

Control of Crop Diseases

Thoroughly revised and updated to reflect current and emerging practices, this book explores modern methods of disease control in field and glasshouse crops. It outlines the major crop diseases of the UK with a particular emphasis on those features of symptomology and life cycle that are most relevant to the development of control measures. Modern diagnostic techniques are considered, focusing on developments in nucleic-acid- and immunological-based procedures and their use in plant quarantine and certification schemes. The potential impact of these and other advances in molecular technology on plant breeding and disease resistance is also covered. Fungicides are an integral part of disease control in the EU and, as such, a comprehensive account of their use forms an important part of the text, along with strategies to minimise the incidence of fungicide resistance in pathogen populations. Looking to the future, the book also addresses legislative, environmental and food safety concerns.

W. R. CARLILE lectured on pesticide selectivity and toxicology for many years at Nottingham Trent University, where he carried out research and contractual work on the mode of action of pesticides and fungicide resistance. From 2006 to 2011, Bill was Chief Horticultural Advisor to Bord na Mona in Ireland, and he now acts as Horticultural Advisor to the company.

A. COULES is a lecturer on Plant Science and Environmental Science courses at Nottingham Trent University. Her main research interests are in growing media and plant pathology. Current activity at Nottingham Trent involves commercial horticultural research and trials, and she has also worked abroad as an agricultural advisor and consultant plant pathologist.

Control of Crop Diseases

Third Edition

W. R. CARLILE

Bord na Mona (Horticulture)

A. COULES

Nottingham Trent University



CAMBRIDGE
UNIVERSITY PRESS

Cambridge University Press & Assessment
 978-0-521-13331-9 — Control of Crop Diseases
 W. R. Carlile, A. Coules
 Frontmatter
[More Information](#)



CAMBRIDGE
 UNIVERSITY PRESS

Shaftesbury Road, Cambridge CB2 8EA, United Kingdom
 One Liberty Plaza, 20th Floor, New York, NY 10006, USA
 477 Williamstown Road, Port Melbourne, VIC 3207, Australia
 314–321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre, New Delhi – 110025, India
 103 Penang Road, #05–06/07, Visioncrest Commercial, Singapore 238467

Cambridge University Press is part of Cambridge University Press & Assessment, a department of the University of Cambridge.

We share the University's mission to contribute to society through the pursuit of education, learning and research at the highest international levels of excellence.

www.cambridge.org
 Information on this title: www.cambridge.org/9780521133319

© W. R. Carlile and A. Coules 2012
 First edition © Cambridge University Press & Assessment 1995
 Second edition © W. R. Carlile 1998

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press & Assessment.

First published 2012

A catalogue record for this publication is available from the British Library

Library of Congress Cataloging-in-Publication data

Carlile, W. R.

Control of crop diseases / W.R. Carlile, A. Coules. – 3rd ed.

p. cm.

Includes bibliographical references and index.

ISBN 978-0-521-13331-9 (pbk.)

1. Plant diseases – Great Britain.

2. Phytopathogenic microorganisms – Control – Great Britain.

3. Plant diseases – Europe.

4. Phytopathogenic microorganisms – Control – Europe. 5. Fungicides.

I. Coules, A. (Anne) II. Title.

SB605.G7C37 2012

571.9'2 – dc23 2012002655

ISBN 978-0-521-13331-9 Paperback

Cambridge University Press & Assessment has no responsibility for the persistence or accuracy of URLs for external or third-party internet websites referred to in this publication and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

Every effort has been made to accurately describe the uses of pesticides mentioned in this book at the time of going to press. Users of pesticides must read manufacturers' instructions on product labels and must be aware of approved uses of these products under the UK Control of Pesticides Regulations of 1986 and Plant Protection Products Regulations of 1995 and 1997. Neither the authors nor the publisher will accept any responsibility for any damage, accidental or otherwise, arising from use of pesticides mentioned in this book.

