Seed Pathology

VOLUME I

Seed Pathology

VOLUME I

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Preface

This book has a dual purpose. On the one hand it is intended as a textbook covering the principles of seed pathology, for use in university courses at different levels. On the other, the intention is to provide a comprehensive reference book on seed-borne diseases, their detection, evaluation and control, for established workers in the following fields: university teaching and research; research at experimental stations; practical seed testing; formulation of quarantine regulations; techniques of quarantine inspection; development and testing of seed-treatment materials and procedures in laboratory and field; seed certification schemes; seed production; and the seed trade.

For some years I have taught seed pathology to students at the graduate, post-graduate and post-doctoral levels. For these courses I have used draft texts of this book. At the Danish Government Institute of Seed Pathology for Developing Countries in Copenhagen, I have had the very great privilege of co-operating with colleagues in developing countries, and I feel that this continuous contact with the problems and the potentials of the 'third world' has been most beneficial in my endeavours to outline the principles, as well as the leading philosophies, of this new branch of plant pathology and seed technology.

Nevertheless, my thoughts also go to my colleagues in the 'old world', in particular to those with whom I have co-operated in the development of seed health testing techniques. Without the numerous contacts and fruitful co-operation (especially within the framework of the International Seed Testing Association and its Plant Disease Committee) in comparative testing schemes, international workshops, etc., I would not have been able to write this book.

Through these contacts I have received much valuable information, some of which has been acknowledged as 'personal communications'. Through the years I have been encouraged by many of my colleagues who have urged me to bring my book to completion. In this connection I cannot forget the late W. C. Moore, formerly director of the Phytopathological Laboratory of the Ministry of Agriculture, Fisheries and Food, at Harpenden, England, for his persistent stimulation.

In extending my thanks to the many colleagues who have helped me by checking the texts that fell within the realms of their specialities, I must first

pay tribute to my closest colleague, Dr. Mary Noble, Department of Agriculture and Fisheries for Scotland, Edinburgh. Since the 1950s we have had the closest co-operation, and our joint efforts, together with other colleagues, in developing seed health testing techniques, and in formulating seed certification schemes and quarantine regulations, all advocate the incontestable principle that prevention is better than cure. Dr. Noble has read the whole book critically, and made numerous comments and suggestions. I can find no adequate expression for my gratitude to her for her careful perusal of the manuscript and for her inspiration and encouragement throughout the years in whatever I may have contributed to seed pathology.

The wide scope of the theme of this book has made consultation with specialists essential. I am grateful indeed for the prompt readiness of many outstanding colleagues for their valuable co-operation in reading chapters or sections of the book and for communicating their criticism and suggestions. I express my deep gratitude to the following for their co-operation: Dr. Joan Moore, Ministry of Agriculture, Fisheries and Food, London, who perused and gave most useful critical comments on Chapter 1 and the whole of Part III. Dr. H. C. Phatak, at present in Bangkok, Thailand, who checked Chapter 3. Professor Ernst Hellmers, Royal Veterinary and Agricultural University, Copenhagen, and Dr. D. C. Graham, Department of Agriculture and Fisheries for Scotland, Edinburgh, who checked Chapter 4. Dr. M. J. Thirumalachar, India, over a period associated with the Institute of Seed Pathology for Developing Countries, Copenhagen, who checked Chapter 5. Professor Clyde M. Christensen, University of Minnesota, U.S.A., who checked Chapter 7. Dr. Palle Krogh, Royal Veterinary and Agricultural University, Copenhagen, Denmark, and Dr. Chester Mirocha, University of Minnesota, U.S.A., who checked Chapter 8. Dr. Dalbir Singh, Reader, University of Rajasthan, India, who checked Chapter 10. Professor R. K. S. Wood, Imperial College, London, England, who checked Chapter 18. Dr. J. T. Mills, Canada Department of Agriculture, Winnipeg, Manitoba, who checked Chapters 21, 22 and 23. Dr. J. de Tempe, Government Seed Testing Station, Wageningen, the Netherlands, and Mr. R. B. Maude, National Vegetable Research Station, Warwickshire, England, who checked Table 22.3. Dr. Johs. Jørgensen, Danish Government Seed Testing Station, Copenhagen, who checked Chapter 24. Dr. S. B. Mathur, Institute of Seed Pathology for Developing Countries, Copenhagen, who checked Chapters 28 and 29. And finally, Professor Gaston Waringhien, Paris, for checking the Greek and Latin etymology of the terms included in the Glossary.

