

Cambridge University Press

978-0-521-42774-6 - Plant Growth Curves: The Functional Approach to Plant Growth Analysis

Roderick Hunt

Frontmatter

[More information](#)

Plant Growth Curves

The Functional Approach to
Plant Growth Analysis

Cambridge University Press

978-0-521-42774-6 - Plant Growth Curves: The Functional Approach to Plant Growth Analysis

Roderick Hunt

Frontmatter

[More information](#)

'In general, curve fitting should be indulged in only when there are clear-cut objectives, and when the practitioner is aware of the pitfalls'.

(Williams, 1975)

'...*omnes observationes nostrae propter instrumentorum sensuumque imperfectionem non sint nisi approximationes ad veritatem* ...' ['all our observations, because of the imperfection of instruments and of the senses, are nothing more than approximations to the truth'].

(Gauss, 1809)

Cambridge University Press

978-0-521-42774-6 - Plant Growth Curves: The Functional Approach to Plant Growth Analysis

Roderick Hunt

Frontmatter

[More information](#)

Plant Growth Curves

The Functional Approach to Plant Growth Analysis

Roderick Hunt

B.Sc., Ph.D., M.I.Biol.

Independent Research Worker, Natural Environment
Research Council Unit of Comparative Plant Ecology,
Honorary Lecturer in Botany, University of Sheffield



CAMBRIDGE
UNIVERSITY PRESS

Cambridge University Press

978-0-521-42774-6 - Plant Growth Curves: The Functional Approach to Plant Growth Analysis
Roderick Hunt

Frontmatter

[More information](#)

CAMBRIDGE UNIVERSITY PRESS

Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore,
São Paulo, Delhi, Dubai, Tokyo

Cambridge University Press

The Edinburgh Building, Cambridge CB2 8RU, UK

Published in the United States of America by Cambridge University Press, New York

www.cambridge.org

Information on this title: www.cambridge.org/9780521427746

© Roderick Hunt, 1982

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.

First published by Edward Arnold (Publishers) Ltd 1982

Re-issued in this digitally printed version by Cambridge University Press 2010

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

ISBN 978-0-521-42774-6 Paperback

Cambridge University Press 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.

Preface

Plant growth curves in the special, but far from idiosyncratic, sense of this book are progressions of plant size against time. They have long occupied a vital place in plant science where studies on the performance of whole plants have often acted as the centre from which work at other levels of organization has radiated. The notion of change in size, too, with its fascination for the human mind and its indispensable involvement in biological sciences, has attracted statisticians from the earliest days of their subject and now occupies, through the agency of the fitted curve, a special place in the quantitative analysis of plant growth.

This book reviews the theory, practice and applications of fitted plant growth curves, a project I undertook both with excitement and with sadness; excitement, because this is the first time that a reasonably comprehensive coverage of this gratifyingly concise topic has been attempted, and sadness because, in view of the explosive development of the literature, it will in all probability also be the last, subsequent work necessarily involving some further subdivision. The time for viewing the subject as an entity is ripe, but this will soon pass as its twigs become branches, and so on.

Such matters as the book's background, anticipated readership and inter-relationships with existing publications I cover in a separate introduction.

The work's existence owes much to many and my special thanks are due to Dr D. R. Causton for his friendly and critical co-operation at all stages of the project; to Dr G. C. Evans, who has on innumerable occasions given generously of his matchless experience; and to I. T. Parsons, a friend from school days and a valued collaborator over the last ten years.

My interest in plant growth analysis was first awakened at Sheffield by Professor A. R. Clapham. Since then, many friends and colleagues at the Universities of Bristol and Sheffield have shared with me their problems, ideas and successes in this and related fields: Dr J. F. Hope-Simpson, Dr E. I. Newman, C. R. Baines, the late Dr P. S. Lloyd, Dr J. Grace, the late Dr R. Law, Professor A. J. Willis, Dr I. H. Rorison, Dr J. P. Grime, Dr P. L. Gupta, Dr A. J. M. Baker, Dr H. Gretton, Dr S. B. Furness, Mrs. S. A. Fathy and Dr S. P. McGrath. Friends, collaborators and correspondents from many parts of the world have also brought me into contact with many diverse topics related to the study of plant growth, their numbers swollen by my good

