

Übersichtsarbeiten

Incidence of *Phaeosphaeria avenaria* f. sp. *avenaria* in Europe between 1994–1998 and varietal reaction of oats to this disease

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Verbreitung von *Phaeosphaeria avenaria* f. sp. *avenaria* (Septoria-Blattflecke, Stängelschwärze und Hoher Halmbruch des Hafers) und Reaktion von Hafer-sorten gegenüber dieser Krankheit in Europa in den Jahren 1994 bis 1998

1. Introduction

Septoria disease on oat has been known since the late 19th century (FRANK, 1895; HARDER and HABER, 1992). The disease can attack any above-ground part of oat plant. Losses 34–43 % were reported from Germany (MIELKE, 1975; MULLER, 1964), but its incidence was also announced from the other parts of Europe (NOBLE and MONTGOMERIE, 1956; ŠEBESTA, 1985; HARDER and HABER, 1992).

It appears that the incidence of *P. a. f. sp. avenaria* has been increasing in recent years (ŠEBESTA, 1993; 1995; ZWATZ et al., 1994). Its ability to cause severe stem infections can result in lodging, and seed-borne infection causes necrotic streaks at the base of the coleoptile (Fig. 1).

COMEAU and PELLETIER (1976) also found that the damage of the black stem phase is made worse by coinfection with Barley Yellow Dwarf Virus and also by the *Gaeumannomyces graminis* var. *avenae* (DOWNES, 1971; HARDER and HABER, 1992). It is supposed that at present time in some oat regions the losses incited by the disease can achieve up to 30 % (ZWATZ et al. 1994).

WEBER (1922) named the disease speckled blotch and described the sexual stage as *Leptosphaeria avenaria*. JOHNSON (1947) identified a form attacking wheat and barley similar to *S. avenae* f. sp. *avenaria* that he described as *Septoria avenae* f. sp. *triticea* (CUNFER and UENG, 1999). BISSETT (1982) transferred the anamorphs to *Stagonospora avenae* f. sp. *avenaria* and *S. avenae* (A.B. Frank) Bissett f. sp. *triticea*.

Zusammenfassung

In Europa wurde im Rahmen eines internationalen FAO-Netzwerkes im Zeitraum von 1994–1998 das Auftreten des pilzlichen Krankheitserregers *Phaeosphaeria avenaria* f. sp. *avenaria* erhoben, der an Hafer den Krankheitskomplex „Septoria-Blattflecke, Stängelschwärze und Hoher Halmbruch“ verursacht. Die Erhebungen wurden in folgenden Staaten durchgeführt: Österreich, Weißrußland, Tschechien, Estland, Finnland, Deutschland, Italien, Polen, Russische Föderation und Jugoslawien. Es ist hervorzuheben, dass während aller vier Erhebungsjahre an der Versuchsstation Petzenkirchen, Österreich (im westlichen Niederösterreich) ein starkes Auftreten dieser Krankheit festgestellt wurde. An der Versuchsstation Wielopole, Polen, wurde während dieses Zeitraumes ein mittleres bis starkes Auftreten befundet. Ein starkes Auftreten wurde ebenso an weiteren europäischen Versuchsorten erhoben. In verschiedenen Hafer-Anbaugebieten Europas werden durch diesen Krankheitserreger Ertragsverluste in unterschiedlichem Ausmaße (bis 30 %) verursacht. Die Werte des Krankheitsresistenzindex (DRI), ein mehrfaktorieller Maßstab eines Genotyps für die Resistenz gegenüber Krankheiten, rangieren von 12 bis 70 (0 = keine Resistenz, 100 = höchste Resistenz). Die höchsten DRI-Werte wurden an den Linien Pc 61, Pc 60, Pc 59 und einigen weiteren Nummern errechnet.

Schlagnworte: Hafer, *Avena Phaeosphaeria avenaria* f. sp. *avenaria*, *Septoria avenae* f. sp. *avenae*, Septoria-Blattflecke, Stängelschwärze und Hoher Halmbruch des Hafers, Verbreitung von *Septoria avenae*, Sortenreaktion, Krankheitsresistenzindex.

