

Contents

1. Materials and Methods	1
1.1 Apparatus for the Experimental Determination of Air Pollution Effects	1
1.1.1 Field Study Near a Sulfur Dioxide Source	1
1.1.2 Fumigation Experiments in the Field	3
1.1.3 Fumigation Experiments in Controlled-environment Chambers	5
1.1.4 Comparison of Experimental Methods	6
1.2 Air Analyses	7
1.3 Test Plants and Soils	8
1.4 Determination of Plant Responses	9
1.4.1 Growth, Yield, and Quality	9
1.4.2 Gas-exchange Measurements	9
1.4.3 Chemical Analysis of Plant Material	10
1.4.4 Electron-microscopic Analysis of Ultrastructure	10
2. Experimental Analysis of the Effects of Gaseous Air Pollutants	11
2.1 Criteria for the Evaluation of Air Pollution Effects	11
2.2 Influence of Concentration and Exposure Time	13
2.3 Significance of Continuous and Intermittent Pollutant Action	23
2.4 Effects of Gaseous Air Pollutants in Combination	26
2.5 Significance of External and Internal Growth Factors	28
2.5.1 Influence of Climatic Factors	29
2.5.1.1 Radiation	29
2.5.1.2 Temperature	34
2.5.1.3 Humidity	37
2.5.2 Edaphic Factors	38
2.5.2.1 Soil Moisture	38
2.5.2.2 Nutrition	39
2.5.3 Influence of Stage of Development and Leaf Age	42
2.5.3.1 Stage of Development	43
2.5.3.2 Leaf Age	44
2.5.4 Specific, Varietal, and Individual Resistance	49

3. Comparisons of the Phytotoxic Characteristics of Sulfur Dioxide, Hydrogen Fluoride, and Hydrogen Chloride	60
3.1 Functions in Plant Metabolism	60
3.1.1 Sulfur	60
3.1.2 Fluorine	62
3.1.3 Chlorine	64
3.2 Accumulation of Pollutants in Plant Organs	66
3.2.1 Accumulation of S, F, and Cl in Connection with Pollutant Dosage	66
3.2.2 Relationship Between Accumulation of Pollutants and Plant Injury	67
3.2.3 Pollutant Content in Plant Organs as an Indicator for Pollutant Activity	69
3.3 Hidden Injury	71
4. Discussion of the Suitability of Plant Responses as a Basis for Air Pollution Control Measures	75
4.1 Air Quality Criteria and Their Use in Setting Air Quality Standards	75
4.1.1 Air Quality Criteria	76
4.1.1.1 Sulfur Dioxide	76
4.1.1.2 Hydrogen Fluoride	80
4.1.1.3 Hydrogen Chloride	82
4.1.2 Air Pollution Standards	84
4.2 Plants as Indicators for Pollutants Containing Sulfur, Fluoride, and Chloride	86
4.3 Measures for the Reduction of Pollutant Action in Plant Stands	93
4.3.1 Cultivation of Resistant Species and Varieties	94
4.3.2 Fertilizing and Cultivation	96
References	98
Subject Index	113
Color Plates	123