BIULETYN INSTYTUTU HODOWLI I AKLIMATYZACJI ROŚLIN Nr 294 / 2021 : 3–12
E-ISSN: 2657–8913

Oryginalny artykuł naukowy
Original research paper

Ocena zdrowotności materiału nasiennego traw w zależności od wybranych zapraw nasiennych

Estimation of the seed health of sowing material of grasses in dependence of selected seed treatments

Barbara Wiewióra ✉, Dagmara Bronisz

Zakład Nasiennictwa i Nasionoznawstwa
Instytut Hodowli i Aklimatyzacji Roślin – PIB,
✉ e-mail: b.wiewiora@ihar.edu.pl

Celem pracy było określenie wpływu wybranych zapraw nasiennych na zdrowotność nasion traw: kostrzewy łąkowej i życicy trwałej z trzech kolejnych lat zbioru, otrzymanych od hodowców. Materiał do badań stanowiły nasiona czterech odmian kostrzewy łąkowej (*Festuca pratesis*) i czterech odmian życicy trwałej (*Lolium perenne*). Badano materiał siewny traktowany czterema zaprawami: dwie biologiczne Bioczos (ekstakt z czosnku) i Polyversum (oospory grzyba *Pythium oligandrum*) i dwie chemiczne Maxim (substancja aktywna: fludioksonil) i Vitavax (substancja aktywna: karboksyna i tiuram) oraz nasiona niezaprawiane, powierzchniowo odkażone podchlorynem sodu. Nasiona badanych gatunków i odmian były licznie zasiedlone przez grzyby zarówno saprotroficzne: *Alternaria alternata, Aureobasidium pullulans*, *Epicoccum purpurascens* i *Penicillium* spp. jak i patogeny: *Fusarium* spp. oraz *Drechslera* spp. i *Bipolaris sorokiniana*. Stwierdzono, że zastosowanie zapraw chemicznych, zwłaszcza użycie zaprawy Vitavax wpływa pozytywnie na poprawę zdrowotności wyrażoną liczbą kolonii grzybowych, w tym głównych patogenów. Nie obserwowano jednak znaczącej poprawy zdolności kiełkowania badanych nasion.

Słowa kluczowe: grzyby, patogeny, trawy, zaprawianie, zdrowotność nasion

The aim of the study was to determine the effect of selected seed treatments on the health of grass seeds obtained from breeders: meadow fescue and perennial ryegrass from three years of harvest. The research material consisted of seeds from four varieties of meadow fescue (*Festuca pratensis*) and four varieties of perennial ryegrass (*Lolium perenne*). Seed material was treated with four products: two biological agents, i.e. Bioczos (garlic extract) and Polyversum (oospores of the fungus *Pythium oligandrum*), and two chemical agents, i.e. Maxim (fludioxonil) and Vitavax (carboxin and thiuram). Untreated seeds were only surface-disinfected with sodium hypochlorite. Seeds of the studied species and cultivars were colonized by saprotrophic fungi: *Alternaria alternata*, *Aureobasidium pullulans*, *Epicoccum purpurascens* and *Penicillium* spp., as well as pathogens: *Fusarium* spp., *Drechslera* spp. and *Bipolaris sorokiniana*. Chemical treatments, especially the use of Vitavax, had a positive effect on seed health measured by the number of fungal colonies, including major pathogens. However, no significant increase in the germination capacity of the tested seeds was observed.

Key words: fungi, grasses, pathogens, seed health, treatments.

Introduction

The quality of seeds of agricultural plants is determined by many factors, including the use of various active substances, both chemical and biological, for seed treatment (Sharma et al., 2015). Dressing is one of the most popular procedures to improve seed quality, and it involves coating seeds with insecticides, fungicides, growth stimulants etc. combined with an adhesive (Kumar S., 2012; Forsberg et al., 2003). Before treatment, an assessment should be performed in order to identify fungal pathogens, since information about seedborne pathogens associated with a given species is essential for the selection of an adequate dressing substance. Pathogens transmitted with seeds are dangerous for seedlings and adult plants, because when introduced into the soil, they might develop and attack plants under favourable conditions and can also be a source of infection for neighbouring crops. Most of these pathogens cause leaf blotch that limits nutrient assimilation and accelerates transpiration (Kutrzeba, 1994b). Negative effects of these processes include premature drying of the leaves, retarded plant development, or deterioration of the yield and quality of fodder if the disease affects grasses grown for forage. In grasses grown for turf such changes are unfavourable,

Managing editor: Wojciech Nowacki.

because users want an attractive lawn, and discolouration or patches are unsightly (Prończuk, 1996). The presence of fungal pathogens, e.g. *Fusarium* spp. on pastures is also gaining importance. These pathogens are not commonly associated with livestock feeding systems, but a study carried out in New Zealand found that toxins from *Fusarium* species in pasture herbage may have a negative effect on animal health (Di Menna et al. 1987, 1991). This negative effect concerns impaired or reduced reproductive performance of ewes (Smith et al., 1990). These findings prompted the authors to investigate seed health, in particular to identify fungal pathogens present on the seeds, and to search for solutions to improve seed heath by treatment.