Summary

In Europe, from 1994-1998, the fungus *Phaeosphaeria avenaria* f. sp. *avenaria*, the causal agent of Septoria leaf blight and black stem, was recorded in Austria, Belarus, The Czech Republic, Estonia, Finland, Germany, Italy, Poland, Russia and Yugoslavia. In particular there was a high level of the disease at Petzenkirchen, Austria, in all years and at a moderate to high level at Wielopole, Poland during the same period. Other incidences of high levels occurred in some years at other sites and these are discussed. The results suggest that this disease is causing disease losses in the oat crops in some parts of Europe. The values of the disease resistance index (DRI), a multi-site indicator of the effectiveness of resistance of plant genotypes against diseases, ranged from 12 to 70 (0 = without any resistance, 100 = highest resistance). The highest DRI values were calculated in lines such as Pc 61, Pc 60, Pc 59 and a number of other ones.

Key words: Oat, *Avena*, *Phaeosphaeria avenaria* f. sp. *avenaria*, Septoria leaf blight and black stem, *S. avenae* f. sp. *avenae*, incidence of *Septoria avenae*, varietal reaction, disease resistance index.

The corresponding teleomorphs are *Phaeosphaeria avenaria* for the form pathogenic to oats and *Phaeosphaeria avenaria* (G. F. Weber) Erikss. f. sp. *triticea* for the form that attacks wheat, barley, rye and certain grasses (BOEREMA et al., 1992; MAKELA, 1975; 1977; SHAW, 1957a, b; SHEARER and WILCOXSON, 1977; CUNFER, 1994; CUNFER and UENG, 1999).

The isolates of *S. avenae* f. sp. *avenaria* exhibit high genetic variation (HOOKER, 1957; JOHNSON, 1947; 1952). DURBIN (1966) found variation in protein banding among 12 isolates of *S. avenae* f. sp. *avenaria*. UENG and CHEN (1994) in RFLP analysis using DNA probes from wheat-biotype *S. nodorum* (SN209, NY) and *S. avenae* f. sp. *avenaria* (SAA001, NY) observed considerable genetic variation in *S. avenae* (UENG and CHEN, 1994).

According to CUNFER and UENG (1999) one interpretation is that *S. avenae* comprises more than one biological species. Another explanation for genetic variation is that sexual reproduction occurs more frequently in this fungus (CUNFER and UENG, 1999).

This is the second article (see ZWATZ et al., 1994) dealing with the incidence of *Phaeosphaeria avenaria* f. sp. *avenaria* (G.F. Weber) (O. Eriksson) (*Septoria avenae* Frank f. sp. *avenae*) in Europe and North Africa (Morocco) and the varietal reaction of oats to Septoria leaf blight and black stem in the European (and Mediterranean) Oat Disease Nursery between 1994-1998. After the enlargement of the project and the establishment of new trial sites in Israel and Morocco, the European Oat Disease Nursery was renamed the European and Mediterranean Oat Disease Nursery in 1998.

2. Materials and methods

The European and Mediterranean Oat Diseases Nursery (EMODN) (ŠEBESTA, 1998) is grown at approximately 40 locations throughout Europe and recently in Israel (one location) and Morocco (four locations). The nursery consists of 66 oat genotypes with resistance or tolerance to either crown rust (*Puccinia coronata* f. sp. *avenae*), stem rust (*P. graminis* f. sp. *avenae*), powdery mildew (*Erysiphe graminis* f. sp. *avenae*), or Barley Yellow Dwarf Virus (ŠEBESTA, 1990-1998; ŠEBESTA et al., 1997a, b; 1998). In addition, the occurrence and varietal reaction of oat genotypes to Septoria leaf blight and black stem, and Helminthosporium leaf blotch was also evaluated.

