Effects of Foliar Applied Potassium on Cotton in the San Joaquin Valley of California

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ABSTRACT

Foliar fertilization of cotton, Gossypium hirsutum and G. barbadense, has been a subject of researchers since 1992 in California. The practice has expanded from its limited beginnings to widespread use for supplying supplemental nitrogen and potassium. Yield and economic advantages have been realized by researchers, and growers alike. Replicated field tests were conducted annually from 1992 to 1997 to evaluate the effects of foliar N and K on cotton yields and quality. K_2SO_4, KNO_3, and KTS (Potassium Thiosulphate) were applied at various timings beginning at first bloom, in single and multiple applications. Rates of K_2O were kept constant at 5.0 Kg/ha for each application. All three materials, K_2SO_4, KNO_3, and KTS resulted in increased lint yields when compared to an untreated control. Maximum positive benefits occurred when applications were made between one and three weeks after first bloom. Increases in lint yields have generally been up to 100 Kg/ha.

Introduction

The application of foliar nitrogen and potassium at or near the early bloom stage of growth, when these nutrients are needed most has rapidly gained popularity in recent years. These, and other cultural changes, have resulted in annual yield increases of 32 Kg of lint per hectare per year from 1983 to 1995.

Widespread potassium (K) deficiencies have been documented throughout the San Joaquin Valley of California. It has been speculated that these K deficiencies are related to the introduction of high yielding, early maturing, fast fruiting cotton cultivars (Oosterhuis, 1993). These deficiencies cannot always be corrected by applying K in the soil and foliar applications of K may allow correction of these deficiencies more quickly and efficiently. They can allow deficiencies, as indicated by petiole analyses, to be corrected in time to prevent yield loss during the current season. Soil applied K at this time would be too late, and effective only for the next season crop.

Potassium can be required at rates of 1.9 to 3.0 Kgs/ha/day during the boll fill period of a cotton crop. It was demonstrated that potassium uptake requirements can be difficult to maintain, especially on vermiculitic soils, and the amount of fixed potassium in these soils is great due to the high potassium buffering capacities. Nitrogen is also required in large amounts during boll formation and its application to leaves can apparently satisfy short-term needs.

San Joaquin Valley cotton growers are very aware of the need to be efficient with fertilizer use and to prevent losses of nutrients to ground water and the atmosphere. Innovative methods of fertilizer applications such as split sidedress, water run, and foliar applications are becoming common. The increasing interest in supplemental applications of N and K as foliar fertilization by cotton growers presents a unique challenge to researchers.

Material and Methods

In 1992 field tests were conducted in Merced and Kings Counties in which K was applied in foliar sprays at various times during the growing season. Since positive results were obtained, other field tests followed during subsequent years. From two to five tests were conducted each year using various carriers of K and different times of applications.

Plots were sprayed by a tractor sprayer set up for foliar plot work. Eight 75 cm rows were sprayed at a time, and plots were generally the length of the field (about 0.4 Km.), and replicated four times. All tests were conducted using a completely randomized block statistical design.

In general, the times of K applications were at bloom followed by applications at weekly intervals. Treatments also included multiple applications of sprays at bloom and one week later, at bloom and two weeks later, etc. Amounts of K per application were generally 5.0 Kgs of K_2O, regardless of the material applied. Materials used included ESP K-Sulfate, which is a Great Salt Lake Minerals material formulated for increased solubility, KNO_3 from Chilean Nitrate Corporation, and KTS produced by Kerley/Tessenderlo. Other materials were KCl, Moraleaf PandK, and Fulcrum.

Results

Positive yield results were measured in field tests where foliar KNO3 was applied in 1992. Very similar results were obtained again in 1993 using Acala Maxxa and Pima S-7 cottons. Greatest yield advantages were measured from plots which received

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foliar K at two to three weeks after first bloom. Foliar applications made later in the season responded less and the effect was similar whether the source of K was from K_2SO_4 or KNO_3 (Tables 1 and 2).

