

Book review

***Fusarium* head blight of wheat and barley.** Edited by Kurt J. Leonard and William R. Bushnell. 530 pp. APS Press, St Paul, Minnesota. US\$89.00. ISBN 0 89054 302 X.

Much of this edited volume, published in 2003, is written from a North American perspective. Hence, the emphasis is on *Fusarium graminearum* as the main causal agent, even though the editors acknowledge that *Fusarium* head blight (FHB) is not a simple disease and can be caused by several different species of the form genus *Fusarium* (together with *Microdochium nivale*). Infection of wheat and barley not only results in reduced yields, but also destroys grain quality by contaminating it with mycotoxins (see *European Journal of Plant Pathology* Special issue 'Mycotoxins in Plant Disease', Volume 108, No. 7, September 2002, also published as a book by Kluwer Academic Publishers, edited by A. Logrieco, J.A. Bailey, L. Corazza and B.M. Cooke).

The book contains 18 chapters which are grouped into six sections: history; the pathogen and disease development; mycotoxins; resistance; control and impact. It is bound in 6" × 9" hardback, contains 39 colour illustrations which are presented in six plates grouped together in Chapter 3, and 36 black and white illustrations. Each chapter contains a useful list of literature cited. Of the 28 chapter contributors, 20 originate from USA institutions, the remaining authors coming from Canada, Hungary, China, Brazil and Uruguay, Ákos Mesterházy from Szeged in Hungary being the only European contributor.

The book begins with a history of the disease (Chapter 1: Robert W. Stack) which is divided into four eras, that is, periods of time when knowledge about this disease went through certain changes, beginning in the 1880s and continuing to the present. The author states that the modern period of research on FHB in North America could be considered to have begun around 1980, coloured by detailed analytical methods for mycotoxins produced by the disease, the use of systemic fungicides for control and the development of molecular tools for resistance breeding. The chapter

also covers nomenclature, occurrence and importance, symptoms and signs and the causal pathogens together with disease cycles. Of particular note is the Section on pages 19 and 20 which details the high risks of infection in wheat after maize (corn). Chapter 2 (Craig M. Liddell) provides brief descriptions of all FHB pathogens including relationships based on current taxonomic concepts of the genus *Fusarium*. Table 1 in this chapter (morphological characters) contains rather poor illustrations of macroconidial shape and size which appear to be photographically derived rather than drawn illustrations. It is indeed unfortunate that on page 41, *M. nivale* is spelt twice incorrectly (yet on page 37 the correct spelling is used). In addition it is also stated that *M. nivale* produces a number of mycotoxins, a statement which is now contested by a number of workers. Chapter 3 (Wm R. Bushnell, Beth E. Hazen and Clara Pritsch) covers histology and physiology of infection and as an introduction to this topic gives an overview of the structure of the grass floret and caryopsis. This approach is useful for illustrating symptoms and signs, and the pathways of floret invasion; the colour plates contained in this chapter enhance this approach. The rest of the chapter is devoted to mechanisms of resistance. The authors correctly point out that beyond types 1 and 2 there is little international agreement on the numbers or letters used to designate resistance types. The epidemiology of FHB (Chapter 4: Gregory E. Shaner) is described in relation to the North America experience, and the re-emergence of the disease as a major problem is blamed on the coincidence of favourable weather conditions, coupled with inoculum supply and reduced tillage. Although this chapter covers monitoring and quantification of the disease, and the relationship of weather to epidemics, no apparent mention is made of current and recent work to develop forecasting models for FHB, although the need for such models is identified at the end of the chapter under 'needed research'. In Chapter 5 (Liane Rosewich Gale) population biology of FHB is discussed, a subject which is evolving through the use of molecular methodology and which is revealing patterns of genetic diversity and population structure. Basic knowledge in these areas, it is claimed, will help answer essential

questions about pathogen adaptability to new cropping practices or cultivars, as well as gene flow and inoculum spread. Of particular interest here is the debate on the degree of host specialisation in members of the FHB complex. Although generally it is agreed that these are non-host specific, the authors correctly identify recent studies on *F. graminearum* which demonstrate some level of host preference; other recent studies, not mentioned, also suggest host specialisation within the two varieties of *M. nivale*. Fungicide resistance in *F. graminearum* is also briefly mentioned in relation to the benzimidazoles, but it is pointed out that the genetic basis for this is still not understood.

Two chapters (Chapter 6: Chester J. Mirocha, Weiping Xie and Edson R. Filho; Chapter 7: Susan McCormick) deal with mycotoxins in grain infested by *Fusarium* species; Chapter 6 describes the chemistry and methods of detection of the trichothecenes and Chapter 7 outlines the biosynthesis of trichothecenes and describes their role in pathogenicity during FHB infection. Importantly, McCormick points out that experiments have now shown that DON (deoxynivalenol) is a virulence factor in FHB of wheat with the consequence that introducing genes for resistance to trichothecene toxins should reduce head blight severity. Chapters 15 (Paul B. Schwartz) and 16 (J.E. Dexter and T.W. Nowicki) further document the effects of mycotoxins on grain yield and quality. In Chapter 15, the author points out that the impact of FHB on malt and beer processing can be disastrous in both barley and wheat. The concerns associated with mycotoxin-contaminated grain are also related to risks for public health and the impact on processing performance and food product/feed quality. The problem of gushing in packaged beer made with infected grain is highlighted and effectively photographed, and the author also discusses the effects of such grain on livestock production. Quality and safety assurance issues associated with FHB in wheat are effectively dealt with in Chapter 16. In Chapter 17 (D. Demcy Johnson, George K. Flaskerud, Richard D. Taylor and Vidyashankara Satyanarayana) a thorough analysis of the economic impact of FHB in the USA is presented. The study is confined to nine states where heavy FHB outbreaks occurred in the 1990s, and three wheat classes are studied (soft red winter, hard red spring and durum). Closely related to the topics covered in Chapters 15–17 is the impact of FHB on social issues in rural America. In this chapter (18: Marcia McMullen), the author presents a most interesting account of the changes

