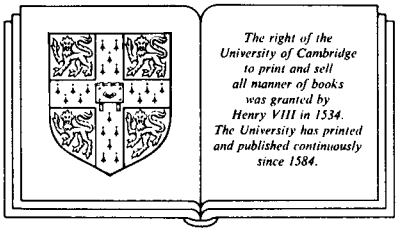
Molecular biology and crop improvement

Commission of the European Communities (Division for Genetics and Biotechnology of the Biology, Radiation Protection and Medical Research Directorate, Directorate-General for Science, Research and Development)

Molecular biology and crop improvement

A CASE STUDY OF WHEAT, OILSEED RAPE AND FABA BEANS

R.B. Austin
with
R.B. Flavell, I.E. Henson and H.J.B. Lowe
Plant Breeding Institute, Trumpington, Cambridge



CAMBRIDGE UNIVERSITY PRESS
Cambridge
London New York New Rochelle
Melbourne Sydney

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo, Delhi

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/9780521112918

EUR 10336
Legal Notice
Neither the Commission of the European Communities nor any person acting on behalf of the Commission is responsible for the use which might be made of the following information.

First published 1986
This digitally printed version 2009

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

ISBN 978-0-521-32725-1 hardback
ISBN 978-0-521-11291-8 paperback

CONTENTS

PREFACE

This book is the report of a study on opportunities for the application of molecular biology to crop improvement in the EEC, with particular reference to wheat, oilseed rape and faba bean, carried out by the Plant Breeding Institute, Cambridge, United Kingdom, under contract to the Commission of the European Communities (Division for Genetics and Biotechnology).

The Division called for an assessment of the opportunities for the application of molecular biology to the improvement of three species which play an important role in European agriculture, namely wheat, oilseed rape and faba beans. We considered that an assessment of this kind should be based on existing knowledge of these crops. From this, the need for particular improvements could be identified and an assessment made of the opportunity for making them offered by the available techniques of molecular and cell biology.

The main conclusions from the study are:

The biochemical study of genes and their primary products will continue to be of great value for research in plant biology. Through such research, a much better understanding will be gained of the molecular basis of growth and differentiation, of responses to environmental factors and of host–pathogen and host–pest interactions.

The ability to insert foreign and modified genes into plants, when better developed, will offer entirely new opportunities for making defined, limited changes to plant genotypes. Comparison of the modified and original genotypes will enable unequivocal tests to be made of alleged limiting points in plant metabolism and of the basis of resistance to particular pests and pathogens. This work will also show how improvements in yield, quality and pest and pathogen resistance may be achieved.

The techniques of molecular biology will not replace existing plant

breeding practice. Comprehensive testing and evaluation for yield, quality and pest and disease resistance will be needed in order to evaluate any products of genetic engineering, just as it is needed for evaluating the progenies of crosses made as part of conventional breeding programmes.

For wheat there is an urgent need to find and develop a vector for transferring alien genes to the species. Subjects for study by molecular biological methods include: photosynthesis, drought resistance and the basis of resistance to the major pathogens, namely yellow and brown rust, mildew and take-all.

For oilseed rape, rapid means of identifying S-incompatibility alleles at the seedling stage, probably by cDNA probes, would aid the development of F_1 hybrid varieties. The possibility of transferring genes from the related genus *Moricandia* to reduce photorespiratory losses in oilseed rape should be investigated. The molecular basis of resistance to stem canker should be studied. Generalised resistance to the numerous insect pests of oilseed rape (many of which are common to other brassica crops) should be sought and transferred to the crop.

For faba beans, where the normal process of sexual hybridisation cannot be used to transfer genes from related species, alternative methods of gene transfer are required. Attention should be given to the transfer of genes which would increase drought resistance and of those which would confer improved resistance to the fungal pathogens *Ascochyta* and *Botrytis* and to the aphid *Aphis fabae*. The scope for modifying the storage proteins and increasing their amounts in the seeds needs to be evaluated. Increased autofertility would reduce or avoid fluctuations in yield caused by the variable effectiveness of pollination by bees. Improved, more stable cytoplasmic male sterility would make the production of F_1 hybrid faba beans a practical possibility.

We have not attempted to provide a comprehensive reference list. The biology of the three crops, together with information on crop quality and pests and diseases, and the basic principles of plant breeding and of molecular biology are covered in many textbooks. Recent developments in the biology of the three crops are covered in reviews and conference proceedings, each of which contains a comprehensive reference list. A reading list which gives this information is given at the end of the book.

Statistics on production and consumption are generally for the ten European Community countries and have been taken from the Eurostat quarterly summary of crop production statistics, published by the Statistical Office of the European Communities, Luxembourg.

December 1985 R.B. Austin
R.B. Flavell, I.E. Henson, H.J.B. Lowe

ACKNOWLEDGEMENTS

We are indebted to numerous colleagues for their help with this book. Particular thanks are due to the plant breeders at the Plant Breeding Institute, J. Bingham, FRS, K.F. Thompson and D.A. Bond; to P.R. Day and P.I. Payne for their helpful suggestions on the applications of molecular biology; to R. Johnson, P.R. Scott and M.S. Wolfe for their guidance on the sections on diseases; and to A.R. Stone of Rothamsted Experimental Station for guidance on the sections on plant nematodes. Valuable comments were made on an early draft of the book by Dr B.J. Miflin of Rothamsted Experimental Station, Professor F. Quétier of the Université de Paris-Sud, Professor A. Rörsch of the Rijksunversiteit te Leiden and Professor D. von Wettstein of the Carlsberg Laboratory. The support and encouragement of the staff of the Division for Genetics and Biotechnology of the Commission of the European Communities is also gratefully acknowledged.

The care and patience of Mrs Karen Parr and Miss Sue Land, who typed the drafts of the study is gratefully acknowledged.