Infection of species of the Gramineae by *Erysiphe graminis* f. sp. *hordei* and *Erysiphe graminis* f. sp. *tritici*

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The ability of 19 isolates of *Erysiphe graminis* f. sp. *hordei (Egh)* and 34 isolates of *E. graminis* f. sp. *tritici* (*Egt*) to infect cultivated and wild species of Gramineae common to southern Ontario was examined. A high level of parasitic specialization of *Egh* was demonstrated by the failure of these isolates to infect any of the 22 species of Gramineae tested, except barley. In contrast, isolates of *Egt* were observed to infect wheat, meadow brome and downy brome. We suggest that these alternative hosts of *Egt* may act as oversummering reservoirs of inoculum for infection of fall sown winter wheat, as well as sources of some of the genetic variability found in the natural populations of the wheat pathogen in southern Ontario.

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On a examine la capacite de 19 souches de *Erysiphe graminis* f. sp. *hordei (Egh)* et de 34 souches de *E. graminis* f. sp. *tritici* (*Egt*) d'attaquer des especes cultivées et sauvages de graminées que l'on trouve couramment dans le sud de l'Ontario. On a de plus démontré un haut degre de spécialisation parasitique de *Egt*, car les souches de cette forme n'ont pu attaquer les 22 espèces de graminees eprouvees, à l'exception de l'orge. En revanche, les souches de *Egt* ont infeste le ble, le brome des pres et le brome des toits. Nous pensons que ces hôtes substituts de Egt servent a conserver pendant l'été des souches qui infecteront a l'automne les semis de ble d'hiver et qu'ils sont aussi à l'origine d'une certaine variabilite génétique de l'agent pathogene du ble observee dans les populations naturelles du sud de l'ontario.

Introduction

Surveys of the virulence spectra of *Erysiphe graminis* f. sp. *hordei* (*Egh*) and *E. graminis* f. sp. *tritici* (*Egt*) have indicated that natural populations of these pathogens in southern Ontario possess a wide range of genetic variability (Bailey and MacNeill, 1983; Menzies and MacNeil, 1986; Louter *et al.*, 1987; Menzies *et al.*, 1989). Possibly, the presence of known genes for resistance in commercial cultivars of barley (Martens *et al.*, 1984) is a source of some of the genetic variability of natural populations of *Egh* through the selection of certain genes for virulence. However, not all the genetic variability observed in natural populations of *Egh* in southern Ontario can be explained in this way. Commercial cultivars of wheat used in southern Ontario do not possess any of the known *Pm* genes for resistance to *Egt* (Martens *et* al., 1984) that might account for the spectrum of virulence in the natural population of the latter pathogen.

The possibility that genetic variability in a pathogen population may be due to selection pressure exerted by alternative hosts rather than the "preferred host" should be examined. Eshed and Wahl (1970) in Israel have demonstrated that both *Egh* and *Egt* enjoy a host range within the family Gramineae that is wider than the *forma* specialis designations would suggest. Fall infection of wild grasses in Israel by ascospores of *Egt* liberated from cleistothecia which have ovesummered on wheat stubble have been observed by Eshed and Wahl (1975). Colonies of Egt on wild grasses act as foci from which conidia are disseminated to cultivated wheat crops throughout

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Table 1. Species of Gramineae tested for compatibility with *Erysiphe graminis* f. sp. *tritici* and *Erysiphe graminis* f. sp. *hordei.*

Scientific Name	Common Name
Agrostis palustris Huds.	Creeping Bentgrass
Alopecurus pratensis L.	Meadow Foxtail
Avena fatua L.	Wild Oats
Avena sativa L.	Oats
Bromus biebersteinii Roem. Schult.	Meadow Bromegrass
Bromus inermus Leyss.	Smooth Bromegrass
Bromus tectorum L.	Downy Brome (Chess)
Dactylis glomerata L.	Orchard Grass
Digitaria ischaemum (Schreb.) Muhl.	Smooth Crabgrass
Digitaria sanguinalis (L.) Scop.	Hairy Crabgrass
Echinochloa crusgalli (L.) Beauv.	Barnyard Grass
Festuca rubra L.	Creeping Red Fescue
Hordeum vulgare L.	Barley
Lolium perenne L.	Perennial Ryegrass
Panicum capillare L.	Witch Grass
Panicum miliaceum L.	Proso Millet
Phalaris arundinacea L.	Reed Canary Grass
Phleum pratense L.	Timothy
Poa pratensis L.	Kentucky Bluegrass
Setaria glauca (L.) Beauv.	Yellow Foxtail
Setaria viridis (L.) Beauv.	Green Foxtail
Triticum aestivum L.	Wheat

Table 2. The compatibility *of* isolates of ***Erysiphe graminis*** f. sp. ***hordei*** and ***Erysiphe graminis*** f. sp. ***tritici*** inoculated to different species of Gramineae commonly found in southern Ontario.