brought about by FHB in the 1990s in North America in terms of the very real impacts it had on farmers and farm communities, on agricultural industries, on farming practices, on educational and research responses, on policy changes and on collaboration within the agricultural community.

Finally, the remaining chapters deal with disease control using resistance – Chapters 8 (Ruth Dill-Macky); 9 (Ákos Mesterházy); 10 (Brian J. Steffenson); 11 (Gui-Hua Bai, Li-Feng Chen and Gregory E. Shaner) and 12 (Gary J. Muehlbauer and Wm R. Bushnell), control by fungicides (13: Ákos Mesterházy) and biological approaches (14: Wilmar Corio da Luz, Christine A. Stockwell and Gary C. Bergstrom). In Chapter 8, inoculation methods and environmental effects on FHB development are considered, both important in resistance breeding, together with evaluation of resistance. On pages 197 and 198 the value of seedling tests for evaluating field reactions is briefly discussed, but no mention is made of recently published work using detached wheat leaves and *M. nivale* for predicting FHB resistance in whole plants by measuring components of partial disease resistance (PDR). The chapter continues with lists of media for isolation, culture and inoculum production of FHB pathogens. In Chapter 9 some duplication with Chapter 8 occurs, as inoculum preparation and inoculum techniques are again (briefly) mentioned; however, most attention is paid to mechanisms of active and passive resistance mechanisms. In Chapter 10, FHB of barley receives extensive attention, in the light of the re-emergence of the disease in economically important epidemics from 1993 to 2000 in the USA, caused primarily by changes in cropping practices, cultivation of susceptible cultivars and moist weather conditions during heading and grain filling. It is concluded that resistance is conferred by several genes with small effects scattered across the barley genome, and that QTLs for FHB reaction coincide with QTLs controlling various agronomic traits. In Chapter 11, breeding for resistance to FHB in China is considered and resistant wheat cultivars Sumai 3 and Ning 7840 are recognized as the best resistance sources in the world; however, combining desired agronomic traits with high degrees of resistance is still difficult. The authors point out that as most resistant cultivars use as their resistance source Sumai 3, genetic homogeneity for FHB resistance may result with consequent genetic vulnerability if the pathogen can adapt to this single resistance source. The potential applications

of biotechnology to genetically engineered novel forms of resistance to supplement resistance naturally available in wheat and barley and their wild relatives is covered in Chapter 12. The chapter explores the prospects for identifying genes that will provide more effective resistance to FHB and the use of transformation technology to introduce them into wheat and barley; this is particularly important because resistance in available germplasm has not provided adequate protection and is difficult to incorporate.

Use of fungicides for control of FHB is considered in Chapter 13. The author points out, correctly, that the use of fungicides to supplement the low levels of genetic resistance to FHB is essential; however fungicides have had mixed success and in most cases control achieved was inadequate, for the various reasons described. The author concludes, with some justification, that the active ingredient tebuconazole showed the best control of FHB pathogens, with the exception of *M. nivale*; although not specifically mentioned here, this differential effect may help to explain the reported observations of fungicide treatments apparently increasing rather than decreasing FHB, which must be assumed to be due to competitive effects between members of the FHB complex. The converse effect of controlling *M. nivale* only could lead to the false conclusion that some fungicides increase mycotoxin levels. In Chapter 14, the prospects for biological control playing a role in the integrated management of FHB is considered. The chapter considers microbial antagonists screened and the strategy of biological intervention in the fungal life-cycle (spikelet infection,

systemic movement of the pathogen, seedling blight development, survival of the fungus in debris or ascospore production and discharge). Induced resistance is discussed as a possible biocontrol mechanism along with mycoparasitism competition, antibiosis and inhibition of mycotoxin production. A recent publication in 2003 which would not have been available as this book went to press reported that cell-free germination fluids of three FHB pathogens reduced significantly disease development and severity suggesting the potential of different members of the FHB complex to affect the pathogenicity of each other, either through polygenically controlled induced resistance and/or the stimulation of phytoalexins by polysaccharides contained in the spore germination fluids used.

In conclusion, I found this book to be a useful text for those researching on the FHB complex. Although published in 2003, some parts of the text are incomplete or inaccurate as identified in this review; this illustrates the speed with which FHB research is progressing. The major criticism of this text is that it is biased towards the North America situation; however, the book should still prove useful to the international scientific community working on the FHB problem.

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