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Editorial

Many economically important diseases of barley and wheat are caused by plant pathogens which are spread by airborne spores, e.g., *Blumeria graminis* (powdery mildews) and *Puccinia striiformis*, *P. hordei* and *P. recondita* (rusts). An increasing public demand for a reduction in the use of pesticides, together with farmers' need to reduce the costs of growing cereal crops, has given increased emphasis to breeding programmes which aim at improving the resistance of barley and wheat to such diseases. However, whenever a new resistant variety is grown over a large area, the pathogen population may adapt in such a way that the resistance becomes ineffective. This process is a constant challenge for breeders, advisors and farmers.

The speed of pathogen adaptation depends among other things on the mechanisms of resistance, the fitness characteristics of the virulent pathotypes (epidemiological parameters), the strategic use of the resistance genes (the cropping system), and the mode of dispersal of fungal spores. Resistance mechanisms may be classified into two main groups, race-specific resistance and partial resistance. The race-specific/hypersensitive type of resistance, which often does not allow the pathogen to reproduce at all, is usually governed by a small number of genes with large effects. This type of resistance may be crossed into new varieties within a few years of being discovered in exotic plant material. Unfortunately, pathogen populations often adapt quickly to varieties with this type of resistance due to strong selection for virulent genotypes. In contrast, partial resistance influences in a quantitative way the growth and reproduction of the pathogen, and may be characterised by decreased infection frequency, longer latent period, lower spore production or shorter infectious period. A variety expressing this type of resistance may become diseased, but the disease development is often delayed and there may be relatively little effect on yield. Partial resistance is often inherited in a more complex way by interaction of many genes with smaller effects. Furthermore, the genetic variation in the pathogen population with respect to virulence corresponding to this type of resistance is expected to be narrow, and pathogen adaptation is accordingly much slower.

As spores of airborne plant pathogens may spread across large distances, from one country to the other, it is important for farmers and plant breeders to get access to knowledge about the composition of the pathogen populations on an international scale. Furthermore, detailed understanding of the processes of spore dispersal and evolution of virulence will help in designing more efficient strategies for breeding and disease control. Information about virulence frequencies, in particular when new virulent pathotypes appear, as well as distribution of resistance genes throughout Europe, is important for predicting the actual changes in the pathogen populations and the corresponding 'breakdown' of resistance. National efforts from different European countries were brought together with the aim of improving integrated strategies for use of resistance genes and fungicides to control cereal diseases. Different disciplines (genetics, breeding, pathology and population biology) were involved in a European Network within the COST (European Cooperation in the Field of Scientific and Technical Research) Framework: "COST Action 817 on Population studies of airborne pathogens on cereals as a means of improving strategies for disease control, 1993–1999".

In this special issue, the actual situation in Europe with respect to host resistance and pathogen virulence is analysed, and future prospects for cereal resistance breeding are examined. Effects of biotic and abiotic factors on epidemiological parameters, mechanisms for dispersal of wheat rust spores, and use of cereal variety and species mixtures in practice, respectively, are discussed in detail. Finally, a review on *mlo*-resistance (a single-gene inherited partial resistance in barley against powdery mildew) completes the description of most of the research carried out.

In conclusion, much genetic variation for resistance to powdery mildews and rusts is found in barley and wheat, and new sources of resistance are being exploited. Despite the adaptation of pathogen populations to new host varieties, resistance is a very useful and sustainable method for controlling disease, especially when using diversification strategies for resistance genes such as pyramiding genes in varieties and mixing varieties within and between fields. The increasing knowledge about host-pathogen interactions is being applied to make breeding programmes and disease management more efficient. However, a "forever-clean crop" without disease is not expected in any cropping system. Even by using the most modern technology in agriculture, we can never escape the dynamic processes of plant pathogen populations as they are exposed to their host.

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Hanne Østergård, Chairperson COST 817