The occurrence of Septoria leaf blight and black stem is evaluated on leaves and stems, mostly taken as one average reading. However, in some cases the leaf and stem evaluation was carried out separately using James's scale (JAMES, 1971), modified to 1-4 = resistant (R), 5-24 = moderately resistant (MR), 25-49 = moderately susceptible (MS), 50+ = susceptible (S) or some other assessment scales were used to record disease severity (ŠEBESTA et al., 1995; ZWATZ et al., 1994). Overall disease levels at individual localities were evaluated each year and measured on the basis of the level of disease on the susceptible control as either low, moderate or high.

The disease resistance index (DRI) (ŠEBESTA et al., 1995) for each genotype was calculated as a sum of resistant (R = 4) and moderately resistant (MR = 3) evaluations. Adjustments were made to the calculated DRIs to correspond to a standard number of 30 sites. The oat genotypes were ranked according to adjusted values of the DRI.

3. Results and Discussion

3.1 Incidence of Septoria leaf blight and black stem

In 1994-1998 the fungus *P. a. f. sp. avenaria* was recorded in Austria, Belarus, The Czech Republic, Estonia, Finland, Germany, Italy, Poland, Russia and Yugoslavia and Morocco. The relative severity of these occurrences are presented in Table 1. The disease appears to be particularly prevalent in Austria with a high incidence at Petzenkirchen in all years; at Edehof in 1994 and 1997 and at Fuchsenbigl in 1994, with moderate levels in the following two years; and at Drauhofen in 1998, with moderate levels in 1995 and 1996. A high incidence was found at Wielopole, Poland, in 1997 with moderate levels in other years and at Krukanice, Czech Republic, in 1997, Schwäbisch Hall, Germany, and Rome, Italy, in 1996 and Rabat, Morocco, in 1997.

From these results it was concluded that Septoria leaf blight and black stem reached damaging levels at a number of localities in Europe between 1994-1998, as was noted in previous years (ZWATZ et al., 1994).

3.2 Disease resistance index of oat genotypes

The data presented in Table 2 show large differences in the DRI to Septoria leaf blight and black stem among oat genotypes evaluated in the EMODN from 1994-1998. The adjustment to the calculated DRI values to the same number of sites enables a more precise comparison of resistances between the various lines. This assumes that there is no or minimum error among the oat lines tested at the identical number of localities.

The values of the DRI ranged from 12 to 70. The highest values were with lines Cc 3678 (70), Pc 61 (66), and Pc 60 (63); although the first of these was only tested at six sites. There was then a gradation in values with no obvious groupings. The following also had high values: Pc 59 (47), cv. Kasadra (47), the lines IL 86-6404 (46), Cc 4761 (43), Pc 54-2 (42) and Pc 58 (41).

3.3 Diversity in severity of Septoria leaf blight and black stem on oat genotypes

The high diversity of reaction to Septoria leaf blight and black stem in the oats tested in the EODN (EMODN)

Table 1: Incidence of Septoria leaf blight and black stem (*Phaeosphaeria avenaria* f. sp. *avenaria*) in Europe in 1994-1998 as recorded at some localities in the European (and Mediterranean) Oat Disease Nursery

Tabelle 1: Anfälligkeit gegenüber Septoria Blattflecken und Stängelschwärze (*Phaeosphaeria avenaria* f. sp. *avenaria*) in Europa während der Jahre 1994-1998, registriert auf einigen europäischen (und mediterranen) Standorten bei Haferkrankheitensortimenten

Country	Locality	1994	1995	1996	1997	1998
Austria	Edelhof	+++			+++	
	Fuchsenbigl	+++	++	++		
	Petzenkirchen	+++	+++	+++	+++	+++
	Drauhofen		++	++		+++
	St. Donat		++		++	
Belarus	Zhodino				++	+
Czech Republic	Kromeriz		+	++	++	++
	Krukanice			+	+++	++
	Prague-East			++	+	
	Prague-West			+	+	
	Ruzyne					++
Estonia	Jõgeva		+		+	
Finland	Anttila					(++)
	Jokionen					
Germany	Schwäbisch Hall		++	+++	(++)	
	Gross Lusewitz		+++			
Italy	Rome			+++		
Morocco	Rabat				+++	
Poland	Wielopole	++	++	++	+++	++
Russia	St. Petersburg		++			++
Yugoslavia	Novi Sad				+	+

+, ++, +++ low, moderate and high level of infection on susceptible genotypes respectively.

