Evaluation of Potassium and Phosphorus Fertility In Arizona Soils

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Abstract

Two field experiments were conducted during the 2000 growing season to address fertility recommendations for fertilizer phosphorus (P) and potassium (K). A K fertility study was conducted near Tonopah, AZ consisting of two treatments, an untreated control and a treatment receiving a total of 20 gallons of K-Sul/acre. No significant differences were observed in leaf blade K concentrations between treatments. Plant growth and development estimates revealed that fruit retention (FR) levels remained consistently higher in the untreated control versus the treated plots. A second study involved treatments consisting of both P and K fertilizers was conducted near Cibola, AZ. Four treatments in this experiment included an untreated control plus treatments of 11-52-0, 0-0-60, and 4-17-40 at 100, 200, and 300 lbs. fertilizer/acre respectively. Plant growth and development estimates were similar among treatments during the season. At the end of the season the untreated control had a slightly higher FR level than the other treatments, which also produced a significantly higher yield. No other differences in yield among the fertilized treatments were observed.

Introduction

Efficient fertility management in a cotton (Gossypium spp.) production system is critical to healthy plant growth and maintaining profitability. Nitrogen (N), phosphorus (P), and potassium (K) are the nutrients most commonly applied to Arizona soils. Nutrient management is important to optimize plant response and yield and should be based upon guidelines for soil and plant tissue analysis. Guidelines have been developed through soil test and plant tissue correlation and calibration. The purpose of soil test calibration is to describe the soil test results in easily understood terminology and to simplify the process of making fertilizer recommendations by placing soils in response categories (Dahnke and Olson, 1990). For example, a $NaHCO_3$ extractable level of P greater than 5 ppm is usually considered sufficient for cotton production, and a level below 5 ppm is indicative of possible deficient levels of P (Silvertooth et al., 1991 and Thelander et al., 1999). However, fertilizer P is often applied under conditions where ($NaHCO_3$ extractable) levels of P that are greater than 5 ppm. Past field experiments on cotton have shown no significant response in lint yield to the addition of a P fertilizer (Silvertooth et al., 1989, 1990, 1991; Galadima et al., 1998; Thelander and Silvertooth, 1999; and Thelander and Silvertooth, 2000).

Potassium fertility requirements for cotton have been a matter of concern due to increasing interest and emphasis on fiber quality and numerous reports of K deficiencies in various cotton producing regions to the east and west of Arizona (Unruh et al., 1993). The plant available forms of soil K are a function of soil mineralogy. Unruh et al. (1993) found that the majority of soils used for agricultural production in Arizona contain K-bearing mica and very little vermiculite. Vermiculite is a soil mineral that has a tendency to fix K. Thus, we can conclude that as mineral weathering continues, K should not be deficient in most of the soils in agricultural production areas in Arizona. Recent studies in Arizona concerning K fertility evaluations with Upland (*G. hirsutum* L.) and American Pima (*G. barbadense* L.) cotton have reinforced current UA guidelines and indicated K deficient conditions in agricultural soils of Arizona are not common (Galadima et al., 1998).

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Materials and Methods

Two field experiments were conducted in central and western Arizona during the 2000 growing season. The K experiment was located near Tonopah (Sierra Negra), AZ on a Gilman loam soil. The two treatments included a control plot (0 K fertilizer) and a treated receiving two in-season applications of K-Sul (0-0-22-23S) fertilizer. Plots were arranged in a randomized complete block design with four replications. Plots consisted of 48, 38 inch rows and extended the full length of the irrigation run (1250 ft.). Agronomic information for this study is presented in Table 1. Dates and rates of applied fertilizer for the treated plots are summarized in Table 2. The K-Sul treatments were applied in the irrigation water for both applications.

The second field experiment was located near Cibola, AZ on an Indio silt loam soil. Agronomic information for this study is summarized in Table 3. Treatments consisted of a control (0 fertilizer) plus three fertilizer treatments arranged in a randomized complete block design with four replications. Treatments for this experiment are outlined in Table 4. Plots consisted of 40, 40-inch rows and extended the full length of the irrigation run (1250 ft.). In this study all treatments were applied pre-plant as a side-dress application.