Contents

Preface to the third edition	<i>page</i> ix
Preface to the second edition	xi
Preface to the first edition	xiii
Trademarks and registered trademarks	xv
1 Introduction	1
2 Major crop diseases in the UK	3
2.1 Introduction	3
2.2 Cereal diseases	3
2.3 Diseases of oilseed crops	15
2.4 Potato diseases	21
2.5 Diseases of sugar beet	25
2.6 Legume diseases	26
2.7 Diseases of top fruit	29
2.8 Diseases of protected crops	31
3 Diagnosis of disease in crops	34
3.1 Introduction	34
3.2 Identification based on symptoms	34
3.3 Isolation and identification of causal agents	36
3.4 The use of immunodiagnostic procedures	39
3.5 Analysis of genome structure	43
4 Eradication, certification and legislation	49
4.1 Introduction	49
4.2 Disposal of crop residues	49
4.3 Removal of volunteer and alternative hosts	50

vi CONTENTS

4.4	Eradication of pathogens from soil	51
4.5	Glasshouse and field hygiene	53
4.6	Vector eradication	53
4.7	Removal of infected plants	54
4.8	Elimination of pathogens from seed	54
4.9	Elimination of viruses from vegetatively propagated crops	55
4.10	Certification schemes	56
4.11	Legislation	59
5	Crop husbandry and cultural practices	66
5.1	Introduction	66
5.2	Cropping systems	66
5.3	Cultivation practices	71
5.4	Alterations in the environment of crops	73
6	Production and use of crop cultivars resistant to disease	76
6.1	Introduction	76
6.2	Sources of resistance	77
6.3	Specific resistance	79
6.4	Expression of specific resistance	83
6.5	Non-specific resistance	85
6.6	Expression of non-specific resistance	86
6.7	Breeding techniques	87
6.8	Cultivar approval and recommendation	90
6.9	Deployment of specific resistance in the field	92
7	Fungicides and biological control	98
7.1	Introduction	98
7.2	Fungicide selectivity	99
7.3	Protectant fungicides	100
7.4	Curative and systemic fungicides	108
7.5	Formulation of fungicides	125
7.6	Application of fungicides	127

7.7	Fungicide resistance	130
7.8	Strategies to avoid fungicide resistance	136
7.9	Environmental and toxicological considerations	141
7.10	Biological control of crop diseases	145
8	Current trends and future prospects	146
8.1	Introduction	146
8.2	Trends in fungicide use	147
8.3	Public health and fungicide use	148
8.4	New fungicides and developments in application	150
8.5	Biological control agents	152
8.6	Novel techniques of plant breeding	153
8.7	The impact of molecular biology and genetic technologies on disease control	158
8.8	The impact of campaigns and legislations on disease control measures	160
8.9	Current perspectives on disease control in crops	163
	Bibliography and further reading	166
	Index	171
	The colour plate section is between pages 112 and 113.	

Preface to the third edition

An extensive revision of the chapter on chemical control of disease and expanded coverage of both diagnosis of disease and deployment of resistant cultivars form part of this new edition. Diagnosis of disease is becoming ever more sophisticated, and if transgenic crops become as acceptable in the European Union as elsewhere in the world, major advances in durable disease control without recourse to the extensive use of fungicides may at last be realised.

The author of previous editions (W. R. Carlile) has worked almost solely with protected horticultural crops over the period 2006–2011, and has admired the careful use of cultural practice, sanitation and adoption of non-chemical methods for pest and disease control: a very different scenario from arable crops, with the principal link being the extraordinary progress in disease diagnosis based on molecular technologies, and perhaps to be surpassed by developments in nanotechnology.

In this respect Bill Carlile would like to pay tribute to colleagues at Bord na Mona in Newbridge, including James Spillane, Dearbhail Ni Chualain, Colman Hynes and Sarah Lombard, for their good company and encouragement. Equally, he would wish to acknowledge the continued interest and help from past graduates of Nottingham Trent University, particularly Chris Danks, now at Forsite Diagnostics; Mark Stevens, at Brooms Barn research station of the UK BBSRC; and staff of Eurofins (Agrisearch) at Melbourne, Derbyshire, especially Owen Scrimshaw.

Anne Coules would like to thank colleagues at Nottingham Trent University, in particular Dave Jukes, Mark Oxenbury and

X PREFACE TO THE THIRD EDITION

Chris Terrell-Nield, for their support and encouragement. She would also like to acknowledge the support, encouragement and good humour of family, Tony and friends.

Finally the authors would like to acknowledge the patience and understanding of Sylvia and George.

