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RESPONSE OF MODERN COTTON VARIETIES TO MID-SEASON POTASSIUM FERTILIZATION

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Abstract

Six potassium treatment combinations were evaluated. Treatments were twenty-five pounds of K applied preplant and a control. Foliar application of five pounds K at first square, five pounds K at first square + seven days, and no foliar K were evaluated in both combinations of preplant fertilizer. The results supported the soil test recommendation of twenty-five pounds of potassium per acre. The data did not support the foliar application of potassium. The varieties responded as expected.

Introduction

Cotton is an important crop in Southeast Missouri and the relatively short growing season encourages producers to plant cotton varieties that mature quickly. These varieties achieve maximum yields by setting relatively greater number of bolls in a shorter time. This increased boll load per day requires that nutrients be available to the plant in greater rates per day. Potassium is an essential nutrient for cotton production because it is involved in maintaining plant water status, cell turgor pressure, and controlling the opening and closing of stomata. The opening of the stomata controls the availability of CO_2 and potassium has an indirect control over photosynthetic activity. Potassium is also involved in cellulose synthesis. Eighty-five percent of K movement in the soil is by diffusion. Since diffusion is a relatively slow process, K fertilization is required to maintain high levels of exchangeable K. Rapid plant growth and uptake may deplete K around the root surfaces. During peak flowering a cotton crop may require 3 to 4 lbs. of K per day and this may be larger than Southeast Missouri soils are capable of supplying.

Methods and Materials

A two-year cotton study was conducted on a field at the University of Missouri-Delta Center Lee Farm (36°N, 89°W) in Pemiscot County, Missouri in 2001and 2002. The eight varieties of cotton were planted on a Tiptonville silt loam soil in May of each year. Soil samples of the study area were collected from the 0 to 15-cm depth before planting. Each year the soil test recommendation for K for this area was for a maintenance fertilization of 25 lbs./a of K_2O. Forty-two lbs./acre of KCl was applied in April each year to plots scheduled for pre-plant K. The nitrogen recommendation was 100 lbs. N/a. Urea-Ammonium nitrate 32% liquid fertilizer was applied in a ¼ at planting and the remainder applied at first-square. Other than potassium fertilization the standard practices for cultivating dry- land cotton in Southeast Missouri were employed.

The experimental design was a split plot with potassium treatment as main plot with variety as the sub-plot. The main plot K treatments are listed in table 1. These applications were made using a Schwiess 4 row self-propelled high clearance sprayer on July 20 And July 31, 2001. The cotton varieties were STV 373, DP 1218BR, FM 958, FM 819, DP 436RR, PSC 355, STV 474, and BXN 47.

Plant height was measured three times during the growing season, in mid July and mid August. Cotton petiole samples were collected from the fourth fully expanded leaf down. These samples were collected following each potassium application. The petioles were dried, ground, digested using H_2SO_4 and H_2O_2, and analyzed by atomic absorption.

In early October of each year the two middle rows of each strip were mechanically harvested and the seed cotton weighed and recorded. The seed cotton was ginned using a 20-saw Continental gin stand preceded by an inclined cleaner and feeder extractor. The gin stand was followed by one stage of lint cleaning. Lint samples from each plot were sent to the International Textile Research Center for fiber quality analysis using a high volume instrument.

Statistical analyses of the data were preformed with SAS 6.1.2 (1990) using General Linear Modeling procedures. Fisher's Protected Least Significant Difference (LSD) was calculated at the 0.05 probability level for making treatment mean comparisons.

Results and Discussion-2001

For both years significant differences were found among the eight varieties. Plant height was as expected with STV 474 and BXN47 being the taller varieties and the later maturing. As expected DP436RR was the shortest and cutout first as shown by the reduced number of nodes per white flower. Closely related lines of STV 373, STV474 and BXN47 all had large numbers of bolls. STV474 had a high yield while BXN, the Buctril resistant version of STV474 yielded 109 pounds less for the two-year average. The micronaire of DP1218BR and PSC355 was high as expected. However STV474 would be expected to be even higher. FM958 produced very long fiber length of 1.161 which was to be expected. The high strength of FM958 and FM819 was high as expected. All of the varieties had excellent fiber strength. As expected varieties with reduced fiber strength had improved elongation. In 2001 trash content was high in FM958 as expected since it is an okra leaf variety. PSC355 had higher trash content than expected even though it is pubescent. For 2002 trash content of FM819 was the greatest. The difference in petiole potassium was very different in STV474 and BXN47 for 2001. In 2002 this difference was not as great. STV474 is the recurrent parent of BXN47. These two lines are very similar other than the engineered gene.