Basic plant measurements were collected from each study. These measurements included plant height, number of mainstem nodes, node of the first fruiting branch, number of aborted or missing fruit, and the number of nodes above the top white flower. This information was collected to track crop growth and development over the season. Leaf blade K concentrations were determined on two separate dates for the Sierra Negra K experiment from leaf tissue samples. Final lint yield for all treatments in both experiments was determined by harvesting the entire block into a module that was subsequently weighed and ginned to determine lint yield. Lint yield data was subjected to analysis of variance according to procedures outlined by Gomez and Gomez (1984) and the SAS Institute (1996) to determine if significant differences in yield due to fertilizer treatments were observed.

Results and Conclusions

Sierra Negra (Tonopah, AZ)

Basic plant measurements did reveal differences between the fertilized plots and the control. FR levels were at or slightly below normal (middle baselines) most of the season while height to node ratio (HNR) levels tracked slightly below normal the entire season (Figures 1 and 2). Fruit retention levels for the untreated control tended to remain at a higher level than the treated plots. Leaf blade samples taken on 25 July and 10 August (Table 5) did not reveal any differences between the treated and untreated plots with respect to leaf blade K concentration. Lint yield results (Table 6) indicated no differences between the untreated check and the K-Sul treatment.

Red River Farms (Cibola, AZ)

Fruit retention and HNR (Figures 3 and 4) estimates for the fertility study at Cibola indicated strong vigor (HNR) and high FR levels over the entire season, with the exception of a slight drop in FR early in the season (Figure 3). A dramatic increase in HNR was observed that coincided with the drop in FR. Height to node ratios subsequently leveled (Figure 4) to above normal indicating maximum vegetative growth accompanied by high levels of FR (Figure 3). Very little differences were detected in plant growth and development among the four treatments. However, near the conclusion of the season (approximately 2800 Heat Units Accumulated After Planting (HUAP)) FR levels for the check plot (Treatment 1) were slightly higher than all other treatments. This increased level of FR is consistent with the lint yield differences (Table 7), where the untreated check plot experienced a significantly ($P \leq 0.05$) higher yield. No differences with respect to lint yield results were observed among the fertilized treatments.

Summary

The crop growth and yield results from these studies reinforce the current fertilization guidelines for irrigated cotton developed and published by the University of Arizona in relation to soil test levels (Tables 8 and 9).

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Table 1. Agronomic information for the K fertility study, Sierra Negra Ranch, Tonopah, AZ, 2000.

Planting Date	13 March
Variety	DP 33 B
Termination Date	16 September
Harvest Date	30 November

Table 2. Treatments for the K fertility study, Sierra Negra Ranch, Tonopah, AZ, 2000.

Treatment	K-Sul (0-0-22-23S) (gallons K-Sul/acre)
1	0
2	6 June – 10 gal with 20 gal UAN 32 (sidedress) 25 June – 10 gal (water-run)

Table 3. Agronomic information for the fertility study, Red River Farms, Cibola, AZ, 2000.

Planting Date	2 April
Variety	DP 458BR
Termination Date	2 October
Harvest Date	10 December

Table 4. Treatments for the fertility study, Red River Farms, Cibola, AZ, 2000.

Treatment	Product*	Rate (lbs. material/acre)
1	---	0
2	11-52-0	100
3	0-0-60	200
4	4-17-40	300

*All materials applied pre-plant.

Table 5. Tissue test results for the K fertility study, Sierra Negra Ranch, Tonopah, AZ.

Sample Date	Treatment	% K (leaf blade)
25 July	1	1.35
	2	1.30
10 August	1	1.48
	2	1.48

Table 6. Lint yield results for the K fertility study, Sierra Negra Ranch, Tonopah, AZ, 2000.

Treatment	Lint Yield (lbs. lint/acre)
1	1521
2	1421
LSD	NS
OSL	0.9152
C.V. (%)	13.4

Table 7. Lint yield results for the fertility study, Red River Farms, Cibola, AZ, 2000.

