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FUNGI COLONIZING GRAIN OF WINTER SPELT GROWN UNDER TWO PRODUCTION SYSTEMS

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Abstract

Grain of winter spelt cv. 'Schwabenkorn' grown in 2004–2006 under organic farming and conventional farming systems was investigated, to determine the species composition and abundance of fungi colonizing the grains.

A total of 1264 colonies in the organic system and 1170 colonies in the conventional system, were isolated. The predominant fungal species was *Alternaria alternata*. Winter spelt grain was also colonized by a high number of *Botrytis cinerea* (only in 2005), *Epicoccum purpurascens* and *Fusarium* spp. The share of non-sporulating fungi was relatively high under both production systems.

Key words: fungi, grains, winter spelt, conventional farming system, organic farming system

Introduction

Spelt is an old species of wheat that had been grown in Europe for hundreds of years. Once almost forgotten, it has now been rediscovered and today is grown commercially on a larger scale, particularly on organic farms (Tyburski and Żuk-Gołaszewska 2005). Compared with common wheat, spelt has lower habitat requirements, is more resistant to adverse climate conditions, and able to better utilize nutrients (Cyrkler-Degulis and Bulińska-Radomska 2006). Due to a high content of valuable nutrients in the grain, spelt is widely used for production of pasta, breakfast flakes, soup concentrates and other functional food products (Gąsiorowski 2004). However, spelt grain is difficult to thresh, and its total yield is lower than that of common wheat. Available literature provides information on pests attacking spelt kernels (Kordan et al. 2007), but there are no reports concerning fungi colonizing spelt grain.

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The aim of this study was to determine species composition and abundance of fungi colonizing grains of winter spelt grown under organic farming and conventional farming systems.

Materials and methods

Laboratory experiment was carried out in 2004–2006. The grain of winter spelt cv. 'Schwabenkorn' was obtained from a field experiment established in Bałcyny near Ostróda (north-east Poland), where winter spelt was grown under organic farming and conventional farming systems. According to the method proposed by Narkiewicz-Jodko (1986), 100 healthy well-developed grains and 100 small grains or with disease symptoms were randomly selected from each treatment. Within each sample of 100 grains, 50 grains were rinsed in sterile water, dried on sterile filter paper and placed on solid PDA medium, and the remaining 50 grains were surface-disinfected for 30 s in 50% ethyl alcohol and for another 30 s in a 0.1% solution of sodium hypochlorite, rinsed three times in sterile water, dried on sterile filter paper and placed on solid PDA medium. Incubation was conducted in an incubator at approximately 20°C, for five–seven days. The fungal colonies that developed were transferred to PDA slants, and the cultures were identified based on the relevant keys.

Results

A total of 2434 fungal colonies representing 30 taxa and non-sporulating mycelia, including 1264 colonies in the organic system and 1170 colonies in the conventional system, were isolated from winter spelt grain (Tables 1, 2). Irrespective of the production system, the predominant fungal species isolated from spelt grains was *Alternaria alternata,* which accounted for 42.0% and 47.3% of all isolates in the organic and conventional system, respectively. Winter spelt grain was also colonized by a high number of *Botrytis cinerea* (but only in 2005) and *Epicoccum purpurascens* colonies. Under the organic farming system, *B. cinerea* accounted for 10.7% and *E. purpurascens* for 13.2% of all colonies isolated from spelt grain, while under the conventional system the respective values were 11.7% and 10.9%. Spelt grains were also colonized by members of the *Fusarium* genus, which accounted for 5.4% and 10.3% of all isolated cultures in the organic and conventional system, respectively. The percentage share of non-sporulating colonies was relatively high under both production systems (12.1% in the organic system and 7.2% in the conventional system).

More colonies of *B. cinerea,* but only in 2005, were isolated from non-disinfected grains, compared with the disinfected ones (6.2% and 4.5%, respectively, in the organic system, and 7.6% and 4.1%, respectively, in the conventional system). Among *Fusarium* spp. the predominant species was *F. poae* (2.0% and 6.8% of all