Materials and Methods

The research material consisted of seeds from four varieties of meadow fescue (*Festuca pratensis*): Pasja, Wanda, Artema and Fantazja, and four varieties of perennial ryegrass (*Lolium perenne*): Flinston, Baronka, Rela and Malowana, harvested in 2014, 2015 and 2016. The mycological assays and evaluation of germination capacity were performed for seeds harvested in these years and treated with biological and chemical agents: Bioczos (garlic extract), Polyversum (*Pythium oligandrum* oospores), Maxim (a.s. fludioxonil) and Vitavax (a.s. carboxin and thiram). Untreated seeds were only surface-disinfected with sodium hypochlorite. Seeds were treated with biological and chemical agents according to recommendations provided by the manufacturers. Untreated seeds were surface-disinfected in 1% NaClO for 10 minutes and then rinsed three times in sterile water. This procedure was aimed at reducing the number of rapidly growing saprotrophs contaminating the surface of the seeds. These fungi could prevent the growth and identification of pathogens, whose count was a measure of the effectiveness of a given treatment agent.

Seed health was assessed for 200 seeds of each cultivar treated with the four above-mentioned agents, and for untreated surface-disinfected seeds. Two hundred seeds (4 replication of 50 seeds each) representing each treatment variant were placed on Petri dishes with potato dextrose agar (PDA). Fungal colonies were grown at 18°C in alternating cycle of 12 h NUV radiation (360 nm) and 12 h darkness. The formed fungi were identified for species after 15–20 days of incubation under the above-defined conditions stimulating sporulation using the descriptions included in the following publications: Barnett (1960), Chidambaram et al. (1972), Ellis (1971), Kwaśna et al. (1991), Malone and Muskett (1997). The health of seeds of tested grass species was expressed as the mean number of fungal colonies for three years of harvest and four cultivars.

The germination capacity was assessed following the International Rules for Seed Testing (ISTA, 2019). Statistical analysis of data was performed using Statistica and LSD values were calculated.

Results and Discussion

The mycological analysis revealed abundant fungal colonization of meadow fescue and perennial ryegrass seeds. Between 36 and 39 species of fungi from 23-26 genera were identified on seeds of both analysed grass species. A greater diversity of fungal species was found on the seeds of perennial ryegrass. The most frequently identified saprotrophic fungi were: *Alternaria alternata, Aureobasidium pullulans*, *Epicoccum purpurascens*, *Cladosporium herbarum* and *Penicillium* spp., and pathogenic *Bipolaris*, *Drechslera* and *Fusarium* (Tabs. 1 and 2). Similar fungi have previously been isolated and identified by Kućmierz et al. (1992), Kutrzeba (1994 a and b), Wiewióra and Prończuk (2000), and Pańka et al. (2010). The most common pathogenic fungi identified on the seeds of meadow fescue and perennial ryegrass were 4 *Drechslera* species (*D. dematioidea*, *D. dictyoides*, *D. siccans*, *D. triseptata*) and 10 *Fusarium* species (*F. avenaceum*, *F. culmorum*, *F. equiseti*, *F. graminearum*, *F. oxysporum, F. poae*, *F. semitectum*, *F. solani*, *F. sporotrichoides*, and *F. tricinctum*). The number of fungal colonies was highest on seeds treated with biological agents: Bioczos and Polyversum. In a parallel experiment with surface-disinfected seeds the mean number of cultured fungal colonies was lower compared to these two agents: by 36-39% for perennial ryegrass and by 23-40% for meadow fescue cultivars (Tabs. 1 and 2). Statistical analysis showed significant differences in the number of colonies depending on the treatment, cultivar and harvest year for both meadow fescue and perennial ryegrass (Tabs. 3 and 4, Figs. 2a and 3a). The most frequently isolated fungal species from the seeds of meadow fescue and perennial ryegrass was saprotrophic *Alternaria alternata*, which, depending on the test variant, accounted for 12.5-66.4% of all fungi isolated from perennial ryegrass and 12.2-43.1% of all fungi isolated from meadow fescue (Tabs. 1 and 2). Studies by Tulloch and Leach (1972), and Labruyere (1980) suggested that *Alternaria alternata* can be used as an approximate indicator of the quality of seed

Table 1
Tabela 1

The fungi species isolated from the seeds of meadow fescue (average of three years and four cultivars).

Wyizolowane z nasion kostrzewy łąkowej gatunki grzybów (średnia z trzech lat i czterech odmian).