Treatment	Lint Yield (lbs. lint/acre)
1	1728 a
2	1599 b
3	1651 b
4	1588 b
$LSD_{0.05}$	71
OSL	0.0060
C.V. (%)	2.7

Table 8. Soil test results, potassium study, Sierra Negra, Maricopa County, AZ, 2000.

pH (1:1 H_2O)	**Ca* (ppm)**	**Mg (ppm)**	**Na (ppm)**	**K (ppm)**	**EC_e (mmhos/cm)**	**NO_3^--N** (ppm)**	**P*** (ppm)**	**ESP§**	**Free Lime**
8.2	6400	250	460	560	3.8	18.0	10.0	5.0	High

* Exchangeable cations using neutral molar ammonium acetate.
** NO_3^--N using specific ion electrode.
*** $NaHCO_3$ extractable P.
§ Computed - exchangeable sodium percentage.

Table 9. Soil test results, cotton fertility study, Ciboloa , La Paz County, AZ, 2000.

pH (1:1 H_2O)	**Ca* (ppm)**	**Mg (ppm)**	**Na (ppm)**	**K (ppm)**	**EC_e (mmhos/cm)**	**NO_3^--N** (ppm)**	**P*** (ppm)**	**ESP§**	**Free Lime**
8.0	7600	930	410	380	3.0	6.0	8	3.8	High

* Exchangeable cations using neutral molar ammonium acetate.
** NO_3^--N using specific ion electrode.
*** $NaHCO_3$ extractable P.
§ Computed - exchangeable sodium percentage.

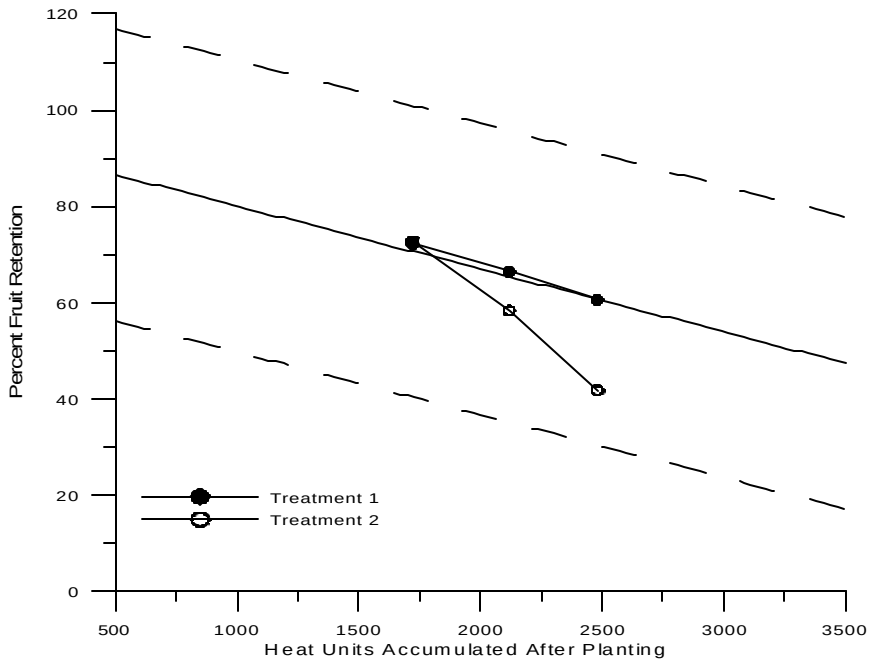

Figure 1. Fruit retention estimates for the K fertility study, Sierra Negra Ranch, Tonopah, AZ, 2000.

