Occurrence and Pathogenicity of *Drechslera teres* Isolates Causing Spot-type Symptoms on Barley in Western Australia

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ABSTRACT

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Drechslera teres, the cause of spot-type symptoms on barley (*Hordeum vulgare*), is reported from Australia for the first time. Spot-type isolates were similar to net-type isolates of *D. teres* in conidial morphology and colony characteristics. Western Australian spot-type isolates differed from Canadian spot-type isolates in pathogenicity on two barley cultivars. A high degree of resistance to spot-type isolates was rare, and only CI 6225 and CI 9214 were resistant to both spot-type and net-type isolates. The common occurrence of spot-type isolates in the northern wheat belt of Western Australia may be the result of widespread use of the susceptible cultivar Clipper, which is field resistant to net-type isolates of *D. teres*.

The commonly known isolates of *Drechslera teres* (Sacc.) Shoem. (perfect state: *Pyrenophora teres* Drechs.) characteristically produce net-blotch—elongated, dark brown blotches, crisscrossed with a netlike venation and accompanied by chlorosis—in barley (*Hordeum vulgare* L.). However, McDonald (7) recognized two isolates, one from Canada, the other from Israel, that caused spotting accompanied by chlorosis of the surrounding tissue instead of the usual netlike symptoms (Fig. 1). Hansen and Magnus (3) found that isolates of *D. teres* that cause "spot" symptoms were more common on barley in Norway than net-type isolates. This was also reported by Smedegaard-Petersen (8) in Denmark and by Makela (6) in Finland. Smedegaard-Petersen (8) described the spot-producing isolates as a new form of *D. teres* and named it *D. teres* (Sacc.) Shoem. forma *maculata* Smedegaard-Petersen (perfect state: *P. teres* Drechs. forma *maculata* Smedegaard-Petersen). Consequently, he named the net-type isolates *D. teres* forma *teres* (perfect state: *P. teres* Drechs. forma *teres* Smedegaard-Petersen). Spot-type isolates occur in Canada (12) on two-row varieties of barley (11).

In view of the multiplicity of symptoms, Smedegaard-Petersen (9) questioned the validity of the common name "net blotch" for the disease caused by *D. teres*. He advocated renaming it "net-spot blotch." He also showed (10) that net and spot forms readily crossed and that two-gene pairs controlled the variation in symptom expression. In segregating generations, two forms of recombinant symptom expression (ie, intermediate and fleck types) were also observed.

In Western Australia, spot-type symptoms were first seen at Chapman Research Station, Nabawa, in 1977 and were later found to be common in the northern wheat belt area. This paper discusses the occurrence, identification, pathogenicity, possible origin of spot-type isolates of *D. teres* in Western Australia, and implications for the breeding program.

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MATERIALS AND METHODS

Culture techniques used in these investigations were described by Khan and Boyd (4). Morphology of conidia was studied for six net-type isolates and four spot-type isolates on V-8 juice agar. Fifty conidia were examined for shape and size from each isolate. Inoculation methods used were described by Khan and Boyd (5) and Tekauz and Mills (12). In Western Australia, all glasshouse investigations were conducted at 20/15 C (day/night) under natural daylight conditions.

Infections of barley by *D. teres* were rated as 0 = no symptoms (escape), R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, and I (MR-MS) = intermediate (1,5,12) at 10 days after inoculation. In studies involving breeding

lines in Western Australia, the percentage of leaf area affected was estimated using keys published by Hampton and Arnst (2), and analysis of variance of the results was carried out. Two replicates were used in each experiment.

RESULTS

Identification of spot-type isolates. Spot symptoms on barley were first noted at Chapman Research Station, Nabawa, in September 1977. However, isolations were not made until October 1978. Four isolates, two from Nabawa and two from South Winchester, produced spot-type symptoms on barley test cultivars. Three isolates sent to Winnipeg, Canada (A. Tekauz), were confirmed to be spot-type variants of *D. teres* f. *maculata*. Since 1978, all isolates originating from the northern wheat belt of Western Australia have been spot-type isolates.

Isolates of the spot-type and net-type *D. teres* produced conidia of similar size and shape. The conidia of all isolates were cylindric, rounded at the ends, light brown in color, and had four to six septa.

Reactions to spot-type isolates. Twelve barley genotypes previously recognized as resistant to net-type isolates of *D. teres*, together with three local cultivars, were tested against spot-type and net-type isolates (Table 1). Both the percentage of leaf area affected and the host reaction score were recorded. A high correlation between percentage of leaf area affected and reaction score (+ 0.72; $P<0.001$) led us to use only the reaction scores for convenience.