Gatunek grzyba/ Fungus species	Liczba kolonii (średnio dla odmian i lat badań) Number of colonies (mean for cultivars and research years)				
	Niezaprawiane/ Untreated	Bioczos	Polyversum	Maxim	Vitavax
Acremoniella atra	-	-	0,17	-	-
Acremonium spp.	0,16	0,23	0,07	0,07	-
Alternaria alternata	27,93	40,90	27,20	5,30	1,00
Ascochyta sp.	0,20	1,43	0,20	0,60	-
Aspergillus spp.	0,23	0,03	0,03	0,73	0,03
Aureobasidium pullulans	3,50	16,60	18,80	8,10	0,53
Bipolaris sorokiniana	0,60	0,27	0,07	-	-
Botrytis cinerea	0,03	0,17	0,27	-	-
Cladosporium herbarum	0,47	3,63	2,73	3,73	0,07
Drechslera dematioidea	0,17	0,07	-	-	-
Drechslera dictyoides	7,87	2,03	0,60	-	-
Drechslera siccans	8,87	5,87	2,67	0,27	0,23
Drechslera triseptata	-	0,07	0,07	-	-
Epicocum purpurascens	7,90	15,23	15,13	1,00	0,20
Fusarium avenaceum	0,13	0,70	0,37	-	-
Fusarium culmorum	0,07	0,63	0,83	0,23	-
Fusarium equiseti	0,13	1,47	1,33	-	-
Fusarium graminearum	-	0,57	0,20	-	-
Fusarium oxysporum	-	0,07	0,07	-	-
Fusarium poae	-	0,30	0,10	-	-
Fusarium semitectum	0,10	0,37	0,17	0,23	-
Fusarium solani	0,23	0,23	0,60	0,10	-
Fusarium sporotrichioides	-	0,07	-	-	-
Fusarium tricinctum	-	0,03	0,03	-	-
Microdochium spp.	0,07	-	-	-	-
Mucor spp.	0,23	0,87	0,80	0,60	0,03
Papularia arundinis	0,17	0,37	-	0,23	-
Penicillium spp.	2,03	9,43	13,40	12,47	5,97
Phoma spp.	0,80	2,57	0,50	1,90	-
Rhizopus sp.	0,27	1,33	1,30	0,63	0,07
Septoria sp.	0,27	0,17	0,03	0,17	-
Sordaria fimicola	0,03	-	-	-	-
Stemphylium botryosum	1,03	0,27	0,17	-	-
Stemphylium consortiale	0,70	1,60	0,33	0,10	-
Trichoderma viride	0,07	0,10	0,03	0,03	-
Trichotecium roseum	-	0,20	-	-	-
grzybnia niezarodnikująca/ non-sporulating mycelium	0,53	0,07	0,07	0,47	0,07
Ogółem/Total	64,79	107,95	88,41	36,96	8,20

material, and its presence also reflects unfavourable weather conditions during seed harvest. Moreover, Kućmierz and Gorajczyk (1991) concluded that *A. alternata* strongly inhibits germination, but reduces the germination capacity only to a small degree. Zang et al. (2006) reported that *Fusarium* spp. and *Bipolaris sorokiniana* have the strongest inhibitory effect on seed germination by producing secondary metabolites or causing direct injury to seed tissues. Our study did not confirm these findings, as the germination capacity of the examined varieties and species was at the level of 87-93% and statistical analysis showed no significant differences between species, varieties or the tested combinations. Nevertheless, it should be noted that the used treatment agents, despite significant changes in the occurrence of fungi, had no significant effect on the germination capacity of tested seeds (Fig. 1). *Fusarium* and *Drechslera* fungi are among the most frequently isolated pathogens of grass seeds (Vargas, 1994; Wiewióra and Prończuk, 2002; Wiewióra, 2012). Our study supports previously reported data, particularly with regard to *Drechslera* species, because on untreated seeds the number of their colonies was 18.50/100 seeds for meadow fescue and 5.50/100 seeds for perennial ryegrass. There were significant differences between cultivars of both grass species. The mean number of colonies ranged from 3.40/100 seeds for Fantazja to 8.87/100 seeds for Artema in meadow fescue, and from 0.53/100 seeds for Flinston to 4.27/100 seeds for Rela in perennial ryegrass. There were also differences in the occurrence of *Drechslera* fungi between harvest years, and the number of colonies ranged from 3.20 to 11.45/100 seeds for meadow fescue and from 1.90 to 2.05/100 seeds for perennial ryegrass (Tabs. 3 and 4). It should also be emphasized that all types of treatments significantly reduced the infection of seeds from both grass species with these pathogens compared to seeds that were only surface-disinfected (Figs. 2b and 3b).

The mean number of isolated *Fusarium* colonies was much lower (untreated samples: 0.92/100 seeds of meadow fescue, and 2.67/100 seeds of perennial ryegrass). The effectiveness of treatments against these pathogens was only observed for chemical agents (Tabs. 3 and 4, Figs. 2c and 3c). The highest frequency of *Fusarium* fungi was observed in seeds treated with biological agents. For meadow fescue seeds the number of colonies increased to 4.58/100 seeds treated with Polyversum and to 5.75/100 seeds treated with Bioczos. A similar relationship was observed for perennial ryegrass seeds, where the mean number of *Fusarium* colonies was 6.75/100 seeds treated with Polyversum and 6.42/100 seeds treated with Bioczos (Tabs. 3 and 4). Significant differences were also observed in the mean number of *Fusarium* colonies between the cultivars of both grass species. It ranged from 0.60/100 seeds for Wanda to 5.60/100 seeds for Fantazja (meadow fescue), and from 1.87/100 seeds for Baronka to 5.40/100 seeds for Flinston (perennial ryegrass). There were also differences in the occurrence of *Fusarium* spp. between harvest years, and the number of colonies ranged from 0.85 to 5.00/100 seeds for meadow fescue and from 0.30 to 7.55/100 seeds for perennial ryegrass (Tabs. 3 and 4).

