

Bipolaris sorokiniana on barley seed in Finland

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Abstract. *Bipolaris sorokiniana* is reported as a common fungus in commercially grown barley seed in Finland with possible economic importance. In 1974, when 200 samples of barley seed were surveyed the fungus was identified in 60 per cent of samples. The three following years the incidence was 19, 29 and 38 %. The mean per cent seeds infected was 3.8, 1.3, 1.2 and 1.9 respectively. The highest recorded individual % was 92. The most severely infected cultivar was Paavo each year. In most cases only the seed cover was invaded by the fungus but also infection in the embryo and the cell layers surrounding it was observed. Such severely infected seeds did not germinate or the seedlings were readily infected after germination. *B. sorokiniana* was less frequent in the western parts of the country. Field experiments in 1972—1979 confirmed the same varietal susceptibility which was found by the survey of commercial samples of barley seed. High rainfall and relative humidity in July and August were the main factors associated with increased seed infection incidence.

Introduction

Bipolaris sorokiniana (Sacc. ex Sorok.) Shoem. (syn. *Helminthosporium sativum* Pamm., King & Bakke), perfect state *Cochliobolus sativus* (Ito & Kurib.) Dastur has a cosmopolitan distribution on many grasses and cereals and causes serious disease and economic losses in spring barley and wheat particularly in warm temperate areas (SPRAGUE 1950, ANDERSON & BANTTARI 1976). In recent years the fungus has become more frequent in North Western Europe (JØRGENSEN 1974, MÄKELÄ 1975, WHITTLE 1977). The sus-

ceptible crop is readily infected by the fungus which is able to overwinter in the soil even in cool climate and because many wild grasses act as an inoculum reservoir (JØRGENSEN 1974, WHITTLE 1977). The diseases the fungus causes are a seedling blight, a foot and root rot, foliar disease, headblight and kernel blight (ANDERSON & BANTTARI 1976). Up to 15 % of yield losses have been recently reported (WHITTLE & RICHARDSON 1978). There is no earlier information as to when the fungus became common in Finland, but in North Western Europe it happened during the 1950s and 1960s (de TEMPE 1964, JØRGEN-

Index words: *Bipolaris sorokiniana*, *Helminthosporium sativum*, *Cochliobolus sativus*, common root rot; barley, seed infection



Fig. 1. A barley seed sample cv. Paavo with very high incidence of *Bipolaris sorokiniana* after 5 days of incubation in a petri dish.

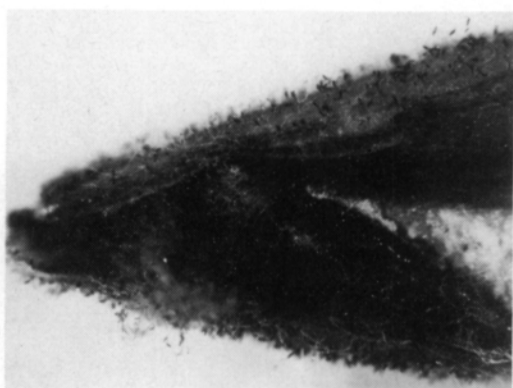


Fig. 2. A seed half with severe embryo infection by the fungus after 4 days of incubation.

SEN 1969, HEWETT 1975). A later report of KURPPA (1982) assumes the fungus gaining still increasing importance as a pathogen of spring barley in Finland.

Materials and methods

During the years 1972 to 1979, 11–19 spring barley cultivars grown in field experiments at the University Farm at Viikki were examined each year for the presense of *Bipolaris sorokiniana*. Experimental seed samples from North Savo Experimental Station, Maaninka were examined during 1972 and 1973. 649 commercial samples of spring barley, including those most commonly sown were taken from those seed lots received annually at the State Seed Testing Institute, Helsinki for testing for purity and germination.

Representative sub-samples of 100 seeds were placed in petri dishes (diameter 14 cm), 50 each on wet filter paper and cotton filter. The dishes were incubated at 20–22°C for six days and then examined for fungal growth. *B. sorokiniana* could be readily identified with a stereo microscope at the magnification of 12 to 50 times if it was present in germinating seeds.