(++) = rather lower than the recorded majority of moderate incidence evaluations

Table 2: Disease resistance index (DRI) of oat cultivars and lines to Septoria leaf blight and black stem (*Phaeosphaeria avenaria* f. sp. *avenaria*) in Europe in 1994-1998 (after adjusting to 30 evaluations per line)

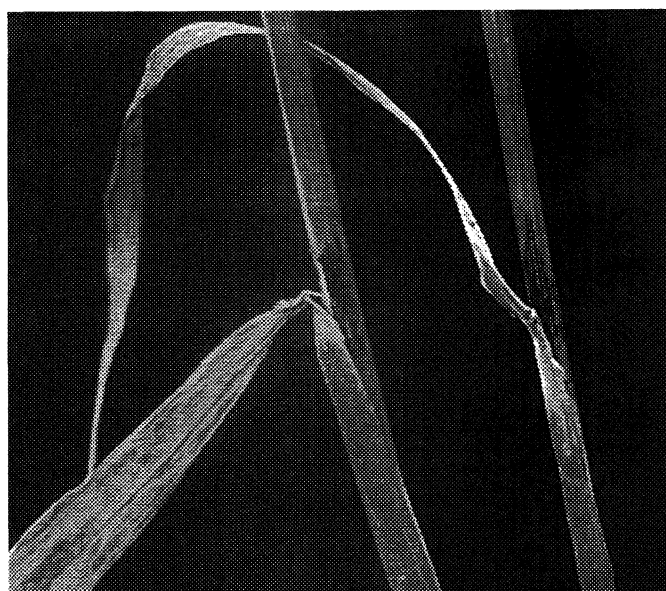
Tabelle 2: Resistenzindex von Hafersorten und -linien gegenüber Septoria Blattflecken und Stängelschwärze (*Phaeosphaeria avenaria* f. sp. *avenaria*) in Europa in den Jahren 1994-1998

Cv./Line	DRI	R	MR	MS	S	Total
Cc 3678	70	2	2	1	1	6
Pc 61	68	10	11	7	4	32
Pc 60	63	7	13	9	3	32
Pc 59	47	6	8	13	4	31
Kasadra	47	4	2	7	1	14
IL 86-6404	46	5	7	6	9	27
Cc 4761	43	3	9	6	9	27
Pc 54-2	42	6	7	14	5	32
Pc 58	41	4	8	9	8	29
Pc 68	39	3	9	12	6	30
OM 1387	38	5	7	9	11	32
APR 122	38	3	9	13	6	31
Cc 6490	37	3	7	12	5	27
OM 1621	35	2	9	11	8	30
Cc 4146	33	4	6	10	11	31
Roxton	33	1	10	10	10	31
Orlando	33	3	6	7	11	27
KR 8122	33	3	8	11	11	33
IL 86-5698	33	3	6	13	5	27
IL 86-4189	32	5	4	16	7	30
Pen2 x CAV 1376	31	2	8	12	9	31
Pg 16	31	3	6	15	5	29
Pc 54-1	30	1	9	14	7	31
Pc 39	30	4	5	16	6	31
OA 504-6	30	1	8	6	13	28
Mostyn	29	1	8	14	6	29
APR 166	29	2	6	13	6	27
Pc 67	28	4	4	17	5	30
Pg 15	28	1	8	15	6	30
IL 86-1158	28	1	8	14	7	30
SG-K 93682	28	2	1	4	5	12
Pc 50-4	27	2	6	15	6	29
Rodney B	27	3	5	14	8	30
Pg a	27		9	13	8	30
Adam	27	3	4	9	11	27
SG-K 95708	27	3	2	8	7	20
Melys	26		8	10	10	28
Pc 50-2	26	3	5	14	9	31
Pc 64	26	3	5	14	9	31
IL 85-2069	26	1	7	12	9	29
IL 85-6467	26	3	5	16	7	31
POB 1429/93	26	3	3	13	5	24
Pc 50	25	1	7	11	11	30
Pc 62	25	3	6	19	8	36
OA 503-1	25	2	4	9	9	24