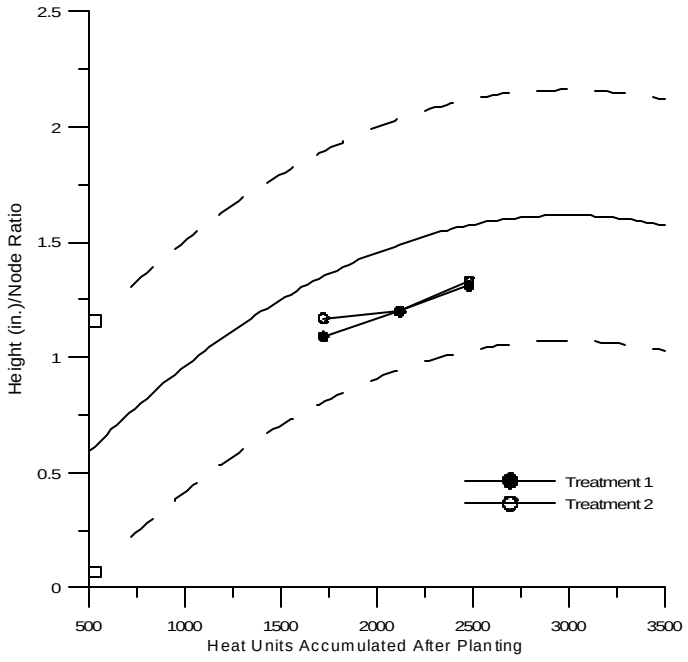

Figure 2. Height to node ratio estimates for the K fertility study, Sierra Negra Ranch, Tonopah, AZ, 2000.

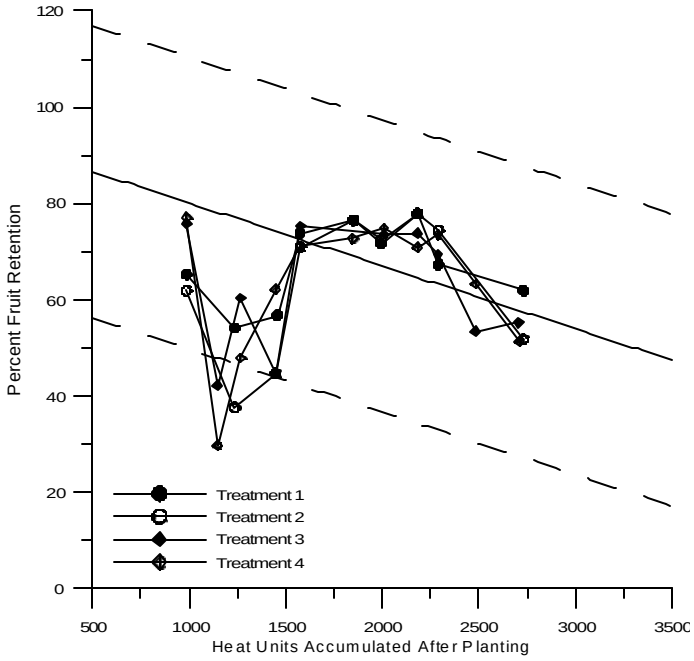

Figure 3. Fruit retention estimates for the fertility study, Red River Farms, Cibola, AZ, 2000.

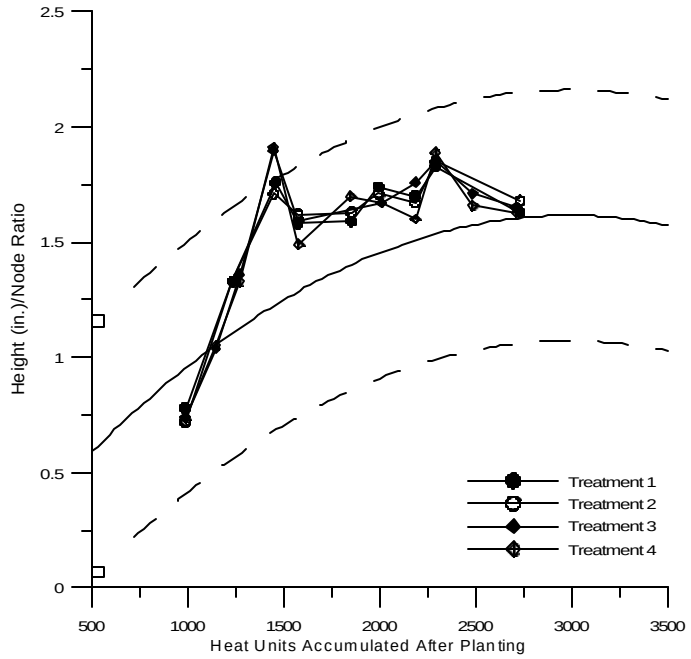

Figure 4. Height to node ratio estimates for the fertility study, Red River Farms, Cibola, AZ, 2000.