
Book Reviews

Biochemistry and Molecular Biology of Plant-Pathogen Interactions. Edited by C. J. SMITH. Clarendon Press, Oxford. 1991. 291 pages. £45.00. ISBN 0 19 857734 6.

Molecular biology, specifically recombinant DNA technology, has made a considerable impact in plant pathology, as in many other areas of biology. The ultimate question for plant pathologists is: what makes plants resistant to pathogens? The power of the molecular techniques is in their ability to assist in the detailed analysis of these interactions to provide answers to this question.

Plant disease is the result of the interaction between a host plant, a pathogen and their environment. Resistance to pathogens is common, occurring in plants to the majority of potential pathogens in non-host/pathogen combinations. Consequently it could be argued that it is disease susceptibility which is the unique feature of plant pathogenic interactions.

In order to feed, a pathogen must overcome both the passive and active defences of the host plant. To do so the pathogen must possess an array of characteristics enabling it to breach host cell walls and either avoid or detoxify any antimicrobial defence compounds that may be present. These features distinguish parasites from non-parasites and may be thought of as constituting basic compatibility; the minimum required for establishing a parasitic interaction. In addition, many plant-pathogen interactions also include a further degree of specificity in which the ability of the pathogen to infect and parasitize a particular host plant is controlled by complementary gene pairs in the host and pathogen. Genes for resistance in the host specifically interact with genes conditioning avirulence in the pathogen, triggering resistance expression. In this case susceptibility results from a lack of recognition of the pathogen by the host.

Plants continually need to repair damage caused by a wide range of biotic and abiotic factors. It should not therefore be strange that many of the responses involved are similar or identical to those induced in response to pathogen invasion. The search for elicitors of active resistance responses or for receptors and signal pathways involved in recognition and communication of the message must necessarily recognize

that plurality of function is probably a characteristic of the system.

Considerable research effort has been directed towards identifying compounds involved in the specific recognition of pathogens conditioned by the gene-for-gene system of resistance. The fact that so many of the potential candidates for elicitors and receptors so far identified have not subsequently been shown to have the necessary degree of specificity probably reflects the role of recognition in the expression of the general defence and wound-healing responses.

Most progress in applying molecular techniques to plant pathogenic organisms has been made with bacterial and viral pathogens, since the standard cloning, transformation and expression systems were initially developed with prokaryotes. In addition, these organisms have relatively small genomes, which greatly assists the identification of genes involved in host colonization and pathogenesis. In fungi, the lack of efficient transformation systems and the obligate biotrophic nature of some of the most specialized groups has meant that progress has been much slower. This apparent imbalance is reflected in the space dedicated to the main groups of pathogens in this book, with twelve of the seventeen chapters allotted to either viral or bacterial systems. It is pleasant, however, to find one chapter devoted to the often-neglected nematodes. In general each chapter is a lucid and concise appraisal of the state of research in each area. Crucially, gaps in our knowledge about the role of many of the proteins specifically expressed during host-pathogen interactions are not ignored.

The chapters on viruses cover control of cell-cell spread, genome organization and the effect of viral gene expression on the host plant. A particularly convenient aspect of some viral genomes is that they are split into several independent segments which can be individually isolated, mutated and remixed to establish roles for their respective genes. This is well illustrated in the work with alfalfa mosaic virus. As a non-virologist I confess to finding some difficulty in remembering all the abbreviations for virus names, and would have welcomed their being assembled in a footnote at the beginning of the relevant chapters. Research with phytopathogenic bacteria has concentrated on the biochemistry of the hypersensitive response, cloning of avirulence genes and the role of

extracellular enzymes and pathogenesis-related host proteins in the host–pathogen interaction. In fungi, changes connected with the hypersensitive response and phytoalexin accumulation have attracted much research interest, as they are readily identifiable events in incompatible host–pathogen interactions.

These subjects are discussed both in general terms and specifically in relation to recognition in incompatible species–species (non-host) interactions and in gene-for-gene interactions. Interestingly it is shown that in some instances some of the responses detected in incompatible interactions are probably irrelevant to the precise outcome of the interaction (e.g. synthesis of chitinase in response to *Phytophthora infestans* in potato leaves).