	Egh[+]		Egt[†]	
Gramineae Species	Number of inoculated isolates	Number of compatible isolates	Number of inoculated isolates	Number of compatible isolates
Wheat (cv Augusta)	13	0	32	32
Barley (cv Bonanza)	19	19	22	0
Creeping Bentgrass	9	0	18	0
Coated Meadow Foxtail	9	0	17	0
Wild Oats	9	0	19	0
Domesticated Oats	10	0	18	0
Meadow Brome	9	0	27	10
Smooth Brome	9	0	23	0
Downy Brome	5	0	18	4
Orchard Grass	9	0	17	0
Smooth Crabgrass	15	0	34	0
Hairy Crabgrass	9	0	18	0
Barnyard Grass	9	0	15	0
Creeping Red Fescue	9	0	17	0
Perennial Ryegrass	9	0	21	0
Witch Grass	10	0	16	0
Proso Millet	5	0	18	0
Canary Grass	9	0	17	0
Timothy	9	0	18	0
Kentucky Bluegrass	10	0	22	0
Yellow Foxtail	9	0	14	0
Green Foxtail	7	0	10	0

'***Erysiphe graminis*** f.sp. ***hordei***
[†]***Erysiphe graminis*** f. sp. ***tritici***

the growing season. In Israel, wild grasses infected by ***fgh*** and ***fgt*** bridge the gap between the different growing seasons for wheat, and may also be selecting for genetic variability in the two ***formae speciales*** involved.

In the present study the ability of ***Egh*** and ***fgt to*** infect cultivated and wild species of gramineae common to southern Ontario was examined.

Materials and Methods

Twenty two species of the Gramineae (Table 1) were tested for their receptivity to various isolates of ***Egh*** and ***fgt.*** The plants represented cultivated and weedy grass species common to southern Ontario. Five to 10 seeds of each grass were sown separately in 10 cm plastic pots and grown for 14 days in a growth room at 20 ± 1°C and 14-h photoperiod.

Nineteen isolates of ***fgh*** were used in these experiments and were derived from single colonies collected from various regions of southern Ontario in 1986 (Louter ***et al.***, 1987) and 1987. Thirty-four isolates of ***fgt*** were used and derived from monoconidial and single colony isolates collected from various regions of southern Ontario during 1981 to 1987 (Bailey and MacNeill, 1983; Menzies and MacNeill, 1986; Menzies ***et al.***, 1989). Inoculum of the isolates of both ***Egh*** and ***Egt*** was obtained by the inoculation of the individual isolates of ***fgh*** onto a 10-day old plant of barley (cv Bonanza) and of ***fgt*** onto a 10-day old plant of wheat (cv Augusta); 8 days later approximately 5 mg of conidia of either an isolate of ***Egh*** or an isolate of fgt was used to inoculate the different species of Gramineae. The inoculum was applied in a settling tower (Eyal ***et al.***, 1968), the plants were capped with glass chimneys (Bailey and MacNeill, 1983), then incubated in a growth room for ***8*** days at 20 ± 1°C and a 14-h photoperiod. After 8 days, the plants were assessed for the presence or absence of colonies of ***E. graminis.*** Included in each set of inoculations of the different species of Gramineae was the barley cultivar Bonanza for ***fgh*** and the wheat cultivar Augusta for ***Egt***. These plants acted as controls to ensure that conditions were favourable for infection by the powdery mildew isolates.

Results and Discussion

A high level of parasitic specialization of ***Egh*** in southern Ontario was demonstrated by the failure of isolates of ***fgh*** to infect any of the species of Gramineae tested except barley