The analyses of seed health for both grass species indicated that chemical treatments with Maxim and Vitavax effectively inhibited the growth of fungi, including major pathogens of grasses, which was previously confirmed in a study for other seed treatments carried out by Falloon (1980). The tested biological agents were less effective in reducing the number of fungal colonies, including major pathogens, and in improving the germination capacity in relation to chemical agents.

Agents used for the treatment of meadow fescue seeds significantly reduced the number of *Bipolaris* and *Drechslera* colonies, and the highest effectiveness was found for Maxim and Vitavax. The highest numbers of colonies, including *Fusarium* spp., were isolated from seeds treated with Bioczos and Polyversum. Statistically significant differences in the number of *Fusarium* spp. colonies were also found between seeds treated with these biological agents and chemical agents Maxim and Vitavax (Tab. 3).

Tests on perennial ryegrass revealed that all used agents significantly reduced the number of *Bipolaris* and *Drechslera* colonies compared to untreated seeds, but chemical treatment with Vitavax also caused a significant reduction compared to Bioczos. There were also significant differences in the number of *Fusarium* colonies. The highest total number of fungal colonies was also isolated from perennial ryegrass seeds treated with Bioczos and Polyversum (Tab.4).

Among the tested agents, Maxim and Vitavax were most effective in both analysed species of grass. Bioczos and Polyversum can be used as an alternative in organic farming to reduce the number of *Bipolaris* and *Drechslera* colonies. However, these agents do not control the growth of *Fusarium* fungi as effectively as chemical agents.

Table 2
Tabela 2

The fungi species isolated from the seeds of perennial ryegrass (average of three years and four cultivars).
Wyizolowane z nasion życicy trwałej gatunki grzybów (średnia z trzech lat i czterech odmian).

Gatunek grzyba/ Fungus species	Liczba kolonii (średnio dla odmian i lat badań) Number of colonies (mean for cultivars and research years)				
	Niezaprawiane/ Untreated	Bioczos	Polyversum	Maxim	Vitavax
Acremoniella atra	0,10	0,53	-	-	-
Acremonium spp.	0,07	0,10	0,10	-	-
Alternaria alternata	48,00	48,03	40,17	22,30	3,23
Arthrobotrys superba	-	0,13	0,13	-	-
Ascochyta sp.	0,07	-	0,03	0,03	-
Aspergillus spp.	0,07	0,07	0,43	-	0,03
Aureobasidium pullulans	1,53	9,83	12,53	4,50	0,27
Bipolaris sorokiniana	0,13	0,20	-	-	0,03
Botrytis cinerea	-	0,67	0,87	0,03	-
Cladosporium herbarum	0,67	1,27	1,00	1,90	0,03
Drechslera dematioidea	0,27	0,07	-	-	-
Drechslera dictyoides	1,07	-	-	-	-
Drechslera siccans	3,33	1,97	1,53	0,47	0,13
Drechslera triseptata	0,07	0,03	-	0,10	-
Epicocum purpurascens	7,93	19,10	16,67	3,67	1,20
Fusarium avenaceum	0,57	0,47	0,77	-	0,13
Fusarium culmorum	0,43	0,90	1,20	0,43	0,10
Fusarium equiseti	0,27	0,93	1,07	0,20	-
Fusarium graminearum	0,33	1,07	1,43	0,27	0,03
Fusarium oxysporum	0,20	0,60	0,13	-	-
Fusarium poae	0,20	0,27	0,07	-	-
Fusarium semitectum	-	0,37	0,60	0,10	-
Fusarium solani	0,63	0,93	1,13	0,27	-
Fusarium sporotrichioides	0,03	-	0,13	0,03	-
Fusarium tricinctum	-	0,20	0,07	-	-
Mucor spp.	0,20	1,67	1,97	1,13	0,10
Microdochium spp.	0,27	0,13	0,10	0,10	-
Papularia arundinis	0,40	0,50	0,93	0,10	-
Penicillium spp.	1,87	24,27	25,50	26,00	20,33
Pestalotia sp.	-	-	0,07	-	-
Phoma spp.	0,43	1,17	1,27	1,93	0,03
Rhizoctonia solani	0,13	0,13	0,13	-	-
Rhizopus sp.	0,10	2,13	2,13	0,80	-
Septonema chaetospira	0,93	0,13	-	-	-
Septoria sp.	0,03	0,07	-	-	-
Sordaria fimicola	0,17	0,03	-	-	-
Stemphylium botryosum	0,30	0,10	-	-	-
Stemphylium consortiale	1,43	0,90	0,70	0,63	0,10
Trichoderma viride	-	0,13	-	0,10	-
grzybnia niezarodnikująca/ non-sporulating mycelium	0,07	0,17	0,17	0,33	-
Ogółem/Total	72,30	119,27	113,03	65,42	25,74

Table 3
Tabela 3

Analysis of variance for some fungi infected seeds of meadow fescue (*Festuca pratensis*).
Analiza wariancji dla wybranych grzybów zasiedlających nasiona kostrzewy łąkowej (*Festuca pratensis*).