This is a fast-moving field, and so it is inevitable that books on this subject are out of date almost as they are published. Based on a symposium which took place in 1989, inevitably some of the material covered in this book will not give a full picture of the most recent advances. It is, however, a coherent and largely accessible account of the biochemical and genetic mechanisms underlying some of the best-characterized host–pathogen interactions. It will be of interest to scientists and postgraduate students working in this area. Get your library to save up for their copy now.

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Plant Breeding in the 1990s. Edited by H. T. STALKER and J. P. MURPHY. C.A.B. International, Wallingford, Oxon OX10 8DE, UK. 1992. 539 pages. Cloth £55.00, US\$104.00 (Americas only). ISBN 0 85198 717 6.

This book presents the edited papers and discussions (mainly question-and-answer sessions) from the international conference on plant breeding at Raleigh, North Carolina in March 1991. The main topics were: the gene base for plant breeding (six papers); modification of plants to tolerate environmental stress (four papers); modification of plants to tolerate stresses due to diseases and insects (three papers); contributions of biotechnology to plant improvement (four papers); and strategies for utilizing unadapted germplasm (two papers); followed by a symposium overview by Peter Day and a very detailed index. Each paper has its own extensive list of references.

An initial chapter by Kenneth Fry provides an excellent introduction to the many topics examined in the rest of the book. From 1960 to 1990 annual cereal grain production increased from about 800 million to nearly 2000 million tons, over 80% of this increase being due to increased annual crop yields. The technology represented by crop cultivars that have high yield potential, are well fitted to their production environments and possess resistance/tolerance to biotic and abiotic stresses, has made a major con-

tribution to this increased yield. Molecular biotechnology is beginning to be applied to further these yields in a number of ways – by somaclonal variation, *in vitro* selection and transformation, each followed by plant regeneration, and by RFLP mapping. These new methods have been taken up by major private companies, who must of course concentrate on crops with very large acreage or very high income per hectare, e.g. maize, soybeans, wheat, rice, tomatoes, sugar beet and truck crops. Other important crops such as oats, pecans, buckwheat, red clover and forage grasses will not support breeding programmes in private industry, and are nevertheless getting declining support from public funding. There is also a decline in training facilities for plant breeders, whose place in applied agriculture cannot be taken by the new crop of molecular geneticists – experienced plant breeders will obviously be essential for the very complex processes of breeding, comparative testing and saving of the new cultivars. These problems will become serious, particularly for the Third World, in the future.

T. T. Chang (in chapter 2) discusses another important problem – the future availability of plant germplasm for use in crop improvement. Ideally, the germplasm resources (PGR) for each crop should include wild relatives, weed races, landraces in areas of diversity, and earlier cultivars as well as improved germplasm; but there is of course argument as to the value of these resources, and maintaining them is both very expensive and very difficult. The major genebanks in different parts of the world (there were 39 in 1984 with long-term storage facilities), mostly suffer from severe shortage of funds and of experienced conservators, so that recording is often incomplete and genetic erosion occurs, particularly in the tropics.

Chapters (3) by Arnel Hallauer on genetic variation in cross-pollinated species, (4) by Baenziger and Peterson on genetic variation in self-pollinated species, (6) by R. W. Allard on predictive methods for germplasm identification and (7) by A. B. Maunder on identification of useful germplasm for practical plant-breeding programmes contain extensive analyses of past and present selection methods and progress on a variety of crops, and form a most valuable segment of this book. I can only refer to a few points from these chapters.

Allard's graph on page 120 shows annual U.S. corn (maize) yields in bushels per acre from 1866 (initially about 25), with almost no increase under open pollinated selection for 65 years, an average gain of 1.04 bushels per acre per year under double cross selection for 30 years from 1930, and even more rapid progress under single cross selection (1.8 bushels per acre per year) from the early 1960s to the present day. The implications are that selection methods improved in 1930 and 1960 and that there is no obvious loss of progress at the current level of 120 bushels per acre. Allard also quotes studies of changes in recognizable