In 1994 several forms of K were applied to cotton in foliar sprays. K_2SO_4, KNO_3, and KTS were all applied at rates of 5.0 Kgs/ha of K_20 per acre per application. Many treatments received more than one application. Tables 1, 2, and 3 show that there were responses in every case to foliar K compared to an untreated control. Findings were consistent with previous year's results, in that the greatest responses occurred with applications about two to three weeks after first bloom.

The 1995 Field tests included: K_2SO_4, KNO_3, and KTS applied as foliar sprays at bloom followed by applications two and four weeks later. K_2SO_4 gave the greatest yield increases where 5.0 Kgs/ha of K_2O were applied at bloom and again two weeks later. Also, the field tests gave very similar results as previous years tests. Greatest yield response was realized when K_2SO_4 or KTS was applied at about two weeks after first bloom.

The 1996 tests the same three materials (K_2SO_4, KNO_3, and KTS) were used in high rates and at different timings. There was little phytotoxicity to plants receiving even 20 Kg/ha of K_2O from KNO_3. Materials applied at bloom and one or two weeks later gave greater yields than earlier or later applications.

The 1997 tests included K_2SO_4, Moraleaf P and K, Fulcrum, and KNO_3. Table 4 shows the results of these tests, and all materials responded as expected except for fulcrum. Fulcrum increased yields most when it was applied early in the season, while applications after squaring or flowering resulted in less lint than the untreated control. This is the only material that has given a positive response to early applications.

K_2SO_4resulted in increased yields as rates were increased with no phytotoxicity or other problems. Mora leaf P and K gave increased yields, although there were no significant differences among the treatment means. KNO_3 rates were increased over previous year's tests and high rates resulted in better yields than standard low rates.

There was a benefit in virtually every test to N or K applied at bloom, but the biggest increase in lint yield was at about two weeks after first bloom (Figure 1).

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Table 1. Effect of foliar potassium sulfate (K2SO4) on cotton yields.

1993	
Treatments	Lint/ha
Control	1155
K_2SO_4 At Bloom	1168
K_2SO_4 At Bloom and 2 Weeks Later	1336
K_2SO_4 At. Bloom and 2 and 4 Weeks Later	1321
LSD (.05)	NS
C.V.%	16.5
1994	
Control	1426
K_2SO_4 at Bloom	1603
K_2SO_4 2 Weeks After Bloom	1707
LSD (.05)	NS
C.V.%	1.20
1995	
Control	1663
At Bloom + 1 and 2 Weeks Later	1720
At Bloom + 1 Week Later	1639
1 and 2 Weeks After 1st Bloom	1805
2 and 3 Weeks After 1st Bloom	1781
LSD (.05)	254
C.V.%	10.7
1996	
Control	1159
At Bloom + 1 and 2 Weeks Later	1326
At Bloom + 1 Week Later	1305
1 and 2 Weeks After 1st Bloom	1398
2 and 3 Weeks After 1st Bloom	1481
LSD (.05)	NS
C.V.%	12.4

Table 2. Effect of foliar potassium nitrate ($KN0_3$) on cotton yields.

1993	
Treatments	Lint/ha
Control	1261
At Bloom	1387
1 and 2 Weeks After Bloom	1301
3 and 4 Weeks After Bloom	1223
4 and 5 Weeks After Bloom	1441
5 and 6 Weeks After Bloom	1338
LSD (.05)	NS
C.V. %	10.7
1994	
Control	1426
20kg K_2O/ha 2 and 3 Weeks After 1st Bloom	1391
Side dress 50Kg K20/ha	1485
50kg K_20/ha Soil App. + 20kg 2 and 3Wk. After 1st Bloom	1500
LSD (.05)	NS
C.V.	14.4
1995	
Control	1311
K_2SO_4 I and 4 Weeks After 1st Bloom	1485
KCL 2 and 4 Weeks After 1st Bloom	1511
KNO_3 2 and 4 Weeks After 1st Bloom	1340
40 ltr KNO_3+ 20 ltr Urea 2 and 4 Wks After 1st Bloom	1316
40 ltr KNO_3+ 40 ltr Urea 2 and 4 Wk. After 1st Bloom	1534
40 ltr KNO_3 and Urea 2 and 4 Wks After 1st Bloom	1551
LSD (.05)	NS
C.V.%	12.3
1996	
Control	1207
10kg KNO_3/ha in 40 ltr of Water	1281
15kg KNO_3/ha in 40 ltr of Water	1235
20kg KNO_3/ha in 40 ltr of Water	1407
3-0-11tr Concentrate	1374
LSD (.05)	NS
C.V.%	13.0

Table 3. Effect of foliar potassium thiosulfate (KTS) on cotton yields.

