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Variability in accumulation of Fusarium mycotoxins in grain of winter wheat breeding lines artificially inoculated with *F.culmorum* in 2015.

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Fusarium head blight (FHB) is a disease of grain caused by the complex of toxinogenic *Fusarium* fungi. The most important species are: *F. graminearum* and *F. culmorum* producing deoxynivalenol, nivalenol and zearalenone; *F. avenaceum* producing moniliformin; *F. poae* producing nivalenol and *F. langsethiae* and *F. sporotrichioides* producing T-2 and HT-2 toxins. Highly pathogenic are *F. graminearum* and *F. culmorum*, which can cause severe epidemics of FHB. Other species are of a medium or weak pathogenicity, however, due to the wide prevalence also may cause significant contamination of grain with mycotoxins. Breeding of a new cultivars with improved resistance to FHB is one of the most important ways in reduction of mycotoxin contamination of food products. The aim of our study was to evaluate selected winter wheat breeding lines in terms of mycotoxin accumulation and resistance to FHB.

MATERIAL AND METHODS

In the field experiments in two locations: Radzików (Central Poland) and Cerekwica (Western Poland) the heads of 70 winter-type wheat lines were artificially inoculated with *F.culmorum* at flowering stage. Grain of 45 genotypes with elevated resistance to FHB was analyzed for content of mycotoxins: deoxynivalenol (DON), zearalenone (ZEA) and ergosterol (ERG). Field trials were conducted in 3 replicates. Wheat heads were inoculated with suspension of 3 isolates of *F. culmorum at 10^5* spores/ml with 1-week interval. *F. culmorum* isolates produced deoxynivalenol (DON), nivalenol (NIV) and zearalenone (ZEA). In Cerekwica mist irrigation after inoculation was applied.

In harvested grain share of damaged kernels (FDK%) was assessed. Content of DON was analyzed with GC-ECD method after derivatization to TMS derivatives. Concentration of ZEA was analyzed with ELISA method. using AgraQuant® Mycotoxin ELISA Test Kit (Romerlabs). ERG was analyzed with HPLC method.

Table 1. Resistance to FHB and mycotoxin accumulation of 45 winter wheat lines and varieties inoculated with *Fusarium culmorum* isolates in Western and Central Poland in 2015.

	Breeding line/ variety	FHBi [%]	FDK [%]	ERG [ppm]	DON [ppb]	ZEA [ppb]	ERG+DON +ZEA stnd
1	STH 9059	6,7	7,8	1,5	1925	0	-1,281
2	KBP 04.164	9,6	8,1	1,6	6015	0	-1,008
3	DED 389/06	9,4	10,1	1,7	5750	0	-1,004
4	KBP 10 58	7,3	13,8	1,6	5695	11	-0,987
5	AND 143/10	9,8	16,9	1,7	5880	0	-0,972
6	POB 262/07	8,3	10,9	1,8	4250	11	-0,936
7	POB 0112	5,8	13,8	1,9	5520	19	-0,762
8	POB 457/07	7,7	14,8	1,9	5930	21	-0,745
9	MOB ZB 301206	9,2	8,0	2,1	6805	18	-0,645
10	NAD12007	6,8	8,8	1,6	4385	49	-0,637
11	KOH 275	8,8	13,4	1,4	8385	41	-0,633
12	LAD 463/05	9,3	5,7	2,5	5100	10	-0,612
13	POB 0114	7,1	7,0	2,3	4865	23	-0,591
14	POB 170/04	4,8	11,8	2,1	11610	0	-0,506
15	STH 102	7,6	19,7	1,7	6835	51	-0,502
16	NAD 11053	4,3	10,9	2,7	7900	0	-0,478
17	KBP 09 36	6,9	16,4	2,5	7490	14	-0,461
18	DC 332/09-3	8,3	21,2	2,2	8080	35	-0,376
19	STH 105	4,2	11,3	2,0	7740	42	-0,364
20	KBP 05.271	11,8	11,4	2,6	11190	9	-0,305
21	DD 137/10-4	10,2	19,8	1,9	8305	57	-0,262
22	NAD 11017	10,2	14,4	2,5	11945	16	-0,246
23	SMH 7974	9,5	10,6	2,3	10935	30	-0,212
24	DM 2566/11	8,5	15,9	2,3	480	79	-0,211
25	STH 9007	9,8	14,7	2,4	4585	55	-0,205
26	DL 423/11/2	7,0	16,4	2,1	11210	46	-0,146
27	KBP 10 40	9,0	13,8	1,9	6490	81	-0,103
28	NAD 11100	12,3	16,8	2,7	13215	18	-0,061
29	POB 679/03	2,8	10,0	2,1	13850	50	-0,003
30	STH 032	6,1	18,7	2,1	9530	70	0,003
31	C 3779/10	8,2	13,4	2,3	5930	87	0,097
32	SMH 8874	7,0	20,9	2,3	13130	65	0,199
33	DM 3131/10	10,8	15,1	2,8	11835	48	0,219
34	SMH 7983	4,7	12,9	3,2	11680	36	0,271
35	POB 0813	12,6	16,8	3,7	15675	16	0,475
36	DD 189/11	6,8	17,2	2,9	9770	83	0,502
37	DM 2728/09	9,6	18,1	2,1	22415	62	0,531
38	SMH 8553	8,2	17,4	3,3	14460	48	0,541
39	Patras	10,8	18,2	2,6	11485	97	0,570
40	C 41/10	9,4	19,9	3,6	16415	28	0,602
41	AND 1055/02	9,8	15,5	3,3	17210	53	0,717
42	POB 0212	6,7	18,9	2,9	12720	98	0,771
43	STH 087	8,8	23,8	3,4	16815	77	1,015
44	DM 3873/10	8,9	26,2	3,1	36115	66	1,650
45	DD 548/09	14,7	19,1	4,6	38065	148	3,197
Mean		8,4	14,8	2,4	10569	42	

