ANTIFUNGAL COMPOUNDS

VOLUME 2

Interactions in Biological and Ecological Systems

Edited by

MALCOLM R. SIEGEL HUGH D. SISLER

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Edited by

MALCOLM R. SIEGEL
Department of Plant Pathology
University of Kentucky
Lexington, Kentucky

HUGH D. SISLER
Department of Botany
University of Maryland
College Park, Maryland

Senior Editor of Volume 2: HUGH D. SISLER

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PREFACE

The need for fungicides is created by fungal activities detrimental to the welfare of mankind. As the bases for such destructive activities are identified, compounds are sought to control the fungi involved. Fungi had been identified as the basis of many problems a half century or more ago, but at that time very few fungicides had been found to control them. A great number of compounds have since been discovered, new methods of application have been developed, and new concepts on modes of action have evolved. At no time in the past has interest in fungicides been greater than during the current period of transition from the protective to the systemic fungicide.

A number of years have elapsed since a comprehensive coverage of fungicides appeared in two volumes edited by D. C. Torgeson (Fungicides: An Advanced Treatise, 1967). Since then, there have been marked advances in the development of systemic compounds, and a rising awareness of the toxicological hazards and the environmental impact of fungicides has evolved. With the advent of more selective fungicides, fungal resistance has emerged as a major problem. In this rapidly changing field, it is the purpose of this book and its companion volume to summarize and evaluate recent developments, to integrate these with significant developments of the past, and to attempt some projections into the future. We believe the various contributors to the volumes have achieved a reasonable measure of success for these goals.

The overall organization of the two books follows a biological—biochemical—ecological approach rather than one based on chemical class. However, individual authors have utilized the latter approach where it was most appropriate for their particular contribution.

The first of the two volumes focuses on the discovery, development, and use of fungicides and the problems associated therewith in plant pathology, medicine, wood preservation, and industry. This volume considers fungicides according to their effects and their fate as they interact with biological, biochemical, and ecological systems.

We are grateful to the many authors whose efforts have made these volumes possible. We wish to thank Carolyn Siegel, Patricia Sisler, Libbie Jones, Debby Owen, and Jeanne Kelleher for generous assistance in the preparation of the manuscripts.

Malcolm R. Siegel
Hugh D. Sisler

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CONTRIBUTORS

H. M. DEKHUIJZEN*
Institute for Organic Chemistry TNO, Central Organization for Applied Scientific Research in the Netherlands, Utrecht, The Netherlands

J. DEKKER
Laboratory of Phytopathology, Agricultural University, Wageningen, The Netherlands

L. V. EDGINGTON
Department of Environmental Biology, University of Guelph, Guelph, Ontario, Canada

LAWRENCE FISHBEIN
Chemistry Division, National Center for Toxicological Research, Jefferson, Arkansas

S. G. GEORGOPOULOS†
Department of Biology, Nuclear Research Center "Demokritos," Athens, Greece

A. KAARS SIJPESTEIJN
Institute for Organic Chemistry TNO, Central Organization for Applied Scientific Research in the Netherlands, Utrecht, The Netherlands

KAZUO KAKIKI
Fungicide Laboratory, Institute of Physical and Chemical Research, Wako-Shi, Saitama, Japan

DONALD D. KAUFMAN
Pesticide Degradation Laboratory, Agricultural Environmental Quality Institute, Agricultural Research Service, United States Department of Agriculture, Beltsville, Maryland

---

*Present address: Center for Agrobiological Research, Wageningen, The Netherlands

†Present address: Department of Plant Pathology, Agricultural College of Athens, Votanicos, Athens, Greece

JOSEPH KUC
Department of Plant Pathology, University of Kentucky, Lexington, Kentucky

H. LYR
Institute of Plant Protection Research, Kleinmachnow, Academy of Agricultural Sciences of the German Democratic Republic

TOMOMASA MISATO
Fungicide Laboratory, Institute of Physical and Chemical Research, Wako-Shi, Saitama, Japan

GAYLORD D. PAULSON
Metabolism and Radiation Research Laboratory, United States Department of Agriculture, Agricultural Research Service, Fargo, North Dakota

CAROL A. PETERSON*
Department of Environmental Biology, University of Guelph, Guelph, Ontario, Canada

NANCY N. RAGSDALE
Department of Botany, University of Maryland, College Park, Maryland

DONALD V. RICHMOND
Department of Agriculture and Horticulture, Long Ashton Research Station, University of Bristol, Bristol, England

LOUIS SHAIN
Department of Plant Pathology, University of Kentucky, Lexington, Kentucky

MALCOLM R. SIEGEL
Department of Plant Pathology, University of Kentucky, Lexington, Kentucky

J. W. VONK
Institute for Organic Chemistry TNO, Central Organization for Applied Scientific Research in the Netherlands, Utrecht, The Netherlands