Preface to the second edition

The second edition includes a chapter on disease diagnosis and expanded coverage of fungicides as well as problems of controlling pathogens in crops and produce entering international trade. In the latter case molecular techniques are likely to play an increasing role in disease diagnosis. Nucleic acid and antibody technologies may also be deployed in future to justify the application of control measures such as fungicides. Indeed, fungicides continue to play a dominant role in maintaining the high standards of disease control evident within the intensive farming systems of the European Union (formerly the European Community or EC) despite efforts to reduce the production of commodities surplus to EU requirements. However, impending economic and legislative pressures, as well as concerns over the long term toxicological and environmental effects of pesticides, may lead to reductions in the quantity of fungicides applied to crops and greater reliance on other methods of disease control.

The text overall is still intended to be a broad introduction to the practices of disease control currently used by farmers and growers within the EU, and particularly in the UK.

I am once again indebted to my colleague Gil Davies for his encouragement and constructive criticism of the text. I am very grateful to both Agrisearch UK and William Sinclair Horticulture, and Graham Partington and Chris Turner respectively for financial support towards the cost of the colour plates. As with the first edition I wish to acknowledge the help that many students from the (Honours) degree and BTEC (Science) sandwich courses in Applied Biology at Trent, as well as their supervisors in industry, NIAB and MAFF, have given in keeping me up-to-date with developments in

xii PREFACE TO THE SECOND EDITION

disease control in crops. Many of the photographs came from material provided by staff of Agrisearch UK and I wish to express my particular thanks to Chris Harrison, Andy Bailey and Stuart Atkinson. Other photographs have been kindly supplied by Ciba Agriculture, Ian Barker of the Central Science Laboratory, Roy Groom, Pete Fitsimons and Shahid Mian. I am greatly indebted to Maggie Martin of the Audio-Visual Unit in the Faculty of Science, who took most of the photographs, often at *very* short notice, and prepared many of the text figures.

Finally my thanks go to Sylvia for her patience and understanding throughout.

Preface to the first edition

The intensive nature of modern agriculture in the European Economic Community, with the demand for better standards of crop quality and yield has required a high degree of disease control. Increased attention to crop hygiene, the production of disease-resistance cultivars and particularly advances in fungicide technology and use have all contributed towards major improvements in crop yield and quality. However, yield increases have led to the accumulation of surpluses of certain agricultural commodities. The current revision of price support within the EEC for crops such as cereals may lead to an examination of input levels as part of an overall effort to reduce the costs of cultivation. This may be especially reflected in the selection and frequency of use of fungicides, and it is possible that with field crops such as cereals, greater reliance in the immediate future may be placed on innate host resistance to diseases. On the other hand, the demand for high quality fruit and vegetable produce is increasing. Strict hygiene, including the development of soilless growing systems for crops under glass, as well as the continued intensive use of fungicides to achieve consistent and thorough control of disease is likely to remain a feature of growing systems where quality is of prime importance. It is, however, in these systems that problems of fungicide resistance are most likely to occur, and the development of strategies to prevent fungicide resistance is recognised by many as a highly desirable objective.

Overall, the crop protection discipline is one of current development and change. This text provides a broad review of

xiv PREFACE TO THE FIRST EDITION

current practices adopted by farmers and growers to control diseases of major crops in the UK, describes some of the problems which have arisen following the deployment of these measures and indicates some of the future developments likely to occur in the sphere of crop disease control.

Trademarks and registered trademarks

The products listed below are trademarks or registered trademarks of the companies and organisations listed.

Agraquest: Serenade

Agriphar SA: Syllit

BASF plc: Adexar; Bavistin; Caramba; Comet; Corbel; Decabane; Ensign; Flexity; Initium; Invader; Opus; Rovral; Signum

Bayer CropScience Ltd: Aviator; Bayleton; Baytan; Cercobin; Consentio; Dithianon; Folicur; Infinito; Jockey; Merlin; Monceren; Proline; Scala; Sportak; Storite; Tattoo; Teldor; Torch; Twist; Xpro

Crompton Corporation: Vitavax

DowAgrosciences Ltd: Dithane; Electis; Fortress; Kindred; Systhane

Du Pont de Nemours: Curzate; Sanction; Tanos

Ishihara Sangyo Kaisha: Ranman

Kumiai Chemical Company Ltd: Valbon; Frupica

Monsanto Corporation: Latitude

Nippon Soda: Cyflamid

Prophyta Biologischer Pflanzenschutz: Contans

Sipcam UK Ltd: Tairel

Syngenta Group Companies: Acanto; Alto; Amistar; Bontima; Bravo; Beret; Fubol; Patrol; Revus; Shirilan; Tilt; Topas; Unix

UniRoyal Chemical Ltd: Vitavax