In 2001 no significant differences were found among the treatments for yields or fiber properties. The plant height was increased by the twenty-five pound application of potassium before planting. The later applications of potassium produced erratic results. Maturity was delayed by the application of potassium before planting as shown in the reduced nodes above white flower. Foliar applications gave inconsistent results. The petiole potassium was increased with the pre-plant application of potassium. Boll number and gin turnout were not significantly influenced by the fertilization. Lint yields were not significantly different but were numerically improved with the addition of pre-plant potassium. Lint yields were very high, especially considering the field had not been irrigated. No significant differences were found for any of the fiber properties, however trash appeared to be increased slightly with the pre-plant application. This would be expected with the delayed maturity.

In 2002 there were significant differences found among the treatments for yield and all fiber properties. There was also a significant interaction between treatment and variety for yield and fiber properties in 2002. Plant height at peak-bloom was not affected by K treatment. At cut out however, the treatment of 25 lbs K pre-plant + two midseason K foliar sprays produced significantly shorter plants than the other treatments. The petiole potassium was significantly increased with the pre-plant application of potassium. Potassium levels for the second sampling date closely track the total K application rates. Boll numbers at harvest were not significantly affected by K treatments in 2002. Lint yields were high considering that the plots were not irrigated in 2002, and that this area had been in continuous cotton cultivation for at least 45 years. Significant differences between lint yields were observed among K treatments in 2002 (LSD = 43). These yields were erratic among the treatments however. The numerically highest yield were for the 0 lbs K pre-plant + two foliar K sprays (1044 lbs/a). The 25 lbs K pre-plant + two foliar K sprays was lowest yielding treatment (996 lbs/a). Gin turn out was not effected by K treatment. Micronaire was affected by K treatment generally increasing as applied K increased. A significant difference was observed with the application of pre-plant K. Average micronaire levels were equivalent for all foliar K treatments that received the same pre-plant K. Micronaire levels were significantly greater for treatments receiving 25 lbs/acre pre-plant K. This indicates a delay in maturity with increasing K rates. Staple length was significantly shorter for the 25 lbs K pre-plant + two midseason K foliar sprays treatment. This combined with the high average microaire levels for this treatment could be evidence of water stress. Fiber strength was generally decreased by K applications. The strongest fibers were from the untreated check (32.23) while the weakest were from the 25 lbs K + one foliar spray treatment (31.53). Differences in elongation results while significantly different from one another were eratic in terms of K treatment. Trash content was increased with increasing K rate. As with micronaire a significant difference was observed with the application of pre-plant K. Average trash contents were generally equivalent for all foliar K treatments that received the same pre-plant K. Trash content was significantly greater for treatments receiving 25 lbs/acre pre-plant K. This also indicates a delay in maturity with increasing K rates. The differences found in fiber properties were not great enough to affect returns to producers in 2002.

Conclusions

The data supports the soil test recommendation of twenty-five pounds of potassium per acre to be applied before planting. This is shown by plant height, maturity, petiole potassium, and lint yield. There was little benefit shown with later applications of foliar potassium.

The varieties did perform very near to what would be expected from historical data.

Acknowledgement

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Table 1. Potassium treatments and application dates for 2001.

Treatment #	Pre-plant K	Peak bloom K	Peak bloom K
1	0	0	0
2	0	5	0
3	0	5	5
4	25	0	0
5	25	5	0
6	25	5	5

Table 2. Average plant growth parameters as effected by K treatments averaged across all varieties.

	Plant Height (peak bloom)			Plant Height (cut out)		
Treatment #	**2001**	**2002**	**2-year average**	**2001**	**2002**	**2-year average**
1	20.2	24.5	22.3	30.4	33.6	33.0
2	19.8	24.4	22.1	28.8	33.8	31.3
3	20.6	24.5	22.5	29.1	34.3	31.7
4	20.6	25.1	22.9	30.1	34.3	32.2
5	22.0	25.1	23.5	31.1	34.2	22.7
6	21.7	25.1	23.4	29.8	32.3	31.0
LSD=0.05	1.2	NS		1.5	1.1	

Table 3. Average plant growth parameters as effected by varieties averaged across all K treatments.

