

THE EFFECTS OF OZONE AND SO₂ ON SJ-2 and SJC-1
COTTON GROWTH AND QUALITY

Prepared for California Air Resources Board
FINAL REPORT ON ARB CONTRACT A3-047-33
January 15, 1985

Executive Summary

Robert F. Brewer
Project Leader

Rulon Ashcroft
Staff Research Associate

University of California
Riverside, CA 92521

EXECUTIVE SUMMARY

Cotton, the most important field crop grown in the San Joaquin Valley, accounts for annual returns in excess of 1.5 billion dollars to the economy of the region. The Acala-type, grown in the central California, is a medium staple length much in demand world-wide because of its uniformity and other good milling properties. A long staple of "Pima"-type cotton is grown in the desert valleys of eastern Riverside and Imperial Counties.

Previous experiments conducted in the San Joaquin Valley beginning in 1972 and continuing through 1978 indicated that the popular Acala cotton varieties were sensitive to oxidant-type air pollution. The SJ-2 variety, introduced in 1973 and continuing to dominate the field accounting for approximately 80% of the planted acreage, was reduced in yield approximately 18% by ambient oxidants present at Parlier, CA. Succeeding Acala varieties; SJ-3, SJ-4 and SJ-5, (the last of the SJ series), are each less sensitive to ozone than is SJ-2, but lack the total yield potential of SJ-2 under most growing conditions. In 1982 SJC-1, the first of a new "C" series of Acala-type cottons bred for the San Joaquin Valley by the California Planting Cotton Seed Distributors, was released. The effect of ambient levels of ozone on SJC-1 is not known, nor is there presently information available on the sulfur dioxide (SO₂) sensitivity of any of the Acala varieties.

The objectives of experiments conducted during 1983 and 1984 seasons were to determine the impact of ambient oxidants and realistic concentrations of SO₂, both alone and in combination on Acala SJ-2 and Acala SJC-1 varieties of cotton. It should be noted that Germain's Acala cotton 510 is a selected strain of SJC-1 and therefore results obtained with the former would probably be applicable to the latter.

The SJ-2 and SJC-1 cotton seed were planted on raised beds in 12 foot square plots enclosed by open top, plastic covered, blower ventilated chambers.

Anhydrous SO₂ in amounts necessary to produce concentrations of .05 and 0.1 ppm SO₂ by volume was metered into the air streams ahead of the blowers six hours per day four days per week during the growing season. The treatments employed were as follows:

1. Filtered air chambers (all air passed through carbon activated filters)
2. Ambient air chambers (no filters)
3. Filtered air plus 0.05 ppm SO₂
4. Filtered air plus 0.10 ppm SO₂
5. Ambient air plus 0.05 ppm SO₂
6. Ambient air plus 0.10 ppm SO₂
7. Outside plots - same size but no chamber walls.

Care was taken to maintain other growing conditions as nearly alike in all chambers as possible. Temperature, humidity, light intensity and soil fertility were uniform from plot to plot. During the second season (1984), however, severe manifestations of Verticillium, a soil-borne fungal disease appeared in some but not all plots. This disease attacks the mature cotton plant during boll development, usually stopping or significantly reducing normal maturation of bolls.

SJ-2 yields of raw cotton (lint plus seed) indicated significant reductions (approximately 20%) due to the higher SO₂ concentration in both ambient and filtered air. With SJC-1 the addition of SO₂ to filtered air had no significant impact, but in 1984 the addition of SO₂ to ambient air reduced yields approximately 16%, an indication of possible synergism. Foliar symptoms of excess sulfur accumulation (chlorosis and marginal necrosis of lower leaves) were also present in all plots receiving the 0.1 ppm SO₂ treatment. There were no classic acute SO₂ injury symptoms.

Ozone in ambient air caused early or accelerated senescence in the upper cotton leaves, particularly SJ-2 leaves.

Neither the ozone in ambient air nor the additions of SO₂ had a significant impact on lint or seed quality. Quality parameters tested included lint to seed ratio, fiber length, diameter (micronaire), strength, uniformity and elasticity.

Conclusions and Recommendations

It can be concluded from these experiments that SO₂ concentrations in the range of 0.1 ppm for six or more hours per day over a prolonged period will have a detrimental effect on cotton yields in addition to effects which ambient oxidants might have. This information should be of interest to cotton growers and air pollution control officers in areas of Kern and Kings Counties which are faced with both oxidant and SO₂ air pollution.

To protect cotton acreage from injury by SO₂ at concentrations averaging 0.1 ppm for six hours per day it will be necessary to lower the 24 hour mean to .025 or establish a six hour mean of 0.05 ppm. With diurnal wind patterns so common to California it is extremely unlikely to get continuous exposures of 8 hour durations, let alone 24 hours. The present standard would allow concentrations of 0.1 ppm for 12 hours, 0.2 ppm for 6 hours, 0.3 ppm for 4 hours or 0.4 ppm for 3 hours on a daily basis. All of these could be expected to cause significant crop damage and loss of potential revenue.