DAVID WOODCOCK
Department of Agriculture and Horticulture, Long Ashton Research Station, University of Bristol, Bristol, England

*Present address: Department of Biology, University of Waterloo, Waterloo, Ontario, Canada

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Chapter 1

SOIL-FUNGICIDE INTERACTIONS

Donald D. Kaufman

Pesticide Degradation Laboratory
Agricultural Environmental Quality Institute
Agricultural Research Service
United States Department of Agriculture
Beltsville, Maryland

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I. INTRODUCTION

Organic pesticides occur in detectable amounts in many parts of the environment. An understanding of the fate and behavior of biologically active substances in the total environment is a necessity for the chemicals to be used safely, and for new products to be developed which will not produce adverse effects. Fungicides are an important part of our chemical arsenal for

controlling agricultural pests. Although they were among the earliest agricultural chemicals developed for use, they currently rank third in total sales. Common and chemical names of fungicides are listed in Table 1.

Fungicides enter into the soil from a variety of treatments. Excess solution from spray applications to the aerial parts of plants may drip from leaves on to the soil surface or may reach the soil surface directly. In preplanting, plant, or other treatments, fungicides can be applied directly to the soil either in solution, as dusts, or in granular formations. The ultimate behavior of a given pesticide in soil depends primarily on the physical, chemical, and biological properties of both the soil and chemical. Sorption, diffusion, volatilization, leaching, runoff, microbial and chemical degradation, photodegradation, and plant uptake are all significant processes affecting fungicide behavior in soil. The interactions of these various parameters determine the effectiveness of the chemical applied to soil and its residual life in soil.

According to Munnecke [1], much of the early research on soil fungicides was empirical. A transition from empirical to experimental research began about 1950 [1, 2] when research on chemical disinfestation was initiated. Despite the view of McNew [3] who believed that research on fungicides in general had the disadvantage of scientists working in a "vacuum," it is interesting to note the significant contributions of research on fungicides in soils to our overall understanding of the behavior of all pesticides in soil. As a disciple of plant pathology and soil microbiology who has worked on the soil microbiology of pesticides (primarily herbicides and insecticides), the author cannot help but be impressed with the contribution of early soil fungicide and fumigant research to our understanding of the behavior of all pesticides in soil. The preponderance of soil fungicide behavior studies, however, have dealt with the basic problems of efficacy. Since the publication of Rachel Carson's Silent Spring [4] increased awareness of our environment dictates that we not only understand the behavior (efficacy) of chemicals released into the environment, but that we also aim for a total concept of the ultimate fate of the chemical. The development and enactment of the U.S. Environmental Protection Agencies Guidelines for Pesticide Registration now requires extensive investigations of the fate and behavior of all chemicals ultimately scheduled for release into the environment. The prominence of herbicide and insecticide development at that critical point in time has resulted in a vast amount of scientific effort being put into understanding both the environmental fate and behavior of those chemicals in soil. With few exceptions, very little attention by comparison has been devoted to fungicide research. While much of the information necessary for continued registration of fungicides must have been developed, very little has appeared in the literature.

Several reviews have been published on the environmental behavior of fungicides [5–17]. The very excellent review by Goring [5], which discusses the physical aspects of soil in relation to the action of soil fungicides,

TABLE 1

Common and Chemical Names of Some Important Fungicides

Common name or designation	Chemical name	Other designations
ACNQ	2-Amino-3-chloro-1,4-naphthoquinone	
Actinomycin D	$C_{62}H_{86}N_{12}O_{16}$	
Anilazine	2,4-Dichloro-6-(o-chloroanilino)-s-triazine	Dyrene, Kemate
Aureomycin	$C_{22}H_{23}ClN_2O_8$	Chlortetracycline
BAS-307	2-Chlorobenzanilide	
BAS-3050	2-Methylbenzanilide	Mebenil
BAS-3191	2,5-Dimethyl-3-furanilide	Furcarbanil
Benomyl	Methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate	Benlate
Binapacryl	2-sec-Butyl-4,6-dinitrophenyl-3-methyl-2-butenoate	Endosan, Morocide, NIA-9044
Captafol	cis-N[(1,1,2,2-Tetrachloroethyl)thio]-4-cyclohexene-1,2-dicarboximide	Difolatan
Captan	N-[(Trichloromethyl)thio]-4-cyclohexene-1,2-dicarboximide	Orthocide
Carbon disulfide	Carbon disulfide	
Carboxin	5,6-Dihydro-2-methyl-1,4-oxathiin-3-carboxanilide	Vitavax, DCMO
Ceresan L	Methylmercuric 2,3-dihydroxypropylmercaptide (2.89%) + methylmercuric acetate (0.62%)	

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