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The effect of foliar fungicides on the mycoflora of seeds of *Triticum aestivum*

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The effect of three foliar fungicides, i.e., Bayleton 25 WP, Dithane M-45, and Funaben K, on the mycoflora associated with the seeds of spring *Triticum aestivum* cv. Kolibri cultivated in the field was investigated. The fungicide which highly reduced the number of both fungal colonies and species was Funaben K. Of the fungi most frequently occurring. Only Funaben K applied on the seeds reduced the proportion of seeds with *Alternaria alternata*, *Cladosporium* spp., and *Septoria nodorum*. In contrast, seeds from plants traeted with Funaben K harboured significantly more colonies of non-sporulating fungi.

INTRODUCTION

The representatives of the mycoflora of cereal seeds have been listed frequently, including those obtained from seeds of wheat (Flannigan, 1971; Hewett, 1965; Łacicowa, 1964). Little attention has been given to microorganisms other than the recognized pathogens, although it was shown that some species associated with seeds can be antagonistic to pathogenic fungi (Fokkema, 1973; Dickinson, Skidmore, 1976). However treatment modified the mycoflora of flag leaves, glumes, and seeds of wheat and barley (Dickinson, 1973; Dickinson, Wallace, 1976). However, these modifications highly depended on e.g. the components of the mycoflora (Hill, Lacey, 1983; Luke, Barnet, Morey, 1977), the fungicides used (Dickinson, 1973), and time of application (Dickinson, Wallace, 1976).

The aim of this study was to determine the effect of three fungicides applied to foliage on the mycoflora of seeds of wheat.

MATERIALS AND METHODS

In 1982-1984, a field experiment at the Agricultural Experiment Station Lipki near Stargard Szczeciński was conducted. The following conditions were set up:
— forecrop (1982-1984) – *Solanum tuberosum* L.,
— experimental design – randomized complete block design with four replicates,
— plant – spring wheat (*Triticum aestivum* L.), cv. Kolibri,
— fertilization (kg/ha): N – 80; P_2O_5 – 110; K_2O – 120,
— fungicides – (1) Bayleton 25 WP, containing 25 % of triadimefon, at a rate of 0.5 kg/ha; (2) Dithane M-45, containing 80 % of mancozep, at a rate of 1.8 kg/ha; and Funaben K, containing 40 % of carbendazim + 40 % captafol, at a rate of 1.5 kg/ha.

Seeds of *T. aestivum* were sown on 23, 21, and 20 April in 1982, 1983, and 1984, respectively. Plots of dimensions of 1.8 x 1.8 m were separated from one another by protective strips 1.8 m wide seeded with *Secale cereale* L. The fungicide sprays were applied with the knapsack sprayer Armitsu. Plants were treated with fungicides twice during each vegetative period, i.e., at the time of shooting (stage 6-7 after Feekes) (L a r g e, 1954) and the beginnig of heading (stage 10.1). Control plants received water-spray applications.

At plant maturation, 100 randomly selected ears were separately collected from each plot. In the laboratory, 25 seeds from each plot were selected randomly and surface desinfected in a 0.1 % solution of $HgCl_2$ prior to fungal isolation. The mycoflora was investigated by placement of five seeds in each 10 cm Petri dish containing potato glucose agar (PGA). The Petri dishes were incubated under room conditions for 10-14 days. At the end of this period, fungal colonies growing out of each seed were transferred individually to PGA slants and identified.

Fungal species were identified according to A r x (1970), B a r n e t t (1960), B o o t h (1971), de V r i e s (1959), D o m s c h, G a m s (1970), D r e c h s l e r (1923), E l l i s (1971), G a m s (1971), G i l m a n (1945), R a p e r, T h o m (1949), R a p e r, F e n n e l (1965), Z y c h a, S i e p m a n n, L i n n e m a n n (1969). Except for *Septoria nodorum*, representatives of the other species were grown from single conidia in Petri dishes of PGA at room temperature with a 12-h photoperiod under cool white fluorescent lamps located 40 cm above cultures. Cultures were grown for 10-14 days. *S. nodorum* was cultured on oatmeal agar, as this medium produces distinctive colonies with abundantly sporulating pycnidia.

Data were processed by analysis of variance. The statistical significance of differences between means was determined using the least significant difference (LSD) at $P = 0.05$ calculated from the Tukey test.

RESULTS

In total of 1720 fungal colonies belonging to 14, 14, and 19 species, respectively, were isolated (Tab. 1) from seeds of wheat.

Table 1

The effect of fungicides on the occurrence of fungi associated with seeds of *Triticum aestivum*

