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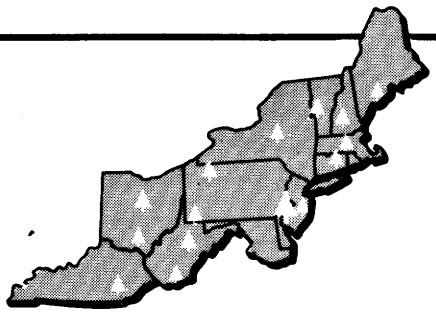

FOREST SERVICE, U.S. DEPT. OF AGRICULTURE, 6816 MARKET STREET, UPPER DARBY, PA. 19082

ODC 425.1:176.1 *Populus deltoides* Bartr. x *P. trichocarpa* Torr & Gray

SULFUR CONTENT OF HYBRID POPLAR CUTTINGS FUMIGATED WITH SULFUR DIOXIDE

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Abstract.—Hybrid poplar cuttings were fumigated with sulfur dioxide ranging in concentration from 0.1 to 5 ppm for periods of 5 to 80 hours. At the end of the fumigation periods, the cuttings were harvested and the sulfur and chlorophyll contents of the leaves were measured. At 0.1 ppm and 0.25 ppm the sulfur content initially increased, but decreased as fumigation continued. At 3 ppm and 5 ppm the sulfur content of the leaves significantly increased, and foliar injury was apparent. No statistically significant change in chlorophyll content was observed.

Much interest has been shown in the importance of vegetation in removing sulfur dioxide (SO_2) from the atmosphere *(2, 6, 8)*. Since forests constitute a major portion of the earth's vegetation, studies are being made to determine whether forest vegetation can remove SO_2 from the air. This study was designed to determine whether hybrid poplar cuttings will absorb SO_2 from the atmosphere. The relationships among chlorophyll content, sulfur content, and foliar injury were also examined.

Methods and Materials

Hybrid poplar cuttings (*Populus deltoides* Bartr. x *P. trichocarpa* Torr & Gray) were placed in 6-inch plastic pots in a mixture of sand, soil, and peat (1:1:1). After 4 weeks, plants with similar foliage were selected and placed in fumigation chambers.

The fumigation chambers, 24 x 30 x 36 inches, have been described by Heck and others *(5)*. The air temperature in the chambers ranged from 25 to 30° C, and relative

humidity ranged from 50 percent to 80 percent. Light was supplied by a bank of cool white fluorescent bulbs with a light intensity of 1,200 foot-candles. SO_2 was added to the inlet air from a gas cylinder before the air entered the chamber. The SO_2 concentration was monitored with a Malpar[1] flamephotometeric sulfur analyzer calibrated by the permeation-tube method.

Cuttings were fumigated from 8:30 a.m. to 4:30 p.m. daily, except on weekends. Cuttings fumigated with 0.1 ppm were harvested after 13, 22, 38, and 80 hours of fumigation. Cuttings fumigated with 0.25 ppm were harvested after 13, 22, and 38 hours. Another group of cuttings was fumigated for 38 hours at 0.25 ppm; these were returned to the greenhouse for 7 days before they were harvested. The other fumigation treatments were at 0.5 ppm SO_2 for 6.5 and 13 hours, 1 ppm and 3 ppm for 6.5 hours, and 5 ppm for 5 hours.

Leaves were removed from each of four control cuttings and four fumigated cuttings at the end of each treatment and were weighed immediately. One-half gram of fresh leaf tissue was removed for chlorophyll analysis and frozen. The remainder of the leaf tissue was dried in an oven at 100° C for 20 hours. The dry leaf tissue was reweighed, combined, ground in a Wiley mill, and re-dried. The sulfur content of the re-dried leaf tissue was determined with a Leco sulfur analyzer. The chlorophyll content of the frozen tissue was measured according to the official method of the Association of Official Agricultural Chemists *(1)*. Sulfur and chlorophyll content of leaves from each treatment were compared with those of their corresponding controls.

[1] The use of trade names is for information only and should not be considered an official endorsement by the U. S. Department of Agriculture or the Forest Service.

