Plant Breeding **120**, 279—284 (2001)

ISSN 0179-9541

Assessment of partial resistance to powdery mildew in Chinese wheat varieties

D. Z. Yu[1], X. J. Yang[1], L. J. Yang[1], M. J. Jeger[2,4] and J. K. M. Brown[3,5]

[1] Plant Protection Institute, Hubei Academy of Agricultural Sciences, 430064, Wuchang, Wuhan, China; [2] Phytopathology Department, Wageningen University and Research Centre, Binnenhaven 9, NL–6709 PD, Wageningen, The Netherlands; [3] John Innes Centre, Colney, Norwich, NR4 7UH, UK. E-mail: james.brown@bbsrc.ac.uk; [4] Current address: Department of Agriculture and Horticulture, Imperial College, University of London, Wye, Ashford, Kent, TN25 5AH, UK; [5] Corresponding author

With 4 figures and 3 tables

Received April 17, 2000/Accepted December 28, 2000
Communicated by R. A. McIntosh

Abstract

Field trials in two cropping seasons and two locations in central China were conducted on 60 Chinese autumn-sown wheat varieties to assess their partial resistance to powdery mildew. Mean levels of disease severity ranged from close to 0 to more than 90%. The method of inoculation and the location in which trials were conducted affected the relative performance of the varieties, but these effects were much smaller than the main effect of variety. The area under the disease progress curve was highly correlated with final disease severity, but both were poorly correlated with apparent infection rate. Disease severity was regressed against frequencies of virulence in the *Blumeria graminis* (syn. *Erysiphe graminis*) f. sp. *tritici* populations in the trial plots. A vertical distance (D) from the mean mildew severity to the fitted line was calculated for each variety and was used to quantify partial resistance. Five of the 60 varieties, 'Hx8541', 'E28547', 'Chuan1066', 'Zhe88pin6' and 'Lin5064', consistently expressed relatively low levels of disease despite high frequencies of virulence in the pathogen and had consistently high D-values. They may therefore have good levels of partial resistance.

Key words: *Triticum aestivum* — *Blumeria graminis* f. sp. *tritici* — AUDPC — disease index — partial resistance

Plant resistance is one of the most important methods of controlling disease. Race-specific resistance genes, following the gene-for-gene relationship, have been used extensively in breeding, but only one mutation is generally needed for a pathogen to change from avirulence to virulence. Thus, race-specific resistance is readily overcome by matching virulent pathotypes when varieties containing these resistances are used on a large scale for a sufficient length of time. To prolong the effectiveness of specific resistance, several methods, such as 'pyramiding', i.e. combining several resistance genes into a variety (Vanderplank 1968), multilines (Browning and Frey 1969, Kølster et al. 1989) and cultivar mixtures (Wolfe and Barrett 1977, Wolfe 1985) have been proposed or used.

Another type of resistance, partial resistance, is characterized by a compatible interaction in all growth stages, but a lower infection frequency, a longer latent period, or a lower rate or a shorter period of spore production (Parlevliet and van Ommeren 1975, Kranz 1983). Partial resistance has provided durable control of powdery mildew (*Blumeria graminis*, syn. *Erysiphe graminis*) in wheat (Shaner 1973), barley (Jones and Davies 1985) and oats (Jones and Hayes 1971).

Wheat powdery mildew (*B. graminis* f. sp. *tritici*) was a minor disease in China before the 1970s in terms of the proportion of the area affected and the frequency of epidemics, only causing yield losses occasionally in the south-west plateau of China (Tao et al. 1982, Liu 1989). Since the early 1980s, however, it has become a serious disease because of changes in methods of wheat cultivation, notably higher inputs of nitrogen fertilizer, expansion of the irrigated area and a shift of varieties from those of tall stature to semi-dwarf cultivars. These changes improved yields, but also caused favourable conditions for powdery mildew. For example, semi-dwarf varieties allow denser plant populations to be grown and this high density provides favourable conditions for the powdery mildew fungus (Bennett 1984).

Since the early 1980s, through the efforts of breeders and phytopathologists, several mildew-resistant varieties have been released, intentionally or otherwise, for commercial production in China (Xia et al. 1995, Huang et al. 1997, Yu 2000). However, these varieties became susceptible to mildew when they were grown over a large area after 4 or 5 years (Yu 2000), as in other countries (Wolfe 1984, Bennett 1984, Brown 1994). Hubei province has experienced such a situation. When the high-yielding wheat variety 'E'an1' was released in 1984, it was highly resistant to mildew in the field (Gan 1985). Five years after its release, the area sown with 'E'an1' reached about 800 000 hectares in Hubei and neighbouring provinces (Anonymous 1990) and it became susceptible to mildew, probably because of changes in the pathogen population structure. In 1989, when weather conditions were favourable for mildew, the disease caused an estimated yield loss of 500 000 t (about 20% of total yield) in 'E'an1' alone. Suitable varieties to replace 'E'an1' were not available to farmers because progress in breeding was not sufficiently rapid to meet demand.

Although identified specific resistance genes are available for breeding, this situation would arise again if lessons were not learned from this experience. China has a vast cultivated area of wheat and many diverse varieties, but little attention has been paid so far to investigating durability of resistance to mildew. The objective of this study was to assess partial resistance to mildew in autumn-sown wheat varieties grown in central China.

Materials and Methods

Field trials: Sixty commercial varieties and breeding lines of wheat, *Triticum aestivum* L., (Table 1) were collected from parts of China where wheat is sown in autumn, especially along the Yangtze River