The commercial barley cultivar Dampier was susceptible to net-type isolates of *D. teres* but was intermediate in reaction to spot-type isolates (Table 1). The other two commercial cultivars (Clipper and Beecher) exhibiting varying degrees of resistance to the net-type isolates of *D. teres* were also intermediate in reaction to spot-type isolates. Susceptible host reaction against spot-type isolates was seen only in CI 7584, which was resistant to moderately resistant to net-type isolates of *D. teres*. Only CI 6225 was resistant to moderately resistant to both types of the pathogen (Table 1).

Twenty-seven breeding lines included in the variety trials of Western Australia were tested against one net-type and three spot-type isolates of *D. teres*. About 40% of these lines were resistant to moderately resistant to the net-type isolates of *D. teres*. However, they were moderately resistant to susceptible to the spot-type isolates.

In both of the above experiments, the range of reaction against spot-type isolates was relatively narrow. This was also reflected in the assessments of leaf area damaged in the experiment involving the breeding lines.

Comparison of isolates. Three Western Australian spot-type isolates of *D. teres* were compared with two spot-type and three net-type isolates from Canada. The isolates from Western Australia were similar to the Canadian isolates in colony characteristics and in conidial production.

In inoculation experiments, Canadian and Western Australian spot-type isolates produced very similar reactions on 14 of the 16 barley genotypes (Table 2). However, consistent differences were observed on cultivars Summit and Norbert. Summit was rated moderately resistant to intermediate to the three Western Australian spot-type isolates and susceptible to the two Canadian ones (Fig. 1). Norbert was rated moderately susceptible to susceptible to the Western Australian isolates and intermediate to the Canadian spot isolates. Only one genotype (CI 9214) was resistant to moderately resistant to both types of isolates of *D. teres*. Many of the genotypes tested were moderately or fully susceptible to both the Australian and Canadian spot-type isolates.

DISCUSSION

This is the first report of spot-type

Table 1. Reaction of barley genotypes to spot-type and net-type isolates of *Drechslera teres*[a]

	Net-type isolates		Spot-type isolates	
Genotypes	KH 334	Mixture of three	KH 313	Mixture of three
Dampier	S	S	I	I
Clipper	I	I	I	I
Beecher	MR	MR	I	I
CI 1179	MR	R	MS-S	S
CI 1243	R	R	MS-S	I
CI 2330	MR	R	I	MS
CI 4795	MS-S	I	I	I
CI 4797	I	I	MS	MR
CI 4929	MS	MS	I	I
CI 5349	R	R	MS-S	S
CI 5791	R	R	I	I
CI 5809	R	R	I	I
CI 6225	MR	R	MR	MR
CI 7584	R	MR	S	S
CI 9159	I	I	I	I

[a] R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, and I (MR-MS) = intermediate in susceptibility to *D. teres* f. *teres* (net-type isolates) or *D. teres* f. *maculata* (spot-type isolates).