The fungi belonging to the other genera were also recorded. The seed lots with high incidence of seed infection were further exa-

mined for possible embryo infection. The seeds were cut into two halves and one half was placed in a petri dish as described above and the other half was discarded. One hundred seeds were examined per a sample. The seed halves were observed after three days of incubation for the localization of the site of infection. During the short incubation time no growth from the seed cover could reach the embryo area, but any fungal growth within the embryo could be easily seen.

Preliminary tests of seed infection incidence included a treatment with 1% Na-hypochloride solution. Comparison of test results with and without this treatment showed no significant differences and the treatment was discontinued.

The weather conditions during the research period:

The growing seasons 1972–1975 were warmer and seasons 1976–1978 cooler than average. The temperature during the 1979 season was near average. Summers in 1973 and 1975 were very dry and 1976, 1977 and 1979 were abnormally rainy. The precipitation during late summer 1974 was also high (ANON 1972–1979).

Results

The incidences of *Bipolaris sorokiniana* in spring barley seed varied marketly during the

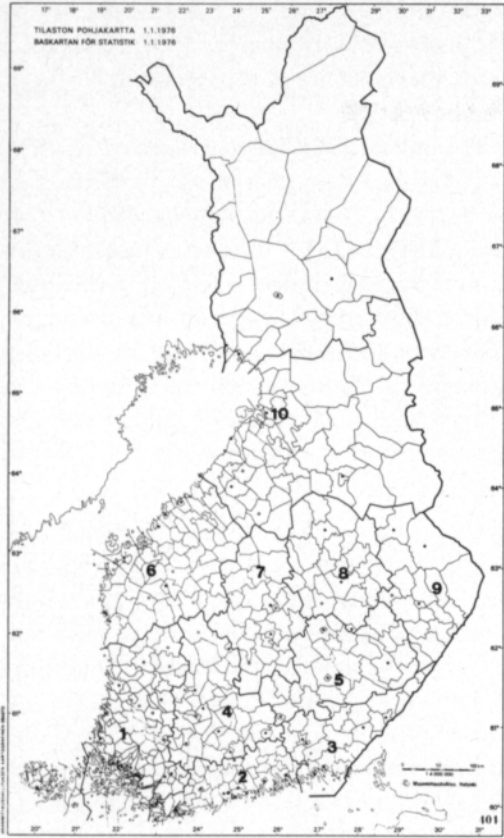


Fig. 3. The regional distribution of the seed samples. See Table 3.

research period 1972—1979. In certain years the fungus was widespread occurring with high levels in susceptible cultivars. Overall figures for seed infection show the fungus was common but associating with certain cultivars. In the seed samples from field experiments at University Farm, Helsinki Viikki, the fungus was very common in 1972 and 1974 but did not occur at all in 1973 and 1975. From low to moderate incidences were recorded in the following years (Table 1). During dry seasons the infection status of the sowing seed did not have any effect on the infection incidence of new grain yield, but during moist seasons the crop grown from infected seed served as an important source for spore liberation for secondary infection.

Fungal growth in individual seeds was mostly superficial and the fungal hyphae had

Table 1. The occurrence of *Bipolaris sorokiniana* in grain yield of different spring barley cultivars from field experiments at University Farm, Viikki during 1972—1979. — = cultivar not in experiments.

