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Short communication

Disease levels in winter wheat, rye and triticale grown on soil artificially inoculated with *Cephalosporium gramineum*

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Abstract

Field experiments with winter cereals grown on soil inoculated with *C. gramineum* showed that wheat and rye cultivars possess some resistance to the pathogen, while the triticale cultivars were the most susceptible. Higher tolerance of the tested wheat cultivars was connected mainly with slow development of disease symptoms; rye cultivars had, on average, lower percentages of plants infected by *C. gramineum*. The greatest variation in susceptibility to *C. gramineum* occurred among the selected cultivars of triticale.

Cephalosporium stripe is a vascular disease of cereals caused by the soilborne fungal pathogen, *Cephalosporium gramineum* Nisikado et Ikata [syn. *Hymenula cerealis* Ell. Ev.]. This disease can cause serious yield losses in winter cereals grown in a continuous cropping system or in short rotations [Mathre and Johnson, 1975; Bockus and Sim IV, 1982]. In Europe Cephalosporium stripe disease occurs in Germany, Italy, The Netherlands, and the UK but most research on this disease has been done in the United States, particularly with respect to its effect on winter wheat [Hawksworth and Waller, 1976; Mathre and Johnston, 1975; Murray, 1988]. Mathre *et al.* [1977] tested over 1000 winter wheat genotypes for susceptibility to *C. gramineum*. Most genotypes were highly susceptible but some were moderately resistant to this pathogen. No such information is available for winter triticale and rye which are important crops in Poland and elsewhere [Mazurek and Mazurek, 1990]. In Poland Cephalosporium stripe disease was first found in 1988 on winter triticale and rye, and a preliminary pot experiment indicated substantial differences in susceptibility of winter cereals to *C. gramineum* [Martyniuk, 1993]. The experiments reported here were carried out under field conditions on soil inoculated with *C. gramineum* and were designed to compare susceptibility of three winter cereals, wheat, rye and triticale, to Cephalosporium stripe disease.

The experiments, during the 1988/89, 19889/90 and 1991/92 growing seasons, were sited in a field (with brown soil, pH 6.7; 1% org. C; 51% sand; 31% silt and 18% clay) which had not been cultivated to cereals for 2 years and was not infested with *C. gramineum*. The soil was fertilized with NPK according to general recommendations for cereals. The experiments were established in a split-plot design with *C. gramineum* inoculated plants and uninoculated controls as the main plots replicated 4 times. Oat kernels inoculum of *C. gramineum* [Mathre and Johnston, 1975] was applied to the soil surface at the rate of 100 g m^{-2}, unless otherwise stated, and incorporated to a depth 4–5 cm by soil raking. The subplots of cultivars and lines consisted of three 1 m rows spaced 11 cm apart and seeded by hand with 30 cereal seeds. Cultivars and lines of triticale, wheat and rye were selected for their importance in Poland (Table 1). At growth stage (GS) 10.5.4. (Feekes' scale) one row of each cereal was pulled out and the incidence of Cephalosporium stripe was recorded as the percentage of plants infected (striped and blighted plants) and the

Fig. 1. Uninfected (right) and *C. gramineum* infected (left) plants of winter wheat when analysed at growth stage 10.5.4. of the Feekes' scale.

percentage of plants killed by the pathogen. Numbers of white heads per 1 m row of winter wheats were counted 4 and 5 weeks after heading. Tukey's test was used to separate means after arcsin transformation of percentage data.

The highest number of plants infected by *Cephalosporium gramineum* was found in 1988/89 and the lowest in 1989/90 (Table 1). Disease incidence in 1989/90 was probably low because the *C. gramineum* inoculum added to the soil was adjusted to one-half of that in 1988/89. This was done because of high disease severity in the 1989/90 growing season. However, the winter of the 1989/90 growing season was mild and apparently not conducive to the disease. In each season the mean percentage of infected plants was highest in triticale; values for wheat and rye were lower and cultivars and lines within these cereals generally did not differ significantly with respect to their resistance to *C. gramineum*. Differences between triticale cultivars were more substantial; Largo and Grado were usually most susceptible with the infection level reaching 74% and 69%, respectively, in the 1988/89 growing season. Of the selected triticale cultivars, Malno had the lowest numbers of plants infected by *C. gramineum* in all growing seasons.

