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Resistance of wheat to septoria tritici blotch (*Mycosphaerella graminicola*) and associations with plant ideotype and the 1BL–1RS translocation

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Septoria tritici blotch (STB) is a major disease of wheat, reaching epidemic proportions in many parts of the world. In several studies, taller, later-maturing cultivars have had lower disease levels. This study was undertaken to investigate the genetic associations of natural field infection by STB with disease-escape mechanisms related to heading date and height components, mainly leaf spacing, in a population where height and maturity are not controlled by major genes. In field trials of a single seed-descent population of a cross between two nonsemi-dwarf cultivars, Apollo (with strong partial resistance to STB) and Thésée (susceptible), conducted over 3 years, there was a negative correlation between STB and heading date. There was no correlation between STB and distance from stem base to leaf 2; and there was an unexpected positive correlation between STB and distance from flag leaf to leaf 2, which contradicted the so-called 'ladder effect' postulated in STB epidemiology. No effect was detected of the presence of the 1BL–1RS translocation on STB levels. The largest single contributor to variation in STB levels was genetic variation between the progeny lines, and the narrow-sense heritability was 42%. These results suggest that breeders can select for STB resistance alongside optimal stature within the range of height which is adaptive in a particular environment.

Keywords: 1BL–1RS translocation, genetics of resistance, *Mycosphaerella graminicola*, plant ideotype, septoria tritici blotch, wheat

Introduction

In recent years, septoria tritici blotch (STB), caused by *Mycosphaerella graminicola* (anamorph *Septoria tritici*), has been recognized as having a major impact on wheat yields (Hardwick *et al.*, 2001; Goodwin *et al.*, 2003), especially when it is severe on flag and second leaves (Shaw & Royle, 1989; Thomas *et al.*, 1989). This has coincided with the widespread replacement of late-maturing, tall, local wheat cultivars by early-maturing, semidwarf, high-yielding cultivars in intensive agriculture. In the UK, annual losses are estimated at *c.* 330 kt (Cook, 1999) despite the use of fungicides on over 95% of wheat crops (Cook, 1999; Hardwick *et al.*, 2001; Pillinger *et al.*, 2004).

There have been many reports of increased STB severity in earlier-heading and shorter cultivars, in some of which the effects on STB of heading date (HD) and height were analysed genetically (Rosielle & Brown, 1979; Eyal, 1981; Danon *et al.*, 1982; Baltazar *et al.*, 1990; Jlibene *et al.*, 1992; Camacho-Casas *et al.*, 1995; Chartrain *et al.*, 2004; Simón *et al.*, 2004). These studies varied greatly in the methods used for disease trialling and assessment, and some of the material tested by these authors segregated for either dwarfing genes (*Rht*), genes for insensitivity to photoperiod (*Ppd*), or genes for vernalization requirement (*Vrn*) (Rosielle & Brown, 1979; Danon *et al.*, 1982; Baltazar *et al.*, 1990; Camacho-Casas *et al.*, 1995; Simón *et al.*, 2004).

Arama *et al.* (1999) concluded that the association between early leaf emergence and disease severity was phenotypic, and that earliness in itself could increase disease levels observed because, at any one time of scoring, disease has had more time to develop on leaves that emerged earlier. It was proposed that resistance in a range of cultivars can be assessed reliably only if disease severity is measured at the same stage of plant development, not at the same point in time (Arama *et al.*, 1999). However, this is generally not practicable in a commercial breeding programme. It is therefore important to assess the effect of plant development on disease levels so that breeders and

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