RESULTS

The mean content of ERG (Tab.1) was relatively low (2.4 ppm), and was 4 fold higher in Western Poland (4.1 ppm) than in Central Poland (0.9 ppm).
The deoxynivalenol (DON) content in wheat grain varied from 480 to 38065 ppb (average 10569 ppb). The level of DON in Western Poland was 20 fold higher than in Central Poland (21114 ppb and 848 ppb respectively).
The content of ZEA was very low (42 ppb). The range of variation of 0 to 148 ppb. In Western Poland, ZEA content was more than 10 times higher than in Central Poland.
This year's conditions were unfavorable for FHB development, as indicated by the low value of analyzed compounds. Only the DON content was high in Western Poland, except that twice lower compared to 2014. Despite the unfavorable weather conditions, obtained results showed that in the winter wheat population coming from Polish breeding programs, there is variability in resistance to the accumulation of Fusarium mycotoxins in the grain. Significant relationship between damage of the grains and the content of toxins were found. As a result, it seems possible to select genotypes combining different types of resistance. Such genotypes are stable under various weather conditions and shows good resistance to both decrease in grain yield and contamination of the grain with toxins caused by Fusarium Head Blight.

Healthy-looking and *Fusarium*- damaged kernels of winter-type wheat

Table 2. Statistics of the FHB parameters of 45 wheat lines and cultivars.

	FHBi [%]	FDK [%]	ERG [ppm]	DON [ppb]	ZEA [ppb]
Minimum	2,8	5,7	1,4	480	0
Maximum	14,7	26,2	4,6	38065	148
Mean value	8,4	14,8	2,4	10569	42
Standard deviation	2,3	4,6	0,7	7296	33
Coefficient of variation	28	31	28	69	80

Figure 1. Relationship between ergosterol and DON contration in grain of 45 lines and varieties of wheat.

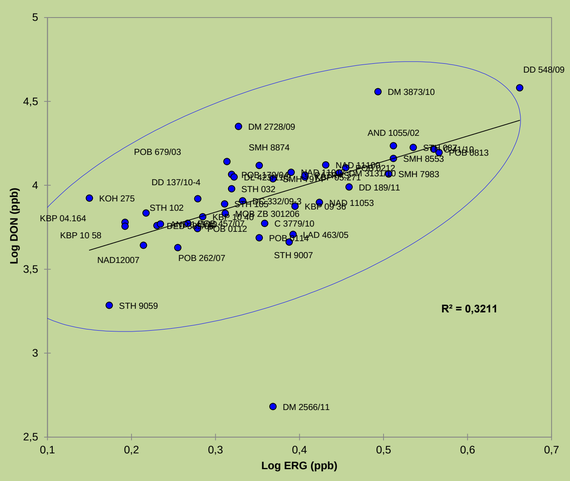

Figure 2. Biplot of the principal component analysis of the FHBi, FDK and mycotoxin concentration in grain of 45 lines and varieties of wheat.

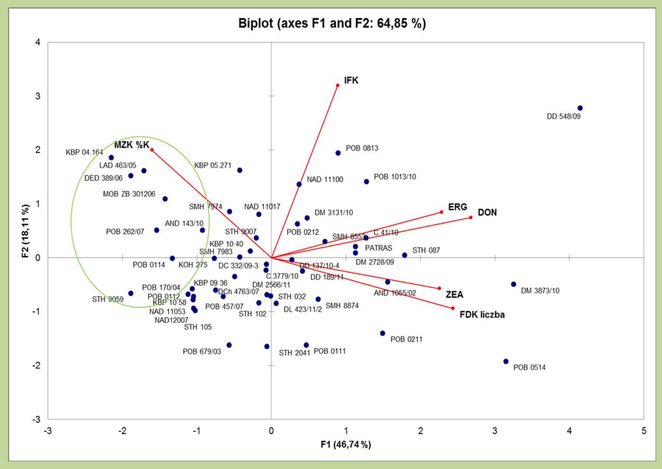

Table 3. Correlation coefficients between FHBi, FDK and mycotoxin content for 45 lines and cultivars of winter wheat in Poland in 2015.

	FHBi [%]	FDK [%]	ERG [ppm]	DON [ppb]
FDK [%]	0,237			
ERG [ppm]	**0,385**	**0,437**		
DON [ppb]	**0,362**	**0,563**	**0,708**	
ZEA [ppb]	0,176	**0,531**	**0,438**	**0,481**

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