| Cultivar | Per cent seeds infected | | | | | | | | | | Yearly mean | | | | | |
|----------|-------------------------|------|------|------|------|-------------------|------|------|--------|------|-------------|------|------|------|------|------|
| | Two-row cultivars | | | | | Six-row cultivars | | | | | | | | | | |
| | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 |
| Aapo | — | — | — | 0 | 2 | 1 | 20 | 7 | — | 16 | — | 0 | 0 | 2 | 6 | 4 |
| Arvo | 26 | 0 | — | — | 1 | — | — | — | 26 | 0 | 14 | 0 | 0 | 2 | 0 | 0 |
| Birgitta | 20 | 0 | 0 | 0 | 0 | 3 | 5 | 6 | — | — | — | 0 | 0 | 1 | 2 | 0 |
| Eva | — | — | — | — | 0 | 1 | 0 | 2 | 3 | 0 | 5 | 0 | 0 | 0 | 0 | 0 |
| Gunilla | 2 | 0 | 0 | 0 | — | — | — | — | 92 | 0 | 14 | 0 | 0 | 3 | 5 | 11 |
| Ingrid | — | — | 7 | 0 | 0 | 0 | 1 | 4 | 8 | 0 | 8 | 0 | 0 | 4 | 0 | 1 |
| Kajsa | — | — | — | — | — | — | — | 2 | 12 | 0 | — | 0 | 1 | 1 | 3 | 0 |
| Karri | 16 | 0 | 12 | 0 | 0 | 0 | 2 | 2 | — | — | — | 0 | 0 | 1 | 1 | 0 |
| Mari | 29 | 0 | — | 0 | 0 | 4 | 4 | 2 | 14 | 0 | — | 0 | 0 | — | — | — |
| | | | | | | | | | Teemu | — | — | — | 0 | 7 | 3 | 4 |
| | | | | | | | | | Vigdis | — | 17 | 0 | 2 | 4 | 4 | 4 |
| | 18.6 | 0.0 | 4.8 | 0.0 | 0.4 | 1.5 | 5.3 | 3.7 | | 24.5 | 0.0 | 0.0 | 0.3 | 2.5 | 2.4 | 2.4 |

only invaded the seed coat. In 1972 severe infection of embryos or the surrounding layers was detected in many cultivars, particularly cvs Paavo, Mari and Birgitta. The highest individual percentage of embryo infection was recorded with cv. Paavo at 32 %. The other common fungus species recorded each year with the survey were *Alternaria* sp., *Cephalosporium* sp., *Cladosporium* sp. and *Ulocladium* sp.. Also *Fusarium* species were common after rainy late growing seasons like 1972 and 1974. A survey of spring barley cultivars at North Savo Experimental Station, Maaninka 1972 revealed the following incidence of *B. sorokiniana* in seed samples (%): Balder 10, Etu 13, Karri 9, Lise 0, Mari 10, Paavo 8, Pirkka 0, Pomo 31, Olli 0, Otra 6 and Vigdis 19. Severe infection of the embryo was detected with the cvs Pomo and Vigdis with an incidence of 10 %. The following summer the mean percent infected seeds of cv. Vigdis was 60.0.

According to surveys of commercial samples of spring barley in 1974—1977 *B. sorokiniana* was a common and widespread fungus throughout the country, wherever barley is grown (Table 2). In 1974, when the fungus was exceptionally common, several samples with high incidence of seed infection were recorded. Differences in the incidence were also found between the cultivars. Each year the highest levels occurred in cv. Paavo. All these samples with high *B. sorokiniana* incidence were also severely infected in the embryos.

Clear differences in incidence between geographic areas could not be found, but it seems obvious that fungus is less frequent in Western and South Western parts of the country (Turku and Pori and Vaasa counties) (table 3).

Discussion

These surveys and other earlier observations of *Bipolaris sorokiniana* occurring in

barley crop by MÄKELÄ (1971, 1972, 1975) and barley seed by KURPPA (1975) show decisively the incidence of the fungus in barley in Finland.

The infection incidence was clearly associated with certain cultivars as also reported by de TEMPE (1964), KIETREIBER (1973, 1974) and WHITTLE (1977). The true susceptibility to seed borne infection is related to the invasion to the seed by the fungus as reported by ANDERSON and BANTTARI (1976). Superficial invasion is effectively controlled by the use of mercurial seed treatment but infection in the embryo or the surrounding cell layers is not controlled.

Differences in the disease incidence and fungal incidence have also been reported between areas and years by JØRGENSEN (1969) and KIETREIBER (1973, 1974) and these are strongly related to the weather conditions as shown by COUTURE and SUTTON (1977). The higher incidence in central part of the country rather than in the coast area is associated to higher relative humidity and afternoon showers which are more frequent outside the coast area during the critical period of seed ripening.