Czynnik /Agent		*Fusarium*		*Bipolaris i Drechslera*		Grzyby/Fungi	
		Średnie/Mean	Odch. std/ Std. dev.	Średnie/Mean	Odch. std/ Std. dev.	Średnie/Mean	Odch. std/ Std. dev.
Zaprawa Treatment	Niezaprawiane/ Untreated	0,92a	2,04	18,50d	16,34	67,79c	30,91
	Bioczos	5,75b	8,45	8,50c	10,15	112,75e	25,28
	Polyversum	4,58b	9,33	3,75b	4,66	92,96d	39,22
	Maxim	1,00a	4,49	0,25a	0,68	33,58b	25,78
	Vitavax	0,00a	0,00	0,25a	0,68	7,58a	14,99
NIR/LSD α = 0,05		1,61		3,15		5,05	
Odmiana Cultivar	Fantazja	5,60c	11,30	3,40a	5,54	55,70a	39,32
	Wanda	0,60a	1,40	8,67b	13,32	61,80b	47,48
	Pasja	2,13b	3,60	4,07a	5,72	68,03c	50,78
	Artema	1,47ab	3,01	8,87b	15,40	66,20bc	52,77
NIR/LSD α = 0,05		1,44		2,82		4,52	
Rok Year	2014	5,00b	9,98	3,20a	7,66	53,05a	44,18
	2015	0,85a	1,80	11,45b	15,49	56,45a	45,17
	2016	1,50a	3,26	4,10a	5,87	79,30b	49,74
NIR/LSD α = 0,05		1,25		2,44		3,91	

Table 4
Tabela 4

Analysis of variance for some fungi infected seeds of perennial ryegrass (*Lolium perenne*).

Analiza wariancji dla wybranych grzybów zasiedlających nasiona życicy trwałej (*Lolium perenne*).

Czynnik /Agent		*Fusarium*		*Bipolaris* i *Drechslera*		Grzyby/Fungi	
		Średnie/ Mean	Odch. std/ Std. dev.	Średnie/ Mean	Odch. std/ Std. dev.	Średnie/ Mean	Odch. std/ Std. dev.
Zaprawa Treatment	Niezaprawiane/Un-treated	2,67b	4,20	5,50c	3,45	71,92b	40,65
	Bioczos	6,42c	8,30	2,17b	3,73	120,75d	23,08
	Polyversum	6,75c	9,25	1,08a	2,36	113,25c	26,44
	Maxim	0,92a	2,12	0,75a	1,94	66,58b	46,58
	Vitavax	0,25a	0,68	0,42a	1,18	36,88a	36,66
NIR/LSD α = 0,05		1,69		0,94		5,64	
Odmiana Cultivar	Flinston	5,40c	9,41	0,53a	1,17	86,33b	55,11
	Baronka	1,87a	3,15	1,47b	2,78	91,87c	43,01
	Rela	3,73b	5,19	4,27c	4,06	65,70a	46,77
	Malowana	2,60ab	6,17	1,67b	3,11	83,60b	40,24
NIR/LSD α = 0,05		1,51		0,84		5,05	
Rok Year	2014	7,55c	8,87	2,05	2,46	98,33c	34,76
	2015	2,35b	4,37	2,00	3,39	89,20b	46,66
	2016	0,30a	0,85	1,90	3,81	58,10a	49,63
NIR/LSD α = 0,05		1,31		ni		4,37	

Fig. 1. Germination capacity of the seeds of meadow fescue and perennial ryegrass depending on the applied seed treatment.

Rys. 1. Zdolność kiełkowania materiału siewnego kostrzewy łąkowej i życicy trwałej w zależności od zastosowanej zaprawy nasiennej.