	Plant height (peak bloom)			Plant height (cut out)		
Variety	**2001**	**2002**	**2-year average**	**2001**	**2002**	**2-year average**
STV 373	21.0	26.0	23.5	30.9	34.3	32.6
DP 1218BR	22.0	26.8	24.4	31.5	35.3	33.4
FM 958	19.2	22.1	21.7	27.2	32.0	29.6
FM 819	21.0	24.1	22.5	29.6	31.5	30.6
DP 436RR	19.6	22.9	22.2	26.9	31.6	29.2
PSC 355	20.4	26.2	23.3	29.1	35.4	32.2
STV 474	21.0	24.8	22.9	31.6	34.9	33.2
BXN 47	22.2	25.3	23.7	32.5	35.0	33.7
LSD=0.05	1.3	1.1		1.7	1.3	

Table 4. Average petiole K % as effected by K treatments averaged across all varieties.

	Petiole K% (peak bloom)			Petiole K% (peak bloom + 10 days)		
Treatment #	**2001**	**2002**	**2-year average**	**2001**	**2002**	**2-year average**
1	4.94	5.51	5.23	4.89	1.50	3.20
2	4.79	5.50	5.15	4.97	1.81	3.39
3	4.79	5.80	5.30	5.41	2.07	3.74
4	5.04	7.76	6.40	6.01	2.05	4.03
5	5.23	5.45	5.34	5.19	2.30	3.75
6	5.23	6.23	5.73	4.99	2.35	3.67
LSD=0.05	0.44	0.56		NS	0.24	

Table 5. Average petiole K % as effected by varieties averaged across all K treatments.

	Petiole K% (peak bloom)			Petiole K% (peak bloom + 10 days)		
Variety	**2001**	**2002**	**2-year average**	**2001**	**2002**	**2-year average**
STV 373	5.38	6.21	5.79	5.46	2.30	3.88
DP 1218BR	4.57	5.31	4.94	4.70	1.86	3.28
FM 958	4.73	5.66	5.20	5.37	1.91	3.64
FM 819	5.81	5.61	5.71	5.08	2.03	3.55
DP 436RR	4.56	5.59	5.08	6.15	1.88	4.02
PSC 355	4.24	5.34	4.79	4.32	1.93	3.13
STV 474	5.52	6.07	5.79	5.64	2.12	3.88
BXN 47	4.16	5.87	5.02	5.27	2.10	3.64
LSD=0.05	0.51	0.65		NS	0.28	

Table 6. Average cotton lint yield parameters as effected by K treatments averaged across all varieties.

	Boll #			Seed Cotton Weight			Lint Yields lbs/acre			Gin turnout		
Treatment #	2001	2002	2-year average	2001	2002	2-year average	2001	2002	2-year average	2001	2002	2-year average
1	7.52	8.85	8.16	11.40	12.28	11.84	1018	1005	1012	.401	.37	.38
2	8.39	9.40	8.90	10.99	12.40	11.69	982	1015	999	.401	.37	.38
3	7.99	9.10	8.54	11.15	12.66	11.91	1006	1044	1025	.406	.37	.39
4	8.84	9.05	8.94	11.34	12.62	11.98	1022	1034	1028	.404	.37	.38
5	7.72	8.85	8.29	11.70	12.22	11.96	1043	1009	1026	.400	.37	.38
6	8.69	8.54	8.61	11.43	12.17	11.80	1023	996	1009	.402	.37	.38
LSD=0.05	NS	NS		NS	0.51		NS	43		NS	NS	

Table 7. Average cotton lint yield parameters as effected by varieties averaged across all K treatments.

	Boll #			Seed Cotton Weight			Lint Yields lbs/acre			Gin turnout		
Variety	2001	2002	2-year average	2001	2002	2-year average	2001	2002	2-year average	2001	2002	2-year average
STV 373	9.38	9.20	9.29	10.72	11.95	11.34	977	996	987	.409	.38	.40
DP 1218BR	7.93	9.35	8.64	11.61	11.67	11.64	1070	968	1019	.413	.37	.39
FM 958	7.02	7.95	7.49	11.41	13.42	12.42	1015	1015	1015	.400	.37	.38
FM 819	6.60	8.50	7.55	11.16	11.28	11.22	990	990	990	.398	.37	.38
DP 436RR	7.76	8.75	8.25	11.52	12.73	12.13	976	975	976	.380	.34	.36
PSC 355	8.66	8.25	8.45	11.64	13.24	12.44	1010	1074	1042	.390	.36	.38
STV 474	9.38	9.55	9.47	11.62	13.11	12.37	1083	1109	1096	.418	.38	.40
BXN 47	8.82	10.56	9.69	11.00	11.58	11.29	1005	969	987	.410	.37	.39
LSD=0.05	1.33	1.16		0.64	0.61		64	49		0.01	0.01	

Table 8a. Average fiber quality parameters as affected by K treatments averaged across all varieties.