I have worked on this book for many years, but particularly intensively during the past eight years when I greatly needed texts for teaching seed pathology at the Institute of Seed Pathology in Copenhagen. I would like to thank my colleagues at the Institute for their interest and co-operation.

The teaching and research activities at this Institute have given me a unique opportunity to study many details pertaining to routine testing for seed-borne pathogens. In these activities Dr. S. B. Mathur, my closest colleague through this period, has taken a most active part; his initiative and enthusiasm should be recorded here.

I have derived considerable benefit from the excellent technical assistance at the Institute in the preparation of the illustrations for the book, and I would like to thank Mrs. Olga Kongsdal for producing or redrawing many of the line drawings, and Mr. Magd El-din Ragab for his devoted and skilful co-operation in producing most of the original photographs.

My final thanks go to the excellent secretarial help I have received, and I am indebted to Mrs. Rigmor Hjelmskov for her patient copying of the thousands of items for the index. In the practical work on the manuscript I have received the greatest support and most efficient help from Mrs. Ellen Hersdorf. Her assistance in the typing of thousands of pages at all stages of the manuscript, and especially her efforts at reducing the 'stealing-in' of errors that is the ever-threatening spectre in the life of an author, have been invaluable. I wish to express my truly deep gratitude for her steady zeal in the elaboration and final accomplishment of this book.

The wide scope of the book, covering as it does a considerable range of aspects of plant pathology including the many categories of pathogens that may be transmitted through seeds, makes this work an ambitious one in the hand of one author. There are advantages and disadvantages of one-man authorship of a book of this type, which is always vulnerable to specialist criticism, and thus finally I wish to make a sincere request for critical comments and corrections.

Copenhagen, August, 1976

Paul Neergaard

Some suggestions on the use of the book

There is a range of possibilities for the use of the book in university teaching. The texts to be included in a course depend, of course, on the scope of the particular course, and the time available.

Part I (Pathogens, Diseases, Hosts) which is the 'special' part is primarily a compendium of seed-borne pathogens and seed disorders, and also includes a review of their harmful effects on crop production and, in one chapter, on human and animal health. While the first eight chapters may be used mainly for reference, the last two chapters may be suitable for some courses, in particular Chapter 10 which deals with the fundamental subject of morphology and anatomy of seeds in relation to transmission of pathogens. This chapter at least should be included for graduate and post-graduate students. The introductory sections of some of the chapters may also be considered for inclusion.

Part II (Mechanisms of Seed Transmission) is considered as basic for any academic study of seed pathology. It outlines the 'natural laws' governing the establishment of pathogens in seeds, their transmission, and their further development in crops. I would suggest that in any comprehensive course at the graduate and post-graduate levels this part should be included as a whole, with some omissions. For courses at the undergraduate level I would certainly concentrate on Chapter 14, largely dealing with the major types of cycles of seed-borne diseases. It might be useful in these elementary courses also to include Chapter 11 describing the influence of environment on establishment of pathogens in the seed crop.

Part III (Control) can be used as a whole for graduate and post-graduate courses, with omissions according to the time available and the scope of the course. For undergraduate courses I would select Chapter 19 on seed crop management; also Section 20.1, the Conclusions of Section 20.2, and Chapter 21 dealing in a general way with seed treatment procedures and equipment.