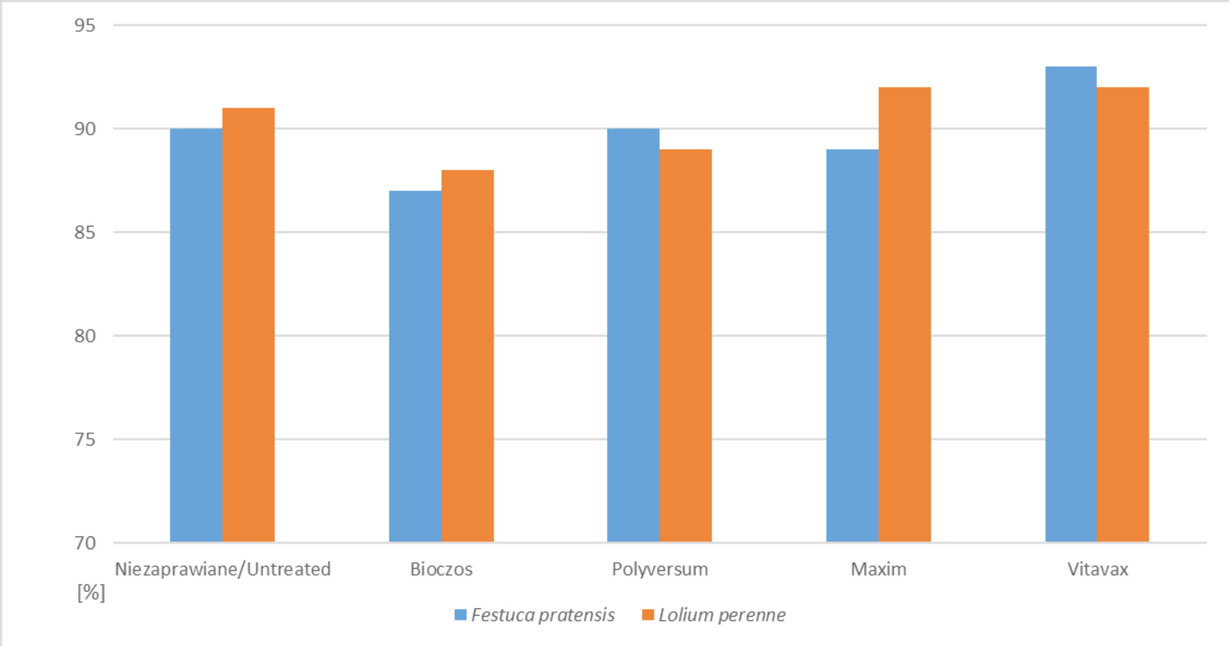
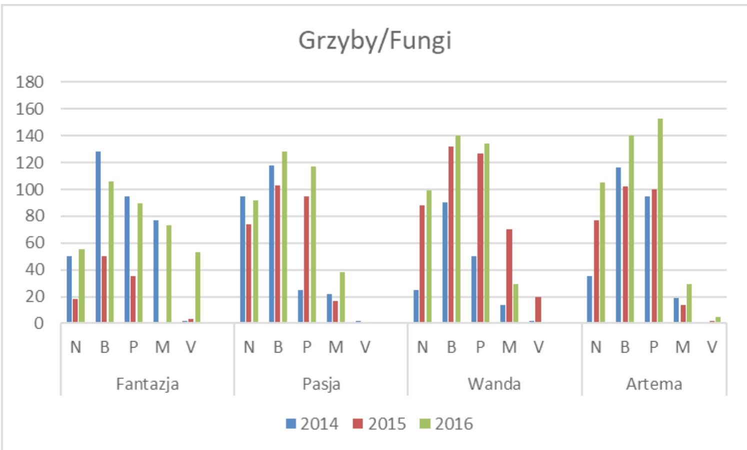


Fig. 2. Occurrence of fungi (a), species of the genera *Fusarium* (b), *Bipolaris* and *Drechslera* (c), isolated from the seeds of the meadow fescue (*Festuca pratensis*) for cultivars and year of harvest depending on used the seed treatment (mean number of colonies/100 seeds).

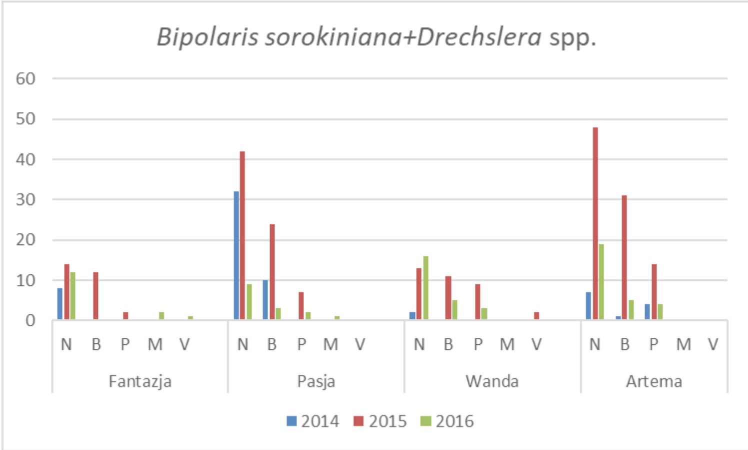
Rys. 2. Występowanie grzybów (a), gatunków z rodzaju *Fusarium* (b), *Bipolaris* i *Drechslera* (c) wyizolowanych z nasion kostrzewy łąkowej (*Festuca pratensis*) dla odmian i lat zbioru w zależności od zastosowanej zaprawy nasiennej (średnia liczba kolonii/100 nasion).

N-niezaprawiane/untreated, B-Bioczos, P-Polyversum, M-Maxim, V-Vitavax

a)



b)



c)