No regional differences in disease incidence could be found associated to sowing seed because commercially distributed seed is mainly used for sowing. Seed dressing to control the pathogen is increasingly important because it also helps to prevent the accumulation of the fungus as a destructive soil borne pathogen. This is particularly true after rainy growing seasons.

The most important factor in seed infection is the location of the fungus in the seed, either in the seed coat or in the embryo.

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Table 2. The occurrence of *Bipolaris sorokiniana* in commercial samples of spring barley examined yearly during 1974—1977.

| Cultivar | Number of samples examined | | | Per cent samples infected | | | Per cent seeds infected | | | The highest recorded individual % | | |
|---|----------------------------|------|------|---------------------------|-------|------|-------------------------|-------|------|-----------------------------------|------|------|
| | 1974 | 1975 | 1976 | 1977 | 1974 | 1975 | 1976 | 1977 | 1974 | 1975 | 1976 | 1977 |
| | | | | | | | | | | | | |
| Six-row cvs | | | | | | | | | | | | |
| Eero | 0 | 2 | 6 | 13 | — | 0.0 | 0.0 | 23.0 | — | 0.0 | 0.0 | 0.0 |
| Etü | 11 | 4 | 4 | 9 | 63.7 | 25.0 | 25.0 | 56.0 | 4.6 | 2.7 | 1.0 | 1.6 |
| Hja-673 | 3 | 8 | 33 | 25 | 100.0 | 13.0 | 27.0 | 20.0 | 4.0 | 0.1 | 0.8 | 0.8 |
| Otra | 59 | 30 | 54 | 34 | 38.0 | 7.0 | 11.0 | 41.2 | 1.0 | 0.1 | 0.2 | 1.1 |
| Paavo | 5 | 8 | 6 | 5 | 100.0 | 88.0 | 67.0 | 100.0 | 47.4 | 11.8 | 12.8 | 17.4 |
| Pirkka | 23 | 14 | 16 | 9 | 48.0 | 21.4 | 37.5 | 55.6 | 1.1 | 0.4 | 1.2 | 1.7 |
| Pomo | 21 | 18 | 25 | 18 | 85.7 | 11.1 | 55.6 | 27.8 | 3.2 | 0.2 | 1.6 | 1.1 |
| Suvi | 18 | 10 | 5 | 4 | 100.0 | 20.0 | 60.0 | 75.0 | 4.4 | 0.3 | 1.2 | 2.7 |
| Teemu | 0 | 0 | 3 | 4 | — | — | 0.0 | 100.0 | — | — | 0.0 | 3.8 |
| Two-row cvs | | | | | | | | | | | | |
| Birgitta | 2 | 0 | 0 | 0 | 100.0 | — | — | — | 34.0 | — | — | — |
| Eva | 0 | 4 | 9 | 10 | — | 50.0 | 44.4 | 50.0 | — | 0.8 | 0.8 | 3.0 |
| Ingrid | 18 | 6 | 4 | 4 | 66.7 | 16.7 | 0.0 | 25.0 | 2.1 | 0.2 | 0.0 | 0.8 |
| Karri | 37 | 19 | 7 | 9 | 70.0 | 15.8 | 28.6 | 33.3 | 2.6 | 0.9 | 0.7 | 1.5 |
| Mari | 3 | 1 | 0 | 0 | 66.7 | 0.0 | — | — | 9.7 | 0.0 | — | — |
| Yearly number of samples examined | 200 | 126 | 173 | 150 | | | | | | | | |
| Mean per cent of samples and seeds infected | | | | | 60.0 | 19.0 | 28.9 | 38.0 | 3.8 | 1.3 | 1.2 | 1.9 |

Table 3. The regional occurrence of *Bipolaris sorokiniana* in Finland during the growing seasons 1974—1977 as determined by a survey of commercial samples of spring barley.