	Micronaire			Length			Strength		
Treatment	2001	2002	2-year Average	2001	2002	2-year Average	2001	2002	2-year Average
1	4.78	4.46	4.62	1.143	1.139	1.141	31.39	32.23	31.81
2	4.79	4.49	4.64	1.145	1.138	1.142	31.62	31.86	3.174
3	4.82	4.46	4.64	1.142	1.143	1.143	31.39	32.19	31.79
4	4.81	4.56	4.68	1.140	1.141	1.140	31.42	31.88	31.6
5	4.82	4.57	4.64	1.148	1.144	1.146	31.33	31.53	31.43
6	4.79	4.61	4.70	1.145	1.129	1.136	31.50	31.98	31.74
LSD=0.05	NS	0.07		NS	0.008		NS	0.54	

Table 9a. Average fiber quality parameters as affected by varieties averaged across all K treatments.

	Micronaire			Length			Strength		
Variety	2001	2002	2-year Average	2001	2002	2-year Average	2001	2002	2-year Average
STV 373	4.61	4.22	4.42	1.146	1.162	11.54	29.76	30.41	30.09
DP 1218BR	5.12	4.69	4.91	1.100	1.101	11.00	29.70	29.68	29.19
FM 958	4.77	4.53	4.65	1.161	1.162	11.61	33.91	34.94	34.43
FM 819	4.54	4.31	4.42	1.179	1.177	11.78	34.24	34.75	34.59
DP 436RR	4.80	4.52	4.66	1.157	1.146	11.51	30.31	30.60	30.46
PSC 355	4.99	4.94	4.96	1.137	1.121	11.29	32.28	32.62	32.45
STV 474	4.85	4.56	4.70	1.130	1.112	11.22	30.48	30.94	30.71
BXN 47	4.73	4.38	4.55	1.141	1.135	11.38	30.85	31.21	31.03
LSD=0.05	0.07	0.08		0.009	0.009		0.38	0.62	

Table 8b. Average fiber quality parameters as affected by K treatments averaged across all varieties.

	Elongation			Uniformity			Trash			+b		
Treatment #	**2001**	**2002**	**2-year Average**	**2001**	**2002**	**2-year Average**	**2001**	**2002**	**2-year Average**	**2001**	**2002**	**2-year Average**
1	5.73	5.11	5.42	84.03	83.08	83.55	2.2	2.4	2.3	8.31	8.65	8.48
2	5.72	5.13	5.43	83.87	82.79	83.33	2.1	2.4	2.3	8.28	8.84	8.57
3	5.82	5.15	5.48	83.85	82.84	83.34	1.9	2.7	2.3	8.21	8.77	8.49
4	5.74	5.06	5.40	83.87	83.09	83.48	2.2	2.6	2.4	8.22	8.77	8.49
5	5.76	5.12	5.44	84.20	82.97	83.58	2.3	2.5	2.4	8.24	8.86	8.55
6	5.74	5.31	5.53	83.98	83.23	83.61	2.2	2.9	2.6	8.22	8.77	8.49
LSD=0.05	NS	0.13		NS	0.22		NS	0.2		NS	0.16	

Table 9b. Average fiber quality parameters as affected by varieties averaged across all K treatments.

	Elongation			Uniformity			Trash			+b		
Variety	**2001**	**2002**	**2-year Average**	**2001**	**2002**	**2-year Average**	**2001**	**2002**	**2-year Average**	**2001**	**2002**	**2-year Average**
STV 373	5.70	4.98	5.32	83.48	82.64	83.04	2.2	2.4	2.3	8.57	8.98	8.78
DP 1218BR	6.15	5.54	5.85	83.90	82.65	83.28	1.5	2.1	1.8	8.50	9.13	8.82
FM 958	4.40	3.76	4.08	83.93	83.04	83.49	2.0	2.5	2.3	7.89	8.25	8.07
FM 819	4.59	4.24	4.42	84.26	83.20	83.73	2.6	3.2	2.9	7.31	8.04	7.68
DP 436RR	6.35	5.68	6.02	84.27	82.98	83.63	1.7	2.3	2.0	7.94	8.65	8.30
PSC 355	6.90	6.30	6.60	84.70	83.53	83.46	2.8	2.9	2.9	8.36	8.92	8.64
STV 474	6.07	5.46	5.76	83.63	82.92	83.28	2.3	2.4	2.4	8.67	9.21	8.94
BXN 47	5.86	5.19	5.53	83.56	82.95	83.26	2.0	2.7	2.4	8.72	9.15	8.93
LSD=0.05	0.14	0.17		0.36	0.26		0.4	0.3		0.14	0.18	