from 1994-1998 is also obvious from Table 2. The most valuable results are those which indicate genotypes with a high proportion of R and MR values in relation to the high total number of values. Both Pc 61 and Pc 60 had a higher proportion of R and MR values than susceptible ones.

Cv./Line	DRI	R	MR	MS	S	Total
Vermiou	25	2	4	10	8	24
Rodney H	24	1	7	9	14	31
Rodney M	24	3	4	17	6	30
Pc 48	23	3	4	16	8	31
Pc 55	23	3	4	16	8	31
Zlaták	23	4	5	13	19	41
KR 3813/73	22	2	5	18	6	31
Pirol	22	3	3	14	9	29
Maldwyn	21	2	4	16	6	26
Pc 56	20	3	3	19	6	31
Rodney A	20	1	5	18	5	29
Rodney ABDH	20		7	12	12	31
Maelor	19		6	12	11	29
Pc 63	18		3	17	7	30
KR 9046	18	2	3	14	10	29
Manod	17	2	3	18	7	30
OA 504-5	17	1	4	15	8	28
IL 86-4467	16	1	4	19	6	30
POB 14391/93	16	1	4	13	11	17
Pc 38	15		5	16	10	31
SG-K 961010	15	1	1	8	4	14
KR 288/73L/569	12		4	14	12	30
Garland	12		4	13	14	31

Others with a high number of resistant values were Pc 59, IL 86-6404, Cc 4761, Pc 54-2 and Pc 58, Pc 68, OM 1387 and APR 122, although again there are no obvious groupings. It is noticeable, however, that none shows a higher number of R values than MR.



Bildquelle: Schöber-Butin, Garbe, Bartels: Farbatafelatlus Krankheiten und Schädlinge an landwirtschaftlichen Kulturpflanzen, Verlag Eugen Ulmer, 1999)

Figure 1: Black stem in the area of leaf sheaths caused by *Phaeosphaeria avenaria* f. sp. *avenaria*
 Abbildung 1: Stängelschwärze im Bereich der Blattscheiden durch *Phaeosphaeria avenaria* f. sp. *avenaria*

3.4 Comparison of the reaction of some genotypes with a previous period (1990-93)

There is an obvious similarity in the DRI in a number of oat genotypes tested in the EODN trials in the previous period (ZWATZ et al., 1994). Oats such as Cc 4761, Pc 60, Pc 54, IL 86-6404, Pc 58, Cc 6490, IL 86-4189, Pc 68, Pen2 x CAV 1376 also had relatively high DRI in disease nurseries between 1990-1993 (ZWATZ et al., 1994).

4. Conclusions

The incidence of *Phaeosphaeria avenaria* f. *sp. avenaria* in Europe between 1994-1998, as in the period 1990-1993 (ZWATZ et al., 1994), indicates that the pathogen is causing losses in the oat crop at some localities in Europe (ŠEBESTA, 1990-1998). The oat genotypes Pc 61, Pc 60, Pc 59, IL 86-6404, Cc 4761, Pc 54-2 and others show a high disease resistance index to Septoria leaf blight and black stem and it appears that the control of this disease through breeding for resistance appears to be feasible. It is, however, necessary to test many more oat genotypes to isolates from different regions to appreciate fully the amount of variation within the pathogen as was pointed out by ZWATZ et al. (1994).

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