| County ¹ | Number of samples examined | | | | Per cent samples infected | | | |
|----------------------------------|----------------------------|------|------|------|---------------------------|---------|---------|--------|
| | 1974 | 1975 | 1976 | 1977 | 1974 | 1975 | 1976 | 1977 |
| 1 Turku and Pori | 57 | 43 | 72 | 63 | 62.6 | 20.9 | 26.4 | 23.8 |
| 2 Uusimaa | 31 | 24 | 31 | 15 | 62.5 | 16.7 | 45.2 | 46.7 |
| 3 Kymi | 27 | 11 | 24 | 13 | 66.7 | 18.2 | 29.2 | 84.6 |
| 4 Häme | 30 | 15 | 6 | 20 | 65.9 | 13.3 | 16.6 | 35.0 |
| 5 Mikkeli | 11 | 1 | 1 | 2 | 71.4 | (100.0) | (100.0) | (50.0) |
| 6 Vaasa | 22 | 20 | 27 | 26 | 43.5 | 10.0 | 11.1 | 34.6 |
| 7 Central Finland | 6 | 0 | 5 | 8 | 83.3 | — | 60.0 | 62.5 |
| 8 Kuopio | 13 | 5 | 5 | 3 | 76.9 | 20.0 | 40.0 | 66.7 |
| 9 Northern Karelia | 2 | 0 | 0 | 0 | (0.0) | — | — | — |
| 10 Oulu | 1 | 7 | 2 | 0 | (100.0) | 42.8 | (50.0) | — |
| Total number of samples examined | 200 | 126 | 173 | 150 | | | | |
| Mean per cent samples infected | | | | | 63.0 | 19.0 | 28.9 | 38.0 |

¹ See fig. 3.

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***Bipolaris sorokiniana*-sienen esiintyminen
ohran siementavarassa Suomessa**

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Bipolaris sorokiniana (syn. *Helminthosporium sativum*, koteloaste *Cochliobolus sativus*) todettiin yleiseksi ja potentiaalisesti haitalliseksi sieneksi ohran siementavarassa vuosina 1972—1979 Helsingin yliopiston kasvipatologian laitoksella suoritetuissa tutkimuksissa. Vuosina 1974—1977 tutkittiin 649 siementavaraksi tarkoitettua ohraerää, joista sienen tartuttamiksi todettiin aikajärjestyksessä 60, 19, 29 ja 38 %. Infektoituneita jyviä oli vastaavasti keskimäärin 3.8, 1.3, 1.2 ja 1.9 % tutkituista. Lajikkeiden välillä oli selviä alttiuseroja, Paavo oli infektoitunein kaikkina vuosina ja yleisesti viljelty Otra tervein. Selviä eroja kaksi- ja monitahoisten lajikkeiden alttiudessa ei todettu. Sientä esiintyi maan länsiosissa jonkin verran vähemmän kuin muualla.

B. sorokiniana esiintyi useimmiten rihmastona siemenkuoressa, mutta monissa tapauksissa se oli infektoinut myös alkion ja sen läheiset solukerrokset, mikä ai-

heutti siemenen itämättömyyden tai oraan sairastumisen heti itämisen jälkeen.

Vuosina 1972—1979 tutkittujen kenttäkokeiden sato-
näytteiden tulokset tukivat otannalla saatuja tuloksia. Koska sieni infektoi jyväsadon sekundäärisesti tuulen mukana leviävien kuromien välityksellä, sen runsaus siemenissä kytkeytyi erityisesti heinä- ja elokuun sademääriin, suhteelliseen ilmankosteuteen ja myös kasvustojen lakoisuuteen. Erityisen kuivissa olosuhteissa sieni ei infektoinut kypsävää jyväsatoa lainkaan.

Sienen todellinen merkitys siemenlevintäisenä taudinaiheuttajana riippuu jyvien infektoituneisuusasteesta; onko sieni vain siemenkuoressa, vaiko myös alkiossa. Pelkän siemenkuoritartunnan saanut kylvösiemen voidaan puhdistaa tehokkaasti taudinaiheuttajasta elohopeapitoisella valmisteella peittaamalla. Toimenpide rajoittaa osaltaan myös sienen lisääntyvää haitallisuutta maalevintäisenä taudinaiheuttajana.