2
3/19/79

MASTER

**RADIOLOGICAL AND ENVIRONMENTAL
RESEARCH DIVISION**

ENVIRONMENTAL RESEARCH CONTRIBUTION

No. 79-04

**SOME PRELIMINARY NOTES CONCERNING THE IMPACT OF FOSSIL FUEL
COMBUSTION ON CROP PLANTS**

Joseph E. Miller and Douglas G. Sprugel

U.S. DEPT. OF ENERGY

*This report contains information of a preliminary nature
and is subject to correction or modification. It may be
referenced if the preliminary nature of the information
is acknowledged in the citation.*

ARGONNE NATIONAL LABORATORY, ARGONNE, ILLINOIS

**Prepared for the U. S. DEPARTMENT OF ENERGY
under Contract W-31-109-Eng-38**

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

The facilities of Argonne National Laboratory are owned by the United States Government. Under the terms of a contract (W-31-109-Eng-38) between the U. S. Department of Energy, Argonne Universities Association and The University of Chicago, the University employs the staff and operates the Laboratory in accordance with policies and programs formulated, approved and reviewed by the Association.

MEMBERS OF ARGONNE UNIVERSITIES ASSOCIATION

The University of Arizona	Kansas State University	The Ohio State University
Carnegie-Mellon University	The University of Kansas	Ohio University
Case Western Reserve University	Loyola University	The Pennsylvania State University
The University of Chicago	Marquette University	Purdue University
University of Cincinnati	Michigan State University	Saint Louis University
Illinois Institute of Technology	The University of Michigan	Southern Illinois University
University of Illinois	University of Minnesota	The University of Texas at Austin
Indiana University	University of Missouri	Washington University
Iowa State University	Northwestern University	Wayne State University
The University of Iowa	University of Notre Dame	The University of Wisconsin

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately-owned rights. Mention of commercial products, their manufacturers, or their suppliers in this publication does not imply or connote approval or disapproval of the product by Argonne National Laboratory or the U. S. Department of Energy.

SOME PRELIMINARY NOTES CONCERNING THE IMPACT OF FOSSIL FUEL
COMBUSTION ON CROP PLANTS¹

Joseph E. Miller and Douglas G. Sprugel

Ecological Sciences Section
Radiological and Environmental Research Division
Argonne National Laboratory
Argonne, Illinois 60439

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

¹Work performed under the auspices of the U. S. Department of Energy.

Projected increases in the use of coal for generation of electrical power have caused concern regarding the environmental impact of combustion emissions. Gaseous and particulate emissions from coal combustion place large quantities of sulfur (primarily SO_2), nitrogen oxides, carbon dioxide, and heavy metals in the environment. Secondary reactions produce ozone and acid rain, all of which are of concern as environmental contaminants. Because of the relative sensitivity of many plant species to SO_2 in the atmosphere and the importance of agriculture in the Midwest, a project concerning SO_2 effects on midwestern crop species is being pursued.

In the summer of 1977 three 80' x 100' field plots of soybeans were periodically fumigated by controlled release of SO_2 through a system of pipes suspended over the plant canopy. The fumigations were performed on 24 days between early July and late August for an average of 4.75 hours per day. The 1978 experiment was similar with 5 plots exposed to 18 fumigations averaging 4.1 hours per day. The mean SO_2 concentrations during fumigation were 117, 300 and 786 ppb in 1977 and 94, 109, 192, 255 and 353 ppb in 1978. Only the plots receiving 786 ppb in 1977 and 353 ppb in 1978 exceeded the national secondary air quality criteria for SO_2 .

Some chlorosis and bronzing of leaf tissue were observed in the plot receiving 786 ppb of SO_2 in 1977, and mild chlorosis was observed in the 353 ppb plot in 1978; no other plots exhibited visible injury. However, bean yields were reduced in all the fumigated plots, regardless of whether or not visible injury occurred (Figure 1). The bean yield reductions were primarily due to decreases in seed size, number of filled seeds per pod, and number of pods per

plant. The protein and oil contents of the seeds in 1977 were only slightly affected by the SO_2 treatments, although the seed concentrations of several essential elements were altered significantly at the highest SO_2 levels.

The effect of SO_2 fumigation on photosynthetic rate of leaf tissues was apparently contingent upon the age of the tissues, their prior exposure to SO_2 and the prevailing environmental conditions. In 1977 photosynthesis was reduced as much as 63% at the highest SO_2 concentrations, while a short-lived stimulation of photosynthesis was occasionally noted at the lowest SO_2 concentrations. Extended post-treatment carryover of the photosynthetic effects was noted only in the tissues exhibiting visible damage. A survey of the incidence and severity of fungal plant pathogens in the SO_2 treated plots in 1977 did not indicate any significant SO_2 related effects.

Figure 1. Effect of SO₂ fumigation on soybean yields in 1977 and 1978. Open symbols indicate plots where visible damage to leaves was observed.