Table 1

Fungi isolated from grains of winter spelt grown under organic farming system

Species of fungus	2004				2005				2006				Sum	%
	small grains		well-developed		small grains		well-developed		small grains		well-developed			
	d	nd	d	nd	d	nd	d	nd	d	nd	d	nd		
Acremoniella atra	–	–	–	–	–	–	–	–	31	16	19	33	99	7.8
Alternaria alternata	42	48	51	57	43	54	34	38	24	30	60	51	532	42.0
Arthrinium phaeospermum	–	–	–	–	4	–	3	7	–	–	–	–	14	1.1
Aureobasidium pullulans	–	–	–	–	1	–	3	–	–	–	–	–	4	0.3
Bipolaris sorokiniana	–	–	–	–	–	1	–	–	2	1	7	2	13	1.0
Botrytis cinerea	–	–	–	–	36	47	21	31	–	–	–	–	135	10.7
Chaetomium murorum	–	–	–	–	–	–	–	–	3	–	–	–	3	0.2
Cladosporium cladosporioides	–	–	–	–	–	–	1	–	–	–	–	–	1	0.1
Cylindrocarpon destructans	–	6	–	10	–	–	–	–	–	–	–	–	16	1.3
Epicoccum purpurascens	8	3	8	6	27	31	22	37	4	14	2	5	167	13.2
Fusarium avenaceum	–	3	–	–	–	–	–	2	–	–	–	–	5	0.4
Fusarium chlamydosporum	–	–	–	–	–	1	–	–	–	–	–	–	1	0.1
Fusarium culmorum	–	–	–	–	–	–	–	1	–	–	–	6	7	0.6
Fusarium equiseti	–	–	–	–	2	–	–	1	3	–	1	3	10	0.8
Fusarium graminearum	–	–	–	–	–	–	–	–	1	–	–	–	1	0.1
Fusarium poae	–	–	–	–	–	1	–	5	8	7	3	1	25	2.0
Fusarium sambucinum	–	–	–	–	–	–	–	1	–	–	–	–	1	0.1
Fusarium solani	–	–	–	–	–	–	1	1	–	–	–	–	2	0.2
Fusarium sporotrichioides	–	–	–	–	–	1	–	2	–	–	–	–	3	0.2
Fusarium spp.	–	–	–	–	1	4	1	3	–	2	–	1	12	0.9
Mucor circinelloides	–	6	–	–	–	–	–	–	–	–	–	–	6	0.5
Rhizopus nigricans	–	–	–	–	7	–	15	7	–	25	–	–	54	4.3
Non sporulating fungi	23	29	23	30	2	1	3	1	21	6	9	5	153	12.1
Total	73	95	82	103	123	141	104	137	97	101	101	107	1264	100.0

d – disinfected seeds, nd – not disinfected seeds.

Table 2

Fungi isolated from grains of winter spelt grown under conventional farming system

Species of fungus	2004				2005				2006				Sum	%
	small grains		well-developed		small grains		well-developed		small grains		well-developed			
	d	nd	d	nd	d	nd	d	nd	d	nd	d	nd		
Alternaria alternata	48	58	33	39	28	48	38	50	41	40	77	54	554	47.3
Arthrinium phaeospermum	–	–	–	–	8	10	8	5	–	–	–	–	31	2.6
Bipolaris sorokiniana	–	–	–	3	15	–	–	2	–	–	3	5	28	2.4
Botrytis cinerea	–	–	–	–	17	43	30	46	–	–	1	–	137	11.7
Chaetomium murorum	–	–	–	–	–	–	–	–	–	–	3	–	3	0.3
Epicoccum purpurascens	8	3	12	5	20	20	9	23	16	6	4	2	128	10.9
Fusarium avenaceum	–	4	–	–	–	–	4	–	–	–	–	1	9	0.8
Fusarium culmorum	–	–	–	–	1	1	–	–	–	–	1	–	3	0.3
Fusarium equiseti	–	–	–	–	–	2	–	–	–	–	–	1	3	0.3
Fusarium oxysporum	–	–	–	–	–	1	–	–	–	–	–	–	1	0.1
Fusarium poae	–	–	–	–	1	–	–	1	43	29	3	3	80	6.8
Fusarium sambucinum	–	–	–	–	–	6	1	–	–	–	–	–	7	0.6
Fusarium semitectum	–	–	–	–	–	–	–	–	–	–	–	1	1	0.1
Fusarium sporotrichioides	–	–	–	–	–	–	–	–	–	–	–	1	1	0.1
Fusarium tricinctum	–	–	–	–	–	–	–	4	–	–	–	–	4	0.3
Fusarium verticillioides	–	–	–	–	2	1	–	–	–	–	–	–	3	0.3
Fusarium spp.	–	–	–	–	4	–	–	2	–	–	–	–	6	0.5
Microdochium nivale	–	–	–	–	–	–	–	–	–	–	1	–	1	0.1
Penicillium spp.	–	–	–	–	–	–	1	–	–	–	3	–	4	0.3
Periconia macrospinosa	–	–	–	–	1	–	–	1	–	–	–	–	2	0.2
Rhizopus nigricans	–	–	–	–	7	–	14	7	–	25	–	27	80	6.8
Non sporulating fungi	2	5	20	42	1	–	2	–	1	–	7	4	84	7.2
Total	58	70	65	89	105	132	107	141	101	100	103	99	1 170	100.0

d – disinfected seeds, nd – not disinfected seeds.

isolates in the organic and conventional system, respectively), which was more frequently isolated from infected grains than from the healthy ones. Under the conventional farming system, significantly more fungal colonies of the genus *Fusarium* were isolated from poorly developed grains, in comparison with the well-developed ones (8.1% and 2.1%, respectively).