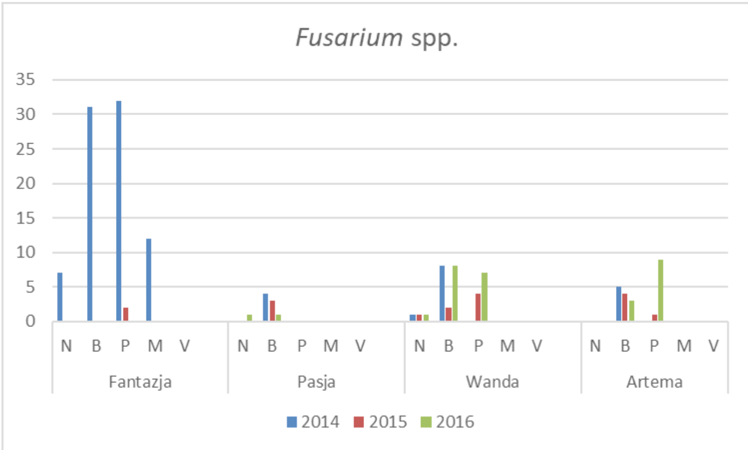
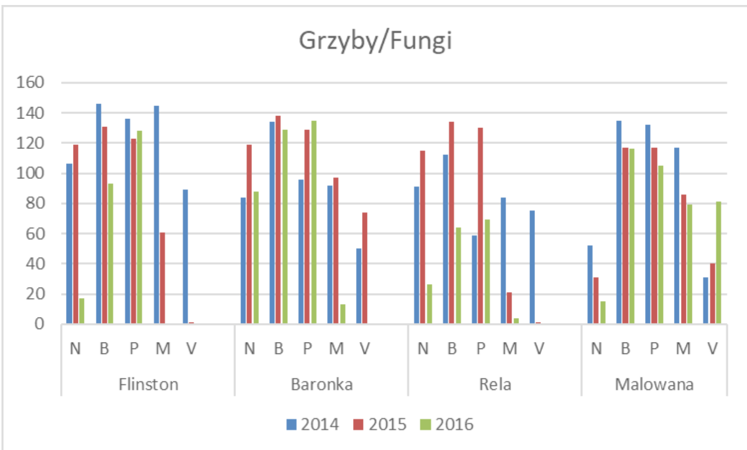


Fig. 3. Occurrence of fungi (a), species of the genera *Fusarium* (b), *Bipolaris* and *Drechslera* (c), isolated from the seeds of the perennial ryegrass (*Lolium perenne*) for cultivars and year of harvest depending on used the seed treatment (mean number of colonies/100 seeds).

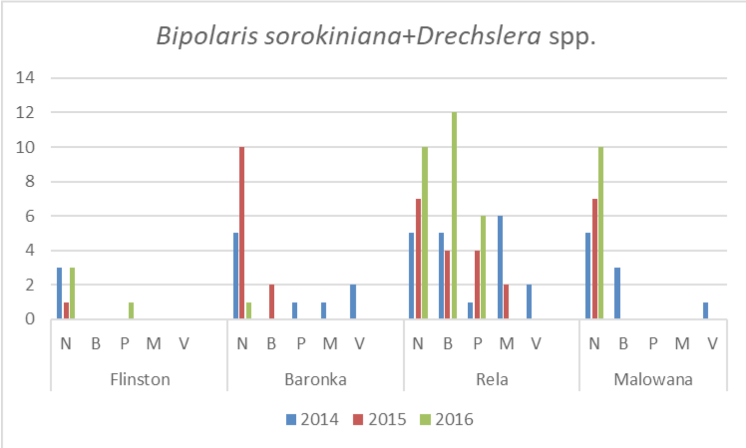
Rys. 3. Występowanie grzybów (a), gatunków z rodzaju *Fusarium* (b), *Bipolaris* i *Drechslera* (c) wyizolowanych z nasion życicy trwałej (*Lolium perenne*) dla odmian i lat zbioru w zależności od zastosowanej zaprawy nasiennej (średnia liczba kolonii/100 nasion).

N-niezaprawiane/untreated, B-Bioczos, P-Polyversum, M-Maxim, V-Vitavax

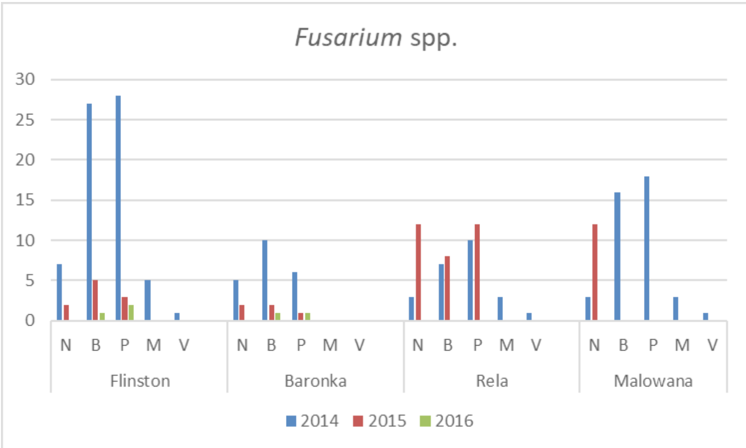
a)



b)



c)



Conclusions

1. The seeds of meadow fescue and perennial ryegrass were colonized by numerous saprophytic and pathogenic fungi. *Alternaria alternata,* commonly isolated from various seeds of agricultural plants, was the dominant species in the analysed seed material.
2. Most pathogenic fungi detected on the seeds of meadow fescue and perennial ryegrass represented two genera, *Drechslera* and *Fusarium*.
3. Chemical treatments with Maxim and Vitavax had a positive effect on the heath of the analysed grass seeds. Treatment with biological agents, Bioczos and Polyversum, did not reduce the number of fungal colonies isolated from seeds compared to surface-disinfected seeds or those treated with chemical agents.

References

Barnett H. L. 1960. Illustrated genera of imperfect fungi. Burgess Pub. Company. Minneapolis: 1 — 225.

Chidambaram S.B., Matur S.B., Neergaard P. 1972. Handbook on seed health testing. The International Seed Testing Association As-NLH. Norway: 1 — 207.