Part IV (Testing Methods) should support courses in practical seed health testing at any level, and would provide texts for thorough studies at the graduate and post-graduate levels.

Part V (Assessment of Seed-borne Inoculum) is, I think, truly basic for any interpretation of results recorded in seed health testing, and funda-

Table 0.1 Summary of suggested sections of the book to be included in university and other courses

<i>Part</i>	<i>Undergraduate</i>	<i>Graduate</i>	<i>Post-graduate</i>	<i>Technicians</i>
I <i>Pathogens, Diseases, Hosts</i> (1–10)	None	Sections 1.3, 3.1–3.4. Introduction to Chapter 4. Sections 4.1, 5.1, 5.2. Introduction to Chapter 6. Chapter 10	As for Graduate, plus Chapter 7	Subsections of Chapter 2
II <i>Mechanisms of Seed Transmission</i> (11–18)	Chapters 11 and 14	All chapters	All chapters	Chapters 13 and 14, with some omissions
III <i>Control</i> (19–24)	Introduction. Chapters 19 and 21, Sections 20.1 22.3, 22.6, 22.10 and 24.1	Introduction. Chapters 19, 21–24, and Section 20.1 and Subsection 20.2.6	Introduction and all chapters	Chapter 23, with some omissions
IV <i>Testing Methods</i> (25–31)	Chapters 25–28 for reference; Sections 31.2 and 31.3	All chapters	All chapters	Chapters 25–30
V <i>Assessment of Seed-borne Inoculum</i> (32)	None	Chapter 32	Chapter 32	None

mental for the establishment of rational disease tolerances in seed certification schemes. This part, I believe, should be included in any course at the graduate and post-graduate levels.

The book may also be used in courses for training technicians in seed health testing. For such purposes, I suggest the selection of Chapter 2 on diseases and injuries of seed (with omissions), and most of Chapter 13 dealing with modes of infection and contamination of seed; the essential sections of Chapter 14, discussing disease cycles, should perhaps also be taught to convey a general understanding of seed-borne diseases. Important in courses for technicians would be the whole of Part IV, dealing with methods of testing (with omission of some special discussions), and possibly also Chapter 23, on testing of seed germicides and treated seed, with some omissions.

I have summarised these suggestions in Table 0.1

List of Colour Plates

(appearing between pages 232/233 and 680/681)

Plates I and II. Habit characters of *Fusarium* on seeds after 7 days of incubation in the blotter test.

Plate III. Colour infrared aerial photograph showing bean fields near Hensall, Ontario, infected with bacterial blight.

Plate IV. Top left — soybean seed with mottling of seed coat, due to infection of mother plants by soybean mosaic virus; top right — seed rot and discoloration in maize seeds due to *Diplodia maydis*. Middle left — rice seed with discoloration due to *Drechslera oryzae* and *Trichoconis padwickii*; middle right — soybean seed with discoloration caused by *Cercospora kikuchii*. Bottom — agar plate test on oxgall-potato dextrose agar, showing different species of *Fusarium*.

Plate V. Aerial photograph of a field of white beans near Hensall, Ontario, infected with bean blight, *Xanthomonas phaseoli*.

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VOLUME II

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Developing Countries, Copenhagen, Denmark*

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- 5. Seed-borne Fungi**
- 6. Seed-borne Nematodes**
- 7. Storage Fungi**
- 8. Impact of Seed-borne and Storage Fungi on Animal and Human Health**
- 9. Types of Host in Relation to Types of Pathogen**
- 10. Morphology and Anatomy of Seeds in Relation to Transmission of Pathogens**

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26. Sampling

27. Examination of Ungerminated Seed

28. Incubation Tests I: Procedures

29. Incubation Tests II: Factors Affecting Test Results

30. Bioassays and Biochemical Procedures

31. Inspection of Plants beyond the Seedling Stage

PART V ASSESSMENT OF SEED-BORNE INOCULUM

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