Discussion

Among a total of 2434 fungal colonies, 52% of cultures were isolated from spelt grown in organic system, and 48% – from spelt grown in conventional system. This indicates that organic farming influence the quantity of microorganisms. Similar results were reported by Fliessbach and Mäder (2000).

Irrespective of the production system, the predominant fungal species isolated from spelt kernels was *Alternaria alternata*. This is a typical cosmopolitan species which dominates among isolates obtained from grain of all cereal crops (Pandey 1978, Baturo 2002, Burgieł and Pisulewska 2003). *Epicoccum purpurascens* also occurred in great abundance, particularly in the organic system. Hill and Lacey (1983), and Błaszkowski and Piech (2002) also noted a high occurrence frequency of *E. purpurascens* on barley and oat grain. Authors vary in their opinions on the effect of the two above mentioned fungal species on grain and cereal crops. According to Gabińska et al. (1991) and Narkiewicz-Jodko (1991), the presence of these fungi on kernels has no impact on seed quality. According to Hudson (1978) and Pokacka (1987), *A. alternata* and *E. purpurascens* are weak pathogens that accelerate the withering of cereal crops and cause kernel discoloration, including the development of black spots.

Members of the *Fusarium* genus were relatively non-abundant. More colonies were isolated under the conventional system than under the organic system (10.3% and 5.4% of all cultures, respectively). *Bipolaris sorokiniana* was also isolated much more frequently in the conventional farming system. As demonstrated by some authors (Trewavas 2001, Baturo 2002), organic farming may promote the growth of the analyzed fungi. However, studies conducted by Kuś and Mróz (2000), and Łukanowski and Sadowski (2002) did not confirm this hypothesis with respect to *Fusarium* spp. Experiments carried out by Wiwart et al. (2004) and Suchowilska et al. (2007), which involved inoculation of spelt heads with *F. culmorum* spores, showed that the infection rate of spelt kernels was higher, in comparison with common wheat kernels, and that spelt responded to infection with a greater yield decrease. In the present study only single colonies of *F. culmorum* were isolated from winter spelt. *Fusarium poae* dominated among fungi of the genus *Fusarium*. This species is generally not a severe pathogen of cereals, but it may create a serious threat to human and animal health as a producer of mycotoxins (Parry and Nicholson 1996, Bottalico and Perrone 2002).

A distinguishing feature of the isolates obtained from spelt kernels, not described in phytopathological literature, was a very large number of *B. cinerea* colo-

nies, which, however, were isolated in one year of the study only. The great abundance of *B. cinerea* on spelt kernels in 2005 could have resulted from high average temperature and high precipitation in July. The fungus is a common saprotroph and facultative parasite that attacks vegetables as well as orchard, ornamental and industrial plants. Nowicki et al. (1996) reported moderate pathogenicity of *B. cinerea* to cereal seedlings.

Conclusions

1. The grain of winter spelt grown under organic system was colonized by a higher number of fungi, as compared with the conventional system.
2. In both production systems, the predominant fungal species was *Alternaria alternata*.
3. Fungi of the genus *Fusarium* were more abundant on spelt kernels in the conventional farming system. *Fusarium poae*, isolated primarily from small kernels with infection symptoms, dominated among them.
4. *Botrytis cinerea* occurred in great abundance, but in one year of the study only. More colonies were isolated from non-disinfected kernels.
5. The most abundant saprotroph was *Epicoccum purpurascens*, followed by *Rhizopus nigricans*.

Streszczenie

GRZYBY ZASIEDLAJĄCE ZIARNO PSZENICY ORKISZ UPRAWIANEJ W DWÓCH SYSTEMACH GOSPODAROWANIA

Ziarno orkiszu ozimego odmiany ‘Schwabenkorn’ pochodziło z doświadczenia polowego zlokalizowanego w Bałcynach koło Ostródy, gdzie orkisz uprawiano w latach 2004–2006 w systemach ekologicznym i konwencjonalnym. Celem badań było określenie składu gatunkowego i liczebności grzybów zasiedlających ziarniaki orkiszu ozimego uprawianego w dwóch systemach gospodarowania.

Z ziarna orkiszu ozimego uprawianego w systemie ekologicznym wyizolowano ogółem 1264 kolonie grzybów, a z uprawianego w systemie konwencjonalnym – 1170 kolonii. Gatunek *Alternaria alternata* dominował na ziarniakach orkiszu, niezależnie od systemu gospodarowania. Wyizolowano również dużą liczbę kultur: *Botrytis cinerea* (tylko w 2005 roku), *Epicoccum purpurascens*, *Fusarium* spp. oraz kolonii niezarodnikujących.

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