1994	
Treatment	Lint/ha
Control	1427
5.0 kgs K_2O /ha as KTS + 2 ltr. Trisert	1623
10.0 kgs K_2O /ha as KTS + 2 ltr. Trisert	1657
LSD (.05)	NS
C.V.%	9.7
1995	
Control	1306
6.0 ltr. KTS and 2 ltr. Tricert 2 Wks After 1st Bloom	1573
6.0 ltr. KTS, 2 ltr. Tricert and 8 Oz PGRIV2 Wks After 1st Bloom	1544
6.0 ltr. KTS, 2 ltr. Tricert and 8 Oz PIX 2 Wks After 1st Bloom	1639
6.0 ltr. KTS and 1 ltr. Tricert 2 and 4 Wks After 1st Bloom	1477
6.0 ltr. KTS, 1 ltr. Tricert and 4 Oz PGRIV2 and 4 Wks After 1st Bloom	1620
6.0 ltr. KTS and 1 ltr. Tricert and 4 Oz PIX 2 and 4 Wk. After 1st Bloom	1615
LSD (.05)	NS
C.V.%	11.2
1996	
Control	1352
6 ltr KTS at Four True Leaves	1397
6 ltr KTS at Pin Head Square	1472
6 ltr KTS at 1st Bloom	1501
6 ltr KTS at 1st Bloom and 2 Weeks Later	1502
3 ltr KTS at Pin Head Square and at 1st Bloom	1411
LSD (.05)	NS
C.V.%	6.4

Table 4. Effect of various foliar materials in 1997 tests.

Treatment	Lint/ha
K_2SO_4	
Untreated Control	1263
4.5 kg K_2O /ha at bloom and 4.5 kg/ha 10 days later	1285
9.05 kg K_2O /ha at bloom and 9.0 kg/ha 10 days later	1497
13.5 kg K_2O /ha at bloom and 13.5kg/ha 10 days later	1594
L.S.D. (.05)	NS
C.V. %	22.5
Moraleaf PandK	
Untreated Control	1468
4.5 kg/ha at bloom and 4.5Kg/ha 10 days later	1465
4/5Lfg/ha at bloom and 9.0 10 days later	1650
4.5 kg/ha at bloom and Tricert (40 l/ha) 10 days later	1530
20.0 kg/ha at bloom	1475
4.5 kg/ha KNO_3 at bloom and 4.5 Kg/ha 10 days later	1356
L.S.D. (.05)NS	
C.V. %	10.0
Fulcrum	
Untreated Control	1348
4.5 kg/ha at first leaf and pin head square	1426
4.5 kg/ha at first leaf, four true leaves and pin head square	1522
4.5 kg/ha at first leaf, pin head square and first flower	1186
4.5 kg/ha at pin head square, and first flower	1350
4.5 kg/ha at mid square and first flower	1111
4.5 kg/ha at first mature boll	1258
L.S.D. (.05)	NS
C.V.%	13.4
KNO_3	
Untreated Control	1494
20 kg/ha K_2O	1678
20 kg/ha from Urea	1772
20 kg/ha from $KNO_3$and 20 Kg/ha From Urea	1739
20 kg/ha from $KNO_3$and 2 Qt Amisorb	1746
20 kg/ha from KNO_3, 20 Kg/ha from Urea and 2 Qt Amisorb	1844
L.S.D.(.05)	NS
C.V. %	14.5

Figure 1. Typical response curve to foliar materials applied at various times after first bloom.