Di Menna, M.E., Lauren D.R., Poole P.R., Mortimer P.H., Hill R.A., Agnew M.P. 1987. Zearalenone in New Zealand pasture herbage and the mycotoxin-producing potential of *Fusarium* species from pasture. N. Z. J. Agric. Res. 30:499.

Di Menna, M. E., Lauren D.R., Sprosen J.M., MacLean K.S. 1991. *Fusarium* and zearalenone on herbage fractions from short and from long pasture. N. Z. J. Agric. Res. 34:445.

Ellis M. B. 1971. „*Dematiaceous Hyphomycetes*“. Commonwealth Mycological Institute. Kew, Surrey, England.

Falloon R.E. 1980. Seedling emergence responses in ryegrasses (*Lolium* spp.) to fungicide seed treatments. New Zealand Journal of Agricultural Research, 23, 385-391.

Forsberg G., Kristensen L., Eibel P., Titone P., Haiti W. 2003. Sensitivity of cereal seeds to short duration treatment with hot, humid air. *Journal of Plant Disease and Protection*, 110 (1): 1-16.

International Rules for Seed Testing. Edition 2019. Published by The International Seed Testing Association (ISTA), P. O. BOX 308, 8303 Bassersdorf, CH-Switzerland.

Kumar S. 2012. Cultural approaches for plant disease management. Research & Reviews: Journal of Agricultural Science and Technology, 1(2): 12-21.

Kućmierz J., Gorajczyk S., 1991: Pathogenicity of fungi isolated from sowing material of perennial ryegrass (*Lolium perenne* L.) for germinating caryopses and seedlings. Phytopathol. Pol. 13, 1: 62–65.

Kućmierz J., Mazur S., Nocoń J., 1992: Mikoflora materiału siewnego kostrzewy łąkowej (*Festucapratensis* Huds.) oraz patogeniczność wybranych gatunków grzybów dla siewek *in vitro*. Zesz. Nauk. AR Krak. 265, Roln. 30: 151–159.

Kutrzeba M., 1994 a: Występowanie grzybów z rodzaju *Bipolaris* i *Drechslera* na nasionach *Festuca pratensis* Huds. Biul. Inst. Hod. Aklim. Rośl. 192: 107–112.

Kutrzeba M. 1994b. Występowanie grzybów patogenicznych na gatunkach traw z rodzaju *Festuca* Huds. Biul. IHAR 192: 113-121.

Kwaśna H., Chełkowski J., Zajkowski P. 1991. Flora Polska T. XXII. Grzyby niedoskonałe. Strzępczakowe. Gruzełkowate. Sierpik (*Fusarium*) PAN Warszawa-Kraków: 1-158.

Labruyere R.E., 1980: Fungal diseases of grasses grown for seed. In: Seed production. Ed. P.D. Hebblethwaite. Butterworths, London, pp. 173–187.

Malone J. P., Muskett A. E. 1997. Seed-borne fungi. Description of 77 fungus species. 3rd Edition. Sheppard J. W. (ed.). ISTA, Zurich: 1 — 191.

Pańka D., Jeske M., Szczepanek M., 2010. Effect of fungicidal control of *Festuca rubra* L. ssp. *Commutate* and *F. rubra* L. ssp. *rubra* on seed infection with fungi. In: Grassland in a changing world. Book of abstracts 23th General Meeting EGF. Kiel, Germany; August 29th–September 2nd 2010. AGGF, Kiel: 93.

Prończuk M. 1996. Główne choroby traw w Polsce. Biul. IHAR 199: 157169.

Sharma K.K., Singh U.S., Sharma P., Kumar A., Sharm L. 2015. Seed treatments for sustainable agriculture-A review. Journal of Applied and Natural Science 7(1): 521 – 539.

Smith J.F., Di Menna M.E., McGowan L.T. 1990. Reproductive performance of Coopworth ewes following oral doses of zearalenone before and after mating. J. Reprod. Fertil. 89:99.

StatSoft, Inc. 2014. STATISTICA (data analysis software system), version 12. www.statsoft.com.

Tulloch M., Leach C.M., 1972: A world-wide survey of the microflora of *Dactylis glomerata* seed. Ann. Appl. Biol. 72: 145–154.

Vargas J.M. 1994. Management of turfgrass diseases. pp. 1-294 *in* Lewis Publ. CPR Press, Inc.

Wiewióra B. 2012. The effect of seed health of perennial ryegrass (*Lolium perenne* L.) on germination capacity. Plant Breeding and Seed Science 65, 51-62.

Wiewióra B., Prończuk M., 2000. Mikroorganizmy zasiedlające nasiona traw i ich wpływ na występowanie chorób w uprawie trawnikowej. Biul. Inst. Hod. Aklim. Rośl. 214: 269–284.

Wiewióra B., Prończuk M. 2002. *Rhizoctonia solani* and other fungi detected in perennial ryegrass seeds after harvest and storage. *Phytopathologia Polonica* 26, 19-27.

Zang Y. Han J.G. Bolkan H. Shi Q.H. 2006. The mycoflora of perennial ryegrass and their effects on the germination and seedling vigour. Seed Science and Technology 34, 429-441.