PESTICIDES IN SOIL AND WATER

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FOREWORD

Soil scientists must understand and be able to manipulate the physical, chemical, and biological properties of soils for the benefit of man. As the world's population increases, the necessity for maintaining the productive capacity of the soil also increases. Loss of productive capacity of the soil through misuse, abuse, or neglect cannot occur without detrimental effects on our food and natural-fiber supplies and will eventually bring harm to life on the earth.

Production of adequate supplies of food and fiber requires that pesticides be used to reach and maintain a balance between the desired species and competitors. Since pesticide usage is necessary and will likely increase, soil scientists must stay in the forefront of knowledge about interactions between pesticides and soil and water. The almost infinite variation in physical, chemical, and biological properties of soils and the variety of environments in which they occur and in which pesticides are used necessitates numerous and extensive research efforts.

The symposium sponsored by the Soil Science Society of America in 1965 resulted in the publication *Pesticides and Their Effects on Soils and Water*. Demand required two additional printings of this volume. Since pesticides are changing rapidly and knowledge about their use and behavior is increasing, it became apparent that a more comprehensive treatment of the subject, encompassing research results since 1965, was needed. This volume *Pesticides in Soil and Water* will serve as an authoritative compendium of information for scientists, students, and laymen who desire information on this topic.

It is the hope of the Soil Science Society of America that this book will accomplish the intended purpose of aiding in man's effort to provide food and natural fiber without destroying the quality of the environment in which he lives.

The Society is indebted to the organizing committee, the authors, the editors, and the headquarters staff for their diligent and dedicated efforts which made this publication possible.

Lubbock, Texas
May 1974

ANSON R. BERTRAND, *president*
Soil Science Society of America

PREFACE

Pesticides in Soil and Water provides a comprehensive review of the principles which control the environmental effects of pesticide-soil-water interactions. The Soil Science Society of America published a book, *Pesticides and Their Effects on Soils and Water*, as ASA Special Publication No. 8 in 1966. Because of the large volume of research reports relating to pesticides which have accumulated since that time, the executive committee of the Society proposed an extensive revision of the book in 1971. The objective was to provide an authoritative, in-depth, and up-to-date review of pesticides in soils and water.

The book covers many facets of pesticide science including movement in soil and surface water, adsorption, volatilization, degradation and persistence, plant uptake, curtailment and detoxification of pesticide residues in soils, and sampling and analytic techniques for determination of pesticides in soil, sediment, and water. In addition, the influence of pesticides on microorganisms in soil and water and on nontarget invertebrates in fresh water and soil, are reviewed and discussed.

The editorial committee is sincerely appreciative of the cooperation it has received from authors and reviewers, and for the continued advice on manuscript processing provided by Matthias Stelly and Richard C. Dinauer of the headquarters office. The committee also acknowledges with gratitude the contributions of T. J. Sheets of North Carolina State University who served as chairman of this committee during portions of 1971 and 1972, and had a major influence on the development of the basic format of the book.

May 1974

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Conversion Factors for English and Metric Units and Plant Nutrients

To convert column 1 into column 2, multiply by	Column 1	Column 2	To convert column 2 into column 1, multiply by
	LENGTH		
0.621	kilometer, km	mile, mi	1.609
1.094	meter, m	yard, yd	0.914
0.394	centimeter, cm	inch, in	2.54
	AREA		
0.386	kilometer^2, km^2	mile^2, mi^2	2,590
247.1	kilometer^2, km^2	acre, acre	0.00405
2.471	hectare, ha	acre, acre	0.405
	VOLUME		
0.00973	meter^3, m^3	acre-inch	102.8
3.532	hectoliter, hl	cubic foot, ft^3	0.2832
2.838	hectoliter, hl	bushel, bu	0.352
0.0284	liter	bushel, bu	35.24
1.057	liter	quart (liquid), qt	0.946
	MASS		
1.102	ton(metric)	ton (English)	0.9072
2.205	quintal, q	hundredweight, cwt (short)	0.454
2.205	kilogram, kg	pound, lb	0.454
0.035	gram, g	ounce (avdp), oz	28.35
	PRESSURE		
14.50	bar	lb/inch^2, psi	0.06895
0.9869	bar	atmosphere,* atm	1.013
0.9678	kg (weight)/cm^2	atmosphere,* atm	1.033
14.22	kg (weight)/cm^2	lb/inch^2, psi	0.07031
14.70	atmosphere,* atm	lb/inch^2, psi	0.06805
	YIELD OR RATE		
0.446	ton(metric)/hectare	ton (English)/acre	2.240
0.891	kg/ha	lb/acre	1.12
0.891	quintal/hectare	hundredweight/acre	1.12
1.15	hectoliter/ha, hl/ha	bu/acre	0.87
	TEMPERATURE		
$\left(\frac{9}{5}\ °C\right) + 32$	Celsius	Fahrenheit	$\frac{5}{9}(°F - 32)$
	-17.8 C	0 F	
	0 C	32 F	
	20 C	68 F	
	100 C	212 F	

PLANT NUTRITION CONVERSION--P AND K

P (phosphorus) × 2.29 = P_2O_5
K (potassium) × 1.20 = K_2O

* The size of an "atmosphere" may be specified in either metric or English units.

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Introduction 1

WAYNE D. GUENZI

Agricultural Research Service, USDA, Fort Collins, Colo.

Pesticides will continue to be used in the production of food and fiber. Drastic reduction of pesticide usage would increase production costs and lower the quality of agricultural products. Some of the pesticides are also essential for protecting human and animal health. Development of alternative pest control methods will no doubt decrease the need for chemical pesticides in the future. Some of the alternatives being investigated are biological control, modification of insect genetics, development of attractants and repellents, development of resistant plant varieties and animals, and changes in crop culture and animal husbandry. The eventual contribution of each of these alternatives to the overall task of controlling pests cannot now be assessed. Probably the outstanding success story in biological control is the screwworm fly (*Callitroga americana*) eradication program.

The challenge is to select and apply pesticides in such a way that the target organism is controlled without harming nontarget organisms or the environment. With our present technology, chemical pest control programs administered by well-trained, conscientious people entail minimal risk to environmental quality. The objectives are to get the proper pesticide at the proper concentration on the target organism at the proper time. This would appear to be straightforward and within our technological capability. In selecting the proper pesticide the user must be concerned not only with the compound's selectivity for the target organism but also with its persistence in the ecosystem. Ideally, a pesticide should persist only long enough to complete its intended mission and then degrade to harmless products. Delivering the proper concentration of a pesticide to the pest through a crop canopy, or into soil, is a very real problem. Significant amounts of the chemical may never reach the target site during application or may volatilize from surfaces after being deposited. Although significant recent advancements have been made in pesticide application technology, much more research effort is needed. Examples of successful application improvements are low-volume sprays, foams, and granular soil applications. Finally, a more precisely timed application must be included in the ultimate goal of control in harmony with the environment.

The logical approach is to use a minimum amount of pesticide per unit of food or fiber production. This can be accomplished by obtaining maximum yields. Achieving maximum yields requires the integration of many factors: sound farm management, good tillage practices, proper supply of plant nutrients, best available varieties, adequate water, and pest control. Even if we fall short of achieving maximum yields, yields can be increased