Results and Discussion

The sulfur content of leaves increased with SO_2 fumigation (table 1). Leaves fumigated

Table 1.—Sulfur content of hybrid poplar leaves
[mg/gm dry weight]

Treatment	Hours of fumigation						38 + 7 days recovery
	5	6.5	13	22	38	80	
Control	—	—	3.39	3.37	2.96	2.97	—
0.1 ppm	—	—	3.73	3.76**	3.31	3.14	—
%[1]	—	—	110	112	112	106	
Control	—	—	2.24	1.88	2.22	—	1.90
0.25 ppm	—	—	2.95**	2.76**	2.76**	—	2.16
%	—	—	132	147	124	—	114
Control	—	2.44	2.38	—	—	—	—
0.5 ppm	—	3.15**	3.34**	—	—	—	—
%	—	129	140	—	—	—	—
Control	—	2.81	—	—	—	—	—
1 ppm	—	3.38**	—	—	—	—	—
%	—	120	—	—	—	—	—
Control	—	2.29	—	—	—	—	—
3 ppm	—	3.24**	—	—	—	—	—
%	—	141	—	—	—	—	—
Control	2.75	—	—	—	—	—	—
5 ppm	4.02**	—	—	—	—	—	—
%	146	—	—	—	—	—	—

* Significant at 0.05 level.
** Significant at 0.01 level.
[1] Percentage of control.

with 0.1 ppm SO_2 all increased in sulfur content, but only the difference after 22 hours was statistically significant.

With fumigation at 0.25 ppm SO_2, significant differences were found in all treatments when the leaves were harvested immediately after fumigation. No significant difference was found when the leaves were harvested 7 days after fumigation had ended. All other fumigations with higher SO_2 concentrations caused significant increases in the sulfur content of the leaves.

The increase in sulfur content of hybrid poplar leaves fumigated with SO_2 demonstrates that SO_2 can be absorbed by hybrid poplar foliage. These findings, supported by other investigators *(2, 3, 4, 8)* suggest that vegetation may remove measurable amounts of SO_2 from the atmosphere. As the concentration of SO_2 increases, and the area exposed to it become larger, vegetation may be important as a cleaning agent in removing SO_2 from the atmosphere.

The increase in sulfur content of plant tissue was not directly related to the concentration of the SO_2 in the atmosphere. With a fivefold increase in pollutant concentration, from 0.1 to 0.5 ppm, the percentage increase in sulfur content of leaves after 13 hours of fumigation was only fourfold higher; and with the sixfold increase from 0.5 to 3.0 ppm, the percentage increase in sulfur content after 6.5 hours of fumigation had not doubled.

At the two low levels of fumigation, 0.1 and 0.25 ppm, the amount of sulfur in the leaves initially increased, but then tended to drop back to the level of the controls as fumigation continued. The decrease reported by other researchers *(3, 4)* was probably due to a reduction in the absorption rate as exposure continued, the translocation of sulfur from the leaves to other parts of the seedlings, the leaching of sulfate out of the plant through the roots, or the release of hydrogen sulfide gas back into the atmosphere.

Foliar injury was observed on the seedlings fumigated with 3 and 5 ppm SO_2. The injury was due to the high concentration of the pollutant in the atmosphere and not to the high sulfur content in the leaf tissue. The sulfur content of the leaves was 141 percent of the control after the 3-ppm fumigation, 146 percent of the control after the 5-ppm fumigation, and 147 percent of the control after 0.25-ppm fumigation for 22 hours. Injury was observed in the first two cases, but not in the latter. Injury apparently occurs when the plants are unable to convert the SO_2 into sulfate fast enough to prevent injurious sulfurous acid from accumulating *(7)*.

Foliar injury observed in the 3- and 5-ppm fumigations was not correlated with a decrease in chlorophyll content, as no significant differences were found in the chlorophyll content in any of the treatments. This may have been due to the leaves being harvested immediately after fumigations, when the water-soaked appearance of the leaves first suggested injury, but before there was any browning of the leaf tissue. Thomas and Hill *(9)* reported a tendency toward a slight reduction in chlorophyll content in SO_2-fumigated plants.

Hybrid poplar cuttings initially accumulated sulfur from a sulfur dioxide-polluted atmosphere. However, the sulfur content then tended to decrease. The reasons for the decrease are not clear, but may be very important in determining how effective tree foliage is in removing this pollutant from the atmosphere. Further studies are needed to determine the capacity and efficiency of tree foliage as an atmosphere-cleansing agent.

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