Cambridge University Press

978-0-521-42774-6 - Plant Growth Curves: The Functional Approach to Plant Growth Analysis
Roderick Hunt

Frontmatter

[More information](#)vi *Plant Growth Curves*

fortune in acting as Liaison Officer to the Natural Environment Research Council Unit of Comparative Plant Ecology at Sheffield. Chief among these are Professor F. A. Bazzaz, Dr M. J. Chadwick, Dr P. D. Crittenden, Dr J. G. P. Dirven, the late Dr A. P. Hughes, Dr R. G. Hurd, Dr B. C. Jarvis, H. T. Khong, Dr J. Květ, Dr A. S. Mahmoud, Dr J. H. Mook, P. Sivan, Dr D. P. Stribley, Dr. A. Troughton and Dr F. I. Woodward. To these and all others not mentioned, my grateful thanks.

Over the years I have been helped by a series of willing and able assistants: R. J. Allen, Miss C. R. V. Rathey, Mrs H. J. Hucklesby and A. M. Neal while, almost throughout, Mrs A. M. N. Ruttle has provided incomparable secretarial support.

The permissions of the authors and publishers of the illustrative examples are gratefully acknowledged and I am indebted to the cited publication by S. Makridakis which prompted me to search the *Theoria motus* for the Gauss quotation which plays Charybdis to the Scylla of R. F. Williams opposite my title page. Dr D. R. Causton improved the whole text by his lengthy series of reader's comments and Dr G. C. Evans responded in characteristically far-sighted style upon receipt of parts of Chapter 8. Errors and omissions remain my own and I will gladly receive due notice of these from readers, for which my thanks in advance.

Sheffield, 1982

R. H.

Contents

Preface	v
Introduction	1
1 Overture	
1.1 Growth	5
1.2 Plant growth	5
1.3 Plant growth analysis	7
1.4 Plant growth analysis in relation to other fields of activity	9
1.5 The 'classical' and the 'functional' approaches to plant growth analysis	10
1.6 Computing support required	11
1.7 Units	12
1.8 Notation	12
1.9 An outline of the course of the book	13
2 Concepts in plant growth analysis	
2.1 Introduction	14
2.2 Growth analysis of individuals	16
2.3 Growth analysis of populations and communities	33
2.4 Independent variables or variates other than time	40
2.5 Synopsis and sources of additional information	41
3 The functional approach in theory	
3.1 Introduction	47
3.2 Models of plant growth	47
3.3 Models in the functional approach to plant growth analysis	51
3.4 Derivations from growth functions	55
3.5 The way ahead	60
4 The functional approach in practice	
4.1 Introduction – and a caution	61
4.2 Indirect estimation of primary data	62
4.3 Freehand curves for interpolation	64

Cambridge University Press

978-0-521-42774-6 - Plant Growth Curves: The Functional Approach to Plant Growth Analysis

Roderick Hunt

Frontmatter

[More information](#)viii *Plant Growth Curves*

4.4	Fitted curves in the classical approach	67
4.5	The practical background to the functional approach	67
4.6	The choice of function	69
4.7	Statistical considerations	73
4.8	In conclusion	77
4.9	A forward look	78
5	Polynomial functions	
5.1	Introduction	79
5.2	First-order polynomial	81
5.3	Second-order polynomial	94
5.4	Third-order polynomial	103
5.5	High-order polynomials	109
5.6	Stepwise polynomials	110
6	Asymptotic functions	
6.1	Introduction	121
6.2	Monomolecular function	123
6.3	Logistic function	126
6.4	Gompertz function	128
6.5	Richards function	135
6.6	Other asymptotic functions	144
7	Special approaches	
7.1	Introduction	147
7.2	Segments	147
7.3	Running re-fits	149
7.4	Splines	154
7.5	Time Series Analysis	164
7.6	Other special functions	166
7.7	Response surfaces involving additional independent variables or variates	168
8	Finalé	
8.1	Which growth function?	174
8.2	The classical versus the functional approach	177
8.3	The biological relevance of parameters and functions	185
8.4	Why plant growth analysis?	186
	Literature cited	194
	Author index	229
	Systematic index	238
	Subject index	243