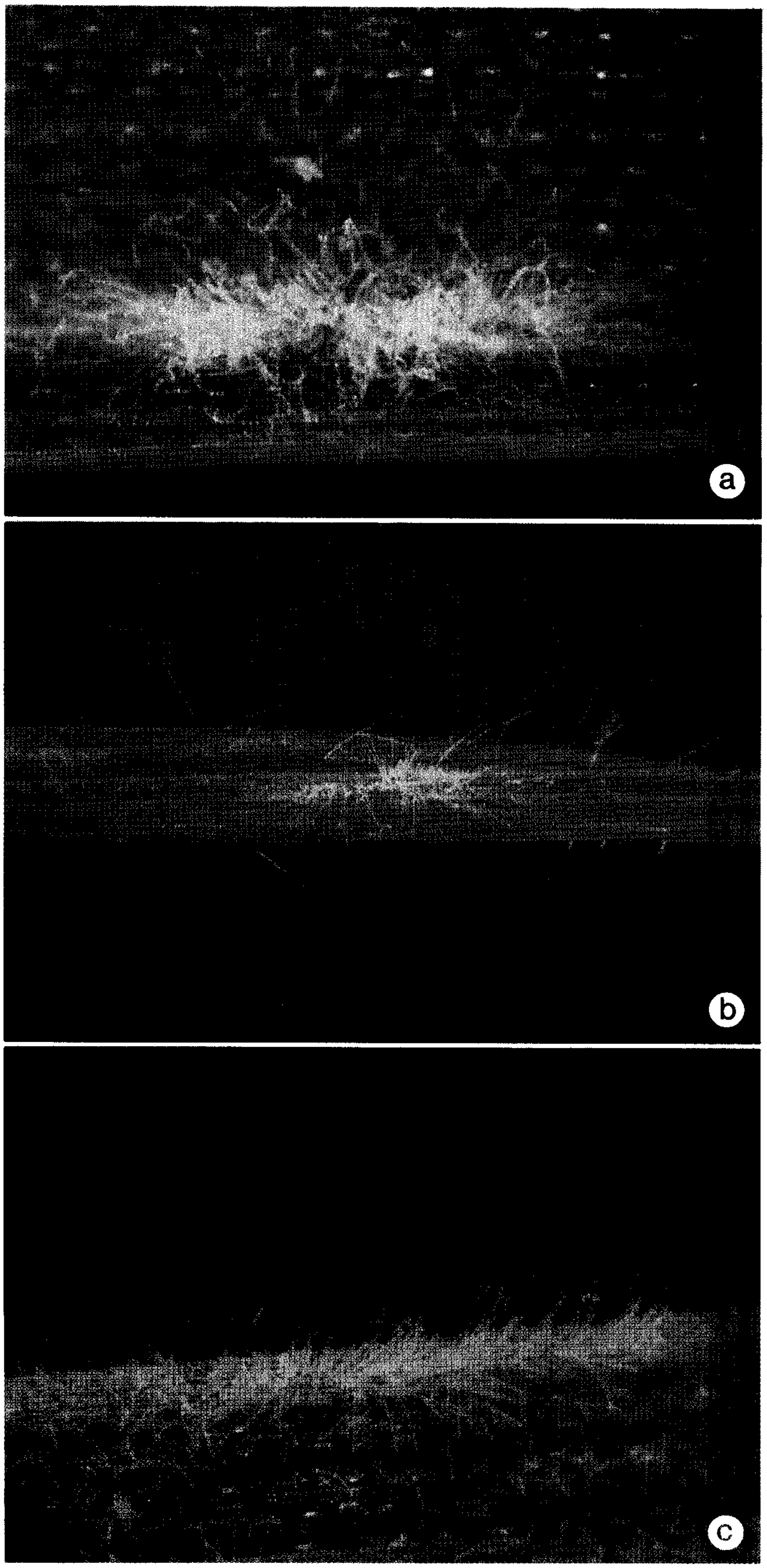

Figure 1. Colonies of *Erysiphe graminis* f. sp. *tritici* on; a) winter wheat; b) meadow brome; c) downy brome.

(Table 2). In Israel, Eshed and Wahl (1970) observed Egh on a wide spectrum of native grasses, and artificially infected 18 of 60 genera of Gramineae. Unlike our experiments, they observed compatible relationships between their isolates of Egh and downy brome. The differences between the results of Eshed and Wahl (1970) and ours may be due to different selection pressures within the natural population of Egh in the two different regions. The Mediterranean region is known to be the centre of origin and diversification of some of the progenitors of barley and wheat (Eshed and Wahl 1970). Greater diversity of host genotypes in the Mediterranean region as compared to southern Ontario may result in selection pressure leading to a broader spectrum of genotypes in the natural population of Erysiphe graminis in the former region.

Erysiphe graminis f. sp. *tritici* was not observed to be as host specific as Egh in southern Ontario; isolates of Egt infected wheat, meadow brome and downy brome (Table 2, Figure 1). Infection of downy brome by Egt has also been reported in Israel (Eshed and Wahl, 1970), but meadow brome was not tested in their trials. In the present study, cultures of Erysiphe graminis observed on plants of meadow brome and downy brome were confirmed as *Egt* by re-inoculation to wheat (cv Augusta).

The presence of alternative hosts for *Egt* in southern Ontario presents the possibility of another source of selection pressure leading to genetic variability. Pressure exerted by downy brome and meadow brome may explain the common occurrence of certain genes for virulence (*p*Ma, *p*3c and *p*4) in southern Ontario (Bailey and MacNeill, 1983; Menzies and MacNeill, 1986; Menzies et *al.*, 1989). Certainly the role of such alternative hosts in contributing to greater variability of *Egt* needs to be examined.

Additionally, the fact the Egt infects downy brome and meadow brome in southern Ontario may also allow the pathogen to use these hosts as oversummering reservoirs of inoculum. The cleistothecia of *Egt* have been postulated to be the oversummering state of the pathogen in Canada (Cherewick, 1944). Menzies (1986) in 1984 and 1985 observed the maturation of cleistothecia of Egt in late July with ascospores being ejected in August, September and to a lesser extent in October. Ascospore ejection occurred, however, during periods when winter wheat was not being grown in southern Ontario. That is, between the harvest of the winter crop and the autumn planting of the next crop. Eshed and Wahl (1975) have suggested that in Israel, ascospore inoculum is important in infection of wild grasses, leading to the formation of colonies of powdery mildew and production of conidia on these grasses. The colonies on the wild grasses act as foci from which conidia 01 *Erysiphe* graminis are disseminated to cultivated small grain crops throughout the growing season. In southern Ontario, colonies of *Egt* on meadow brome and downy brome, whether they are produced by ascospore or asexual conidial inoculum, may be important in the survival of *Egt* from the time of harvest of winter wheat in July, to the emergence of newly seeded winter wheat in October.

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