Fungus	Bayleton 25 WP			Dithane M-45			Funaben K			Control		
	1982	1983	1984	1982	1983	1984	1982	1983	1984	1982	1983	1984
Acremoniella atra Sacc.	–	–	–	–	–	–	–	–	–	–	–	1
Alternaria alternata (Fr.) Keissler	25	54	77	32	52	74	34	24	37	54	50	72
Aureobasidium pullulans (de Bary) Arn.	2	4	1	–	1	–	–	–	–	–	1	1
Botrytis cinerea Pers. Fr.	–	–	1	–	–	2	–	–	1	4	–	5
Cladosporium cladosporioides (Fres.) de Vries	2	5	1	–	1	–	–	1	–	2	8	1
C. herbarum (Pers.: Fr.) Link	30	13	3	23	9	2	12	5	–	30	5	1
C. macrocarpum Preuss	1	1	–	1	1	1	–	–	–	1	–	–
Epicoccum purpurascens Link	–	1	5	–	3	9	–	2	–	2	8	1
Fusarium culmorum (W. G. Smith) Sacc.	–	–	–	–	–	2	–	–	–	–	1	1
F. graminearum Schwabe	–	–	–	–	–	–	–	–	1	–	1	–
F. lateritium Nees	–	–	2	–	–	–	–	–	–	–	–	2
F. oxysporum Schl.	–	–	–	–	–	–	–	–	–	–	–	2
F. poae (Peck) Wollenw.	4	2	–	4	1	–	–	–	–	–	1	–
Gonatobotrys simplex Corda	–	–	–	–	–	1	–	–	1	–	–	1
Helmithosporium sativum Pammel, King, Bakke = *Bipolaris sorokiniana* (Sacc.) Schoemaker	–	–	–	1	–	1	–	1	4	1	–	3
H. triseptatum Drechsl.	–	–	–	–	–	1	–	–	1	–	–	2
Mucor hiemalis Wehmer	2	–	–	–	–	1	–	–	–	–	1	–
M. strictus Hagem	–	–	–	–	–	–	–	–	–	–	–	1
Nigrospora oryzae (Berk. et Br.) Petch	–	–	–	–	–	1	–	–	–	–	–	–
Penicillium notatum Westling	–	–	1	–	–	–	–	–	–	–	–	–
Penicillium spp.	–	–	1	6	–	1	4	–	–	8	–	2
Phoma sp.	–	1	–	–	1	–	–	–	–	–	1	–
Septoria nodorum Berk.	6	–	–	5	1	6	–	–	–	11	4	12
Stemphylium botryosum Wallr.	2	3	–	2	–	–	2	1	–	4	1	1
Trichothecium roseum Link	–	15	–	–	–	–	–	–	1	–	–	–
Trichoderma viride Pers.: Fr.	–	–	–	–	–	–	1	–	–	–	–	–
Ulocladium botrytis Preuss	–	–	–	1	–	–	–	2	–	–	–	–
Yeast-like pink	8	7	3	–	4	–	–	3	3	4	–	5
Non-sporulating	61	50	74	66	56	27	74	59	83	46	65	67
Total	143	156	169	141	130	129	127	98	132	167	147	181
No. of species	9	9	8	8	8	12	4	7	7	9	11	16

The fungi most frequently recovered were *Alternaria alternata*, *Cladosporium* spp., and non-sporulating fungi (Table 1). Species most abundantly found were *Epicoccum purpurascens*, *Septoria nodorum*, and fungi forming yeasts-like pink colonies.

The fungicide which inhabited the development of the mycoflora associated with the seeds investigated the most was Funaben K. It reduced the number of fungi by 24 % (in 1982) and 35 % (in 1983). The lowest toxicity was indicated by Bayleton 25 WP.

Funaben K lowered the number of fungal species the most. The range of decrease was from 36 (in 1983) to 56 % (in 1982 and 1984).

Of the fungi most frequently occurring, only Funaben K significantly reduced the proportion of seeds contaminated by *A. alternata*, *Cladosporium* spp., and *Septoria nodorum* (Table 2). *S. nodorum* was completely eliminated in all the years of this study. In contrast, plant treatment with Funaben K significantly increased the occurrence of seeds with non-sporulating fungi.

Table 2

The effect of fungicides on the proportion of seeds colonized by fungi (means for 1982-1984)

Fungi	Bayleton 25 WP	Dithane M-45	Funaben K	Control
Alternaria alternata	32.6 a	40.0 a	26.4 b	35.4 a
Cladosporium spp.	12.6 a	9.3 a	4.8 b	9.9 a
Epicoccum purpurascens	1.2 a	3.1 a	0.7 a	2.4 a
Septoria nodorum	1.4 a	3.0 a	0.0 b	5.3 a
Yeast-like pink	4.0 a	1.0 a	1.8 a	1.7 a
Non-sporulating	39.5 a	36.7 a	60.5 a	36.2 a

Means followed by the same letter do not differ significantly at the 5 % level acording to Tukey test.

DISCUSSION

Most of the fungal species recovered in the present study have been previously isolated from *Triticum aestivum* seeds (e.g., Flannigan, 1971; Hewett, 1965). These include: *Alternaria alternata*, *Cladosporium* spp., *Epicoccum purpurascens*, *Septoria nodorum*, yeast-like pink colonies, and non-sporulating fungi, predominating in mycoflora of wheat seeds (Hewett, 1965; Hill, Lacey, 1983; Luke, Barnett, Morey, 1977; Łacicowa, 1964).

The most toxic fungicide with respect to both the total number of fungi and the number of species associated with the seeds examined during the present study was Funaben K. Carbendazim-generating fungicides have a broad spectrum of toxicity against fungi (Webster, Cook, 1979).

The inhibitory effect of Funaben K on *Alternaria alternata* contradicts the results obtained by Edgington (1971) in which this species has been shown to be tolerant to benomyl.

The reason for the increased proportion of non-sporulating fungi in the seed mycoflora of wheat treated with Funaben K compared with that from control plots was probably the vacation of niches occupied earlier by *Alternaria alternata*, *Cladosporum* spp., and *S. nodorum*, as Edgington, Khew, Barron (1971) suggested.

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