Resistance to fusarium ear rot in maize: heritability and trait associations

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INTRODUCTION

- Maize is one of the most important crops, widely used not only for food and animal feed, but also as biofuel and bioproduct source.
- Poland, over the past decade, became fifth producing country in Europe, with total area planted over 1M ha (silage and grain combined).
- Ear rot caused by *Fusarium* spp. are most significant fungal disease, causing reduction in yield and affecting its quality.
- Changing environmental conditions, among conservations tillage techniques and maize/wheat dominated crop rotating systems influence the incidence of the disease. These factors may also affect the structure of the pathogen population, disease severity and associated mycotoxin contamination levels. In Poland an increase in the level of grain contamination by toxins produced by *Fusarium* has been observed in recent years.
- Among with appropriate agronomic practice, the use of highly resistant hybrids is an important part of the integrated plant protection method.

STUDY OBJECTIVE

Aim of this study was to determine heritability of resistance to ear rot and traits that are related to this disease resistance.

MATERIALS AND METHODS

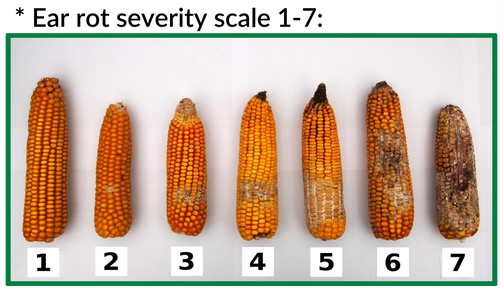
- Plant material: 42 inbreed lines of different gene pools (KOB and SH) and F_1 hybrids populations, each in three replications
- Traits determined under field conitions
  - time of silk emergence (as numer of days from sowing time till silking time),
  - cob morphology with silks length (cm),
  - anthocyanin content (1 – 7 scale),
  - plant height (cm),
- *Fusarium graminearum* (GER) ear rot severity tests:
  - Kernel inoculation with 4-channel syringe, 9 – 12 days after silking time
  - Phenotypic ear rot severity assessment with 1-7 scale during harvest
- DON content in grounded grain inoculated and non-inoculated samples was determined by RIDA QUICK SCAN immunochromatographic test reader
- Heritability and correlations between disease severity, DON content and selected traits were determinded

RESULTS

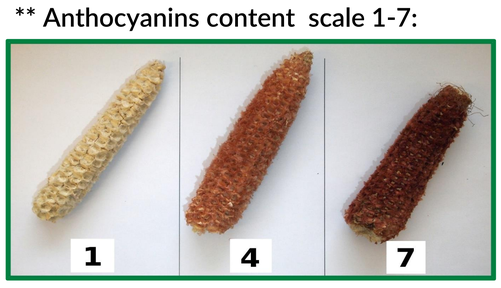
Tab. 1. Hybrids F_1: ear rot severity and DON content under natural infection and after inoculation *F. graminearum*, plant morphology

	Artificial infection		Natural infection		Earlliness (days number from sowing till silking)	Height (with tassels - cm)	Anthocyanins content (1-7)**			Ear morphology - silking time (cm)			Husks density (1-5)**	Cobs - harvesting time			1.000 kernel weight
	Ear rot (1 - 7)	DON (ppm)	Ear rot (1-7)*	DON (ppm)			pollen	silks	corncobs	channel length	silks length	corncobs length		corncobs length	kernel weight per cob (g)	kernel number per cob	
F_1 - dent (n=15)																	
Mean	4,9	153,1	1,1	0,0	74,4	277,1	3,5	1,7	3,9	54,6	68,4	160,8	2,7	189,7	199,3	290,6	344,6
S.D.	0,4	109,6	0,1	0,0	2,0	25,8	1,2	0,9	0,8	17,8	14,6	26,4	1,0	11,3	29,3	46,9	20,9
Min.	3,7	48,0	1,0	0,0	72,0	246,7	1,0	1,0	1,0	21,6	45,0	122,9	2,0	175,7	141,6	190,8	316,7
Max.	5,4	385,1	1,4	0,0	76,0	320,0	5,0	3,0	4,8	75,5	89,6	206,9	4,0	209,0	248,0	379,7	378,5
F_1 - flint (n=23)																	
Mean	3,6	110,9	1,2	0,0	71,1	222,3	3,4	1,6	1,3	65,4	58,5	170,4	2,6	173,4	147,8	227,6	324,8
S.D.	0,5	44,9	0,3	0,0	2,1	37,4	1,6	1,1	1,3	13,8	10,5	18,6	0,9	14,2	25,3	20,2	46,7
Min.	2,6	26,8	1,0	0,0	68,0	180,0	1,0	1,0	1,0	41,0	43,4	143,5	2,0	155,9	108,1	194,4	258,2
Max.	4,7	242,8	1,9	0,0	74,0	285,0	7,0	5,0	7,0	98,6	81,8	212,3	4,0	200,6	192,2	267,8	423,0

* Ear rot severity scale 1-7:



** Anthocyanins content scale 1-7:

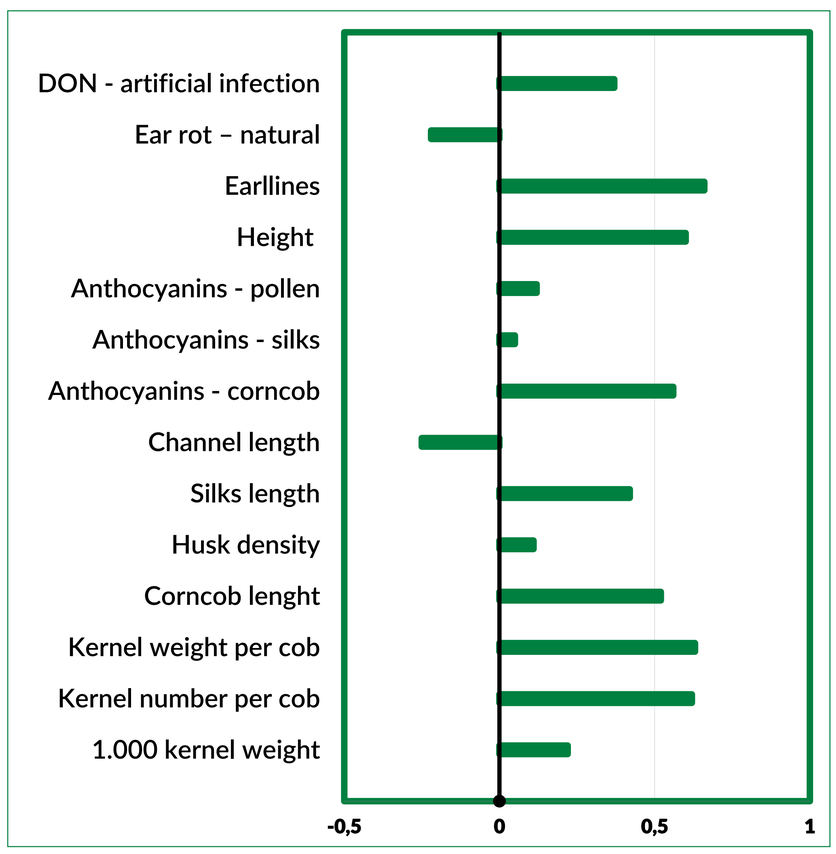


*** Husk density scale 1-5 (1 – loose husk leaves)

Tab. 2. Estimates of mid-parent heterosis (expressed in percent of the mid-parent) for fusarium ear rot and plant morphology

Hybrids and their parental lines	Kernel type	Ear rot - artificial infection*	Ear rot - natural infection*	Earlliness	Height	Anthocyanins content - pollen	Anthocyanins content - silks	Channel length	Silks length	Corncobs length
F3 (LDK5 x LDK6)	dent	4,8	1,2	76,0	246,7	1,0	1,0	21,6	44,9	206,9
LDK5		5,8	1,2	88,0	176,7	1,0	1,0	42,3	63,2	163,2
LDK6		4,2	1,2	76,0	163,3	1,0	1,0	30,4	63,6	148,8
Heterosis		-3,93%	-1,29%	-7,32%	45,10%	0,00%	0,00%	-40,63%	-29,08%	32,63%
F8 (LDK10 x LDK8)	dent	4,8	1,2	76,0	256,7	2,5	2,0	28,1	47,1	186,9
LDK10		5,5	1,5	88,0	185,0	1,0	1,0	47,5	66,2	165,1
LDK8		5,5	1,0	76,0	173,3	1,5	2,5	43,3	81,3	163,5
Heterosis		-13,34%	-8,06%	-7,32%	43,26%	100,00%	14,29%	-38,13%	-36,13%	13,73%
F9 (LDK10 x LDK9)	dent	5,0	1,4	76,0	246,7	3,5	1,0	43,4	52,7	174,4
LDK10		5,5	1,5	88,0	185,0	1,0	1,0	47,5	66,2	165,1
LDK9		4,8	1,0	82,0	186,7	1,0	1,0	44,9	79,2	152,0
Heterosis		-3,40%	9,38%	-10,59%	32,74%	250,00%	0,00%	-5,93%	-27,56%	10,00%
F18 (LFK1 x LFK5)	flint	4,0	1,0	72,0	263,3	3,0	1,5	70,7	76,7	173,3
LFK1		3,8	1,6	74,7	156,7	1,3	1,0	58,5	56,3	145,7
LFK5		5,8	1,2	76,0	180,0	3,5	3,0	69,7	45,1	142,4
Heterosis		-17,40%	-26,38%	-4,42%	56,44%	24,14%	-25,00%	10,27%	51,33%	20,33%
F26 (LFK4 x LFK5)	flint	3,9	1,1	74,0	270,0	3,0	1,0	65,4	54,3	186,0
LFK4		3,5	1,1	76,0	180,0	1,0	1,0	35,8	52,1	147,2
LFK5		5,8	1,2	76,0	180,0	3,5	3,0	69,7	45,1	142,4
Heterosis		-15,18%	-3,33%	-2,63%	50,00%	33,33%	-50,00%	24,12%	11,78%	28,46%
F23 (LFK3 x LFK4)	flint	3,9	1,0	72,0	270,0	5,0	2,0	47,7	59,9	212,3
LFK3		3,4	1,2	72,0	176,7	5,7	3,0	53,0	49,0	114,3
LFK4		3,5	1,1	76,0	180,0	1,0	1,0	35,8	52,1	147,2
Heterosis		14,21%	-12,41%	-2,70%	51,40%	50,00%	0,00%	7,57%	18,49%	62,37%

Tab. 3. Relationships between *fusarium* ear rot , DON content and plant morphology



CONCLUSIONS

- Weather conditions influenced ear rot and DON content
- Narrow sense heritability for fusrium ear rot resistance: dent group - 66,7%, flint group - 25,2%
- Positive heterosis for fusarium ear rot resistance was observed both in the flint and dent group
- Positive relationships were observed between fusarium ear rot severity and following plant traits:
  - DON content, earliness till silking, plant height, anthicyainins content in bare corncob, silks and corncob length, kernel weight and numbr per corncob

Acknowledgements

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