Differences in susceptibility of the winter cereals were more pronounced in the data for plants killed prematurely by the pathogen. While about 22% of triticale plants and 13% of rye plants (average for the 1988/89 and 1991/92 seasons) had already been killed GS 10.5.4., none of the infected wheat plants was dead by this stage of plant development (Table 1). These differences are shown in detail on Figs. 1 and 2. Many infected triticale plants had already been destroyed at early tillering or shortly after heading, while all infected wheat plants had stripes on their leaves but were still alive. White heads in winter wheats were found to appear 4–5 weeks after heading. The results of our field experiments indicate that though none of the examined cereal species is immune to *C. gramineum*, winter wheat and rye possess more resistance than triticale. The higher resistance of the winter wheats was manifested by a slower rate of symptom development. Higher resistance of winter rye was expressed as a generally lower percentage of plants undergoing infection, though infected plants were usually severely diseased.

To the authors' knowledge, the susceptibility of winter cereals to Cephalosporium stripe has not previously been compared. Two types of resistance were described by Morton and Mathre [1980] within winter wheat cultivars as pathogen restriction and pathogen exclusion. Since both types of resistance were expressed independently in some wheat geno-

Fig. 2. Uninfected (extreme right) and *C. gramineum* infected plants of winter triticale when analysed at growth stage 10.5.4. of the Feekes' scale.

types, Morton and Mathre [1980] suggested that attempts should be made to combine these two types of resistance to produce a genotype with maximum resistance to *C. gramineum*. It seems, however, that this combination has not been achieved with triticale, at least as far as the cultivars tested here are concerned.

Table 1. Disease severity in winter cereals grown in the field on soil inoculated with *Cephalosporium gramineum* during 1988/89, 1989/90 and 1991/92. The percentages (mean of 4 replicates) of infected and dead plants in 1 m rows were analysed at growth stage 10.5.4. of the Feekes' scale

Cereals	Infected plants (%)			Dead plants (%)		
	1988/89	1989/90	1991/92	1988/89	1989/90	1991/92
Triticale:						
Dagro	47.5a*	2.1a	43.0bc	14.3a	0	21.4ab
Grado	69.0b	3.3a	48.0c	24.2b	0	33.3c
Largo	73.6b	4.2b	32.2b	28.2b	0	13.3a
Malno	38.0a	1.3a	17.8a	12.6a	0	12.5a
Presto	56.0ab	3.2b	37.3b	33.3b	0	27.6bc
Mean	56.8	2.8	35.7	22.3	0	21.6
Wheat:						
Alba	50.8a	2.1a	22.8a	0	0	0
Delta	47.6a	2.1a	28.5ab	0	0	0
Emika	43.8a	1.7a	22.0a	0	0	0
Parada	nt	1.7a	38.3b	0	0	0
Rada	nt	1.3a	26.4a	0	0	0
Mean	47.4	1.8	27.6	0	0	0
Rye:						
Dankowskie N.	37.2a	1.7a	20.7a	11.1a	0	13.3a
IEC-K	30.7a	2.1a	20.1a	7.7	0	11.9a
Motto	nt	1.7a	25.2a	nt	0	20.5a
SMH-102	nt	2.1a	22.5a	nt	0	15.2a
SMH-104	nt	2.1a	25.6a	nt	0	19.1a
Mean	34.0	1.9	22.8	9.4	0	16.0

* Numbers followed by the same letter do not differ significantly within each cereal species according to Tukey's test ($p \leq 0.05$).

According to our results winter triticale appeared to be more susceptible to *C. gramineum* than its parental species since it had a high percentage (generally higher than wheat and rye) of plants undergoing infection, with many infected plants being quickly killed by the pathogen. More research is needed to explain the differences in susceptibility of winter cereals to Cephalosporium stripe, and subsequently to improve the resistance of cereals, particularly that of winter triticale, to *C. gramineum*. However, marked differences in susceptibility to this pathogen found among the tested cultivars of triticale suggest that selection of relatively tolerant lines of this new cereal is possible.

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