8/16
	Pima	1670		2937	
Marana**	Upland	2181	7/29	2626	8/15
	Pima	2181		2626	

\*Integrated heat units calculated with an 86/55 threshold.

\*\*Foliar applications made after 1964 H.U. accumulated, on July 21, 1988.

Table 6. Mean values for phosphate levels extracted from cotton petioles sampled at Coolidge, AZ, June 30, 1988.

<u>Treatment</u> lb. P <sub>2</sub> O <sub>5</sub> acre <sup>-1</sup>	<u>Upland</u> -----μg PO <sub>4</sub> g <sup>-1</sup> -----	<u>Pima</u>
0	1692	2470
30	1675	2575
65	1572	2668
LSD <sub>0.05</sub>	NS	NS

Table 7. Mean values for total P levels determined from cotton leaf blades sampled at Coolidge, AZ, June 30, 1988.

<u>Treatment</u> lb. P <sub>2</sub> O <sub>5</sub> acre <sup>-1</sup>	<u>Upland</u> -----% P-----	<u>Pima</u>
0	0.47	0.48
30	0.47	0.46
65	0.48	0.48
LSD <sub>0.05</sub>	NS	NS

Table 8. Mean values for phosphate levels extracted from cotton petioles sampled at Coolidge, AZ, August 16, 1988.

<u>Treatment</u> lb. P <sub>2</sub> O <sub>5</sub> acre <sup>-1</sup>	<u>Upland</u> -----μg PO <sub>4</sub> g <sup>-1</sup> -----	<u>Pima</u>
0	692 A*	1843
30	772 AB	2007
65	888 B	2127
LSD <sub>0.05</sub>	192	NS

\*Means followed by the same letter are not significantly different at the 0.05 probability level according to pairwise comparisons using a Fisher's LSD.

Table 9. Mean values for total P levels determined from cotton leaf blades sampled at Coolidge, AZ, August 16, 1988.

<u>Treatment</u> lb. P <sub>2</sub> O <sub>5</sub> acre <sup>-1</sup>	<u>Upland</u> -----% P-----	<u>Pima</u>
0	0.30	0.41
30	0.31	0.43
65	0.33	0.43
LSD <sub>0.05</sub>	NS	NS

Table 10. Mean values for phosphate levels extracted from cotton petioles sampled at Marana, AZ, July 29, 1988.

<u>Treatment</u> lb. P <sub>2</sub> O <sub>5</sub> acre <sup>-1</sup>	<u>Upland</u> -----μg PO <sub>4</sub> g <sup>-1</sup> -----	<u>Pima</u>
0	2291	3651
30	2316	3784
30 + 10§	2357	3693
65	2321	3791
LSD <sub>0.05</sub>	NS	NS

§Soil + foliar applied P<sub>2</sub>O<sub>5</sub>.



Table 11. Mean values for total P levels determined from cotton leaf blades sampled at Marana, AZ, July 29, 1988.

<u>Treatment</u> lb. P <sub>2</sub> O <sub>5</sub> acre <sup>-1</sup>	<u>Upland</u> -----% P-----	<u>Pima</u>
0	0.42	0.57
30	0.41	0.54
30 + 10§	0.43	0.57
65	0.45	0.54
LSD <sub>0.05</sub>	NS	NS

§Soil + Foliar applied P<sub>2</sub>O<sub>5</sub>.

Table 12. Mean values for phosphate levels extracted from cotton petioles sampled at Marana, AZ, August 16, 1988.

<u>Treatment</u> lb. P <sub>2</sub> O <sub>5</sub> acre <sup>-1</sup>	<u>Upland</u> -----µg PO <sub>4</sub> g <sup>-1</sup> -----	<u>Pima</u>
0	1281	2649
30	1212	2671
30 + 10§	1373	2877
65	1274	2459
LSD <sub>0.05</sub>	NS	NS

§Soil + foliar applied P<sub>2</sub>O<sub>5</sub>.

Table 13. Mean values for total P levels determined from cotton leaf blades sampled at Marana, AZ, August 16, 1988.

<u>Treatment</u> lb. P <sub>2</sub> O <sub>5</sub> acre <sup>-1</sup>	<u>Upland</u> -----% P-----	<u>Pima</u>
0	0.37	0.48
30	0.34	0.49
30 + 10§	0.37	0.50
65	0.36	0.48
LSD <sub>0.05</sub>	NS	NS

§Soil + foliar applied P<sub>2</sub>O<sub>5</sub>.

Table 14. Cotton lint yields taken from both Upland and Pima experiments at Coolidge, AZ, 1988. §

<u>Treatment</u> lb. P <sub>2</sub> O <sub>5</sub> acre <sup>-1</sup>	<u>Upland</u> -----lb. lint acre <sup>-1</sup> -----	<u>Pima</u>
0	1227	973
30	1216	958
--	--	--
65	1250	955
LSD <sub>0.05</sub>	NS	NS
CV (%)	2.3	6.4

§Harvest dates: Oct. 10 and Nov. 16 for Upland and Pima experiments respectively.

Table 15. Cotton lint yields taken from both Upland and Pima experiments at Marana, AZ, 1988. §

<u>Treatment</u> lb. P <sub>2</sub> O <sub>5</sub> acre <sup>-1</sup>	<u>Upland</u> -----lb. lint acre <sup>-1</sup> -----	<u>Pima</u>
0	1132	878
30	1191	862
30 + 10	1246	897
65	1270	869
LSD <sub>0.05</sub>	NS	NS
CV (%)	7.0	4.7

§Harvest dates: Oct. 28 and Dec. 16 for the Upland experiment, and Nov. 21 for the Pima Experiment.