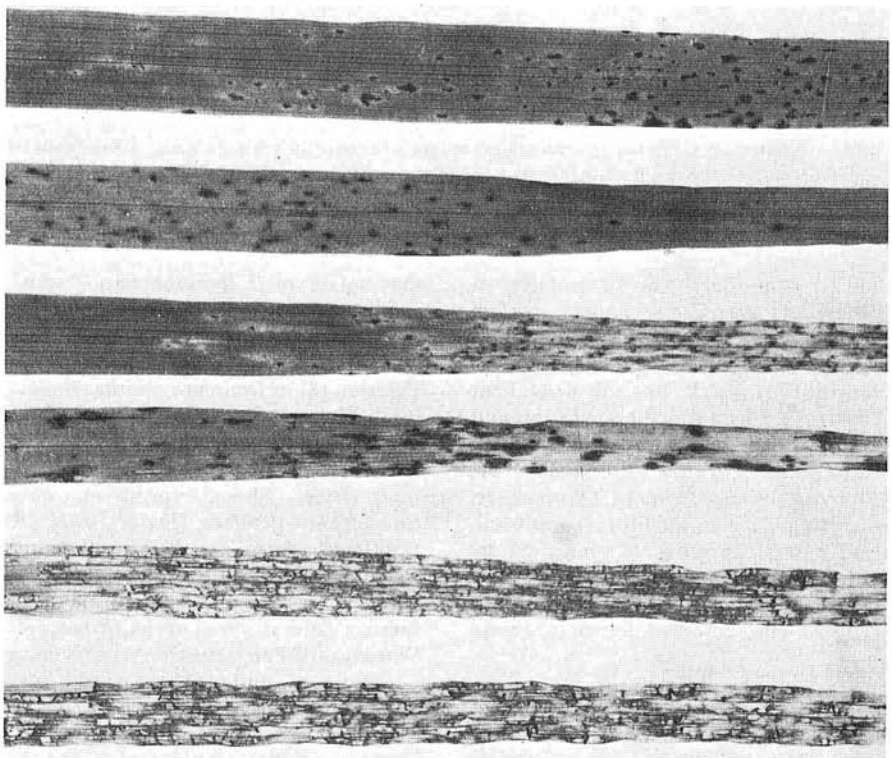

Fig. 1. Host reaction of barley cultivar Summit in Canada showing symptoms produced by the spot-type and net-type isolates of *Drechslera teres* and the differences in the pathogenicity between Western Australia spot-type (WAS), Canadian spot-type (CS), and Canadian (CN) net-type isolates. **Top to bottom.** Isolate KH 311 (WAS), KH 313 (WAS), 857 (CS), 1049 (CS), 102 (CN), and 858 (CN).

Table 2. Host reaction of barley genotypes to spot-type isolates of *Drechslera teres* from Australia and Canada

Genotype	Reaction to isolates[a]			
	KH 311[b]	KH 313[b]	857[c]	1049[c]
Two-rowed barley				
CI 5791	I	MR	MR	MR
CI 9214	MR	MR	MR	MR
Two-rowed cultivars				
Betzes (CI 6398)	S	MS	S	S
Fairfield	S	S	S	S
Herta (CI 8097)	S	S	S	MS
Klages (CI 15478)	MS	MS	S	S
Summit (CI 2248)	I	MR	S	S
Norbert	S	MS	I	I
Six-rowed cultivars				
Bedford (CI 15774)	MS	MR	MS	I
Bonanza (CI 14003)	MS	I	I	I
Melvin	MS	I	S	I
Olli (CI 6251)	S	MS	S	S
Steptoe (CI 15229)	MS	MS	MS	I
Winter-types				
Hudson (CI 8067)	MS	MS	MS	MS
Huron (CI 15236)	S	S	I	MS
Dover (CI 10435)	S	S	S	MS

[a] R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, and I (MR-MS) = intermediate in susceptibility.
[b] Australian spot-type isolates of *D. teres* f. *maculata.*
[c] Canadian spot-type isolates of *D. teres* f. *maculata.*

isolates of *D. teres* f. *maculata* from Western Australia and, we believe, from Australia. Spot-type isolates were similar to net-type isolates in morphology, confirming the observations of Smedegaard-Petersen (8).

Among spot-type isolates from Western Australia and Canada, variation in pathogenicity was observed. Clear-cut resistance to spot-type isolates of *D. teres* f. *maculata* may be a rarity, and only two barley cultivars were found to offer resistance to both the spot-type and net-type isolates. Despite the restricted distribution of isolates producing spot-type symptoms, crops heavily infected with *D. teres* f. *maculata* spot-type isolates have been observed in commercial barleys in Canada. Preliminary work in Western Australia has shown that up to 25% losses in grain yield can occur under field conditions in cultivars showing intermediate host reaction to spot-type isolates in glasshouse tests. The potential of spot-type isolates of *D. teres* to cause extensive foliar damage is illustrated in Figure 1. A need for a high degree of resistance to *D. teres* f. *maculata* in commercial cultivars is therefore suggested.

Circumstantial evidence suggests that spot-type isolates in Canada may have been introduced from Scandinavia in untreated seed imported by plant breeders (12). Although barley seeds imported in Australia have, for more than two decades, been treated with fungicides to prevent the introduction of exotic fungi, spot-type isolates of *D. teres* f. *maculata* may have been introduced, like other leaf pathogens of barley, some time ago. However, these isolates were not recognized until the release in 1970 of the Clipper barley variety, which is field susceptible to the spot-type but resistant to the net-type isolates of *D. teres*. The predominance of the Clipper variety in the northern wheat belt may have offered selective advantage to the spot-type isolates of *D. teres* that now commonly occur.

Although spot-type isolates of *D. teres* f. *maculata* are now known to occur in barley growing regions of the world outside of Scandinavia, in Australia and in Canada, they are not as common as isolates that produce "normal" net-type symptoms. Therefore, we do not advocate a change in the common English name of the disease from "net blotch" to "net-spot blotch," as was suggested by Smedegaard-Petersen (9). Such a change could lead to confusion, particularly since the barley foliar disease caused by the *Drechslera* state of *Cochliobolus sativus* (Ito and Kuribayashi) Drechs. ex Dastur is commonly known as spot blotch or barley leaf spot, and this disease can occur along with "net blotch" as part of the leaf-spot complex on barley in some parts of the world (12).

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