Mass Selection with an Optical Sorter for Head Scab Resistance in Soft Red Winter Wheat

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Introduction

Fusarium head blight (FHB) or head scab, caused by *Fusarium graminearum* Schwabe [telomorph: *Gibberella zeae* Schwein.(Petch)], is recognized as one of the most destructive diseases of wheat (*Triticum aestivum L. and T. durum L.*) and barley (*Hordeum Vulgare L.*) world wide (Balut, 2012). The objective of this study was to select for lower Fusarium damaged kernels (FDK; %) and deoxynivalenol (DON: ppm) using an optical sorter.

Methods and Materials

- In 2010, 20 bulk F_3 SRW wheat populations with scab resistant parents in their pedigrees from 2 and 3 way crosses were in bulk.
- Grain was sorted on optical sorter according to a calibration that reflected visual differences between asymptomatic and scabby grain.
- This process was repeated in 2011 using grain from plots that had conidial suspension applied at anthesis.
- In 2012, an unreplicated plot study of the C_0, C_1 and C_2 cycles of selection, inoculated with grain spawn and conidial suspension, was evaluated for FDK and DON concentration.
- In October 2012, 4 selection cycles (C_0 – C_3) of the 20 populations were planted in a RCB experiment at Lexington and Princeton, KY, and in the inoculated, irrigated scab nursery.

Table 1: Pearson correlation coefficients between visual estimate on weight basis (Visual_W) and on a count basis (n= 600 kernels) (Visual _C), FDK assessed by air separation machine (AIR_S), FDK assessed by air separation machine with adjustment to scabby portion (AIR_S_J), FDK assessed by image-based optical sorter (S_FDK), DON and FDK assessed by near infrared reflectance (NIR) using two different calibrations (NIRFDK1, NIRFDK2, NIRDON1, and NIRDON2), incidence (INC), severity (SEV), index, plant height (PH), heading date (HD), rating, yield, and deoxynivalenol (DON) Lexington, KY 2012.

	FDK.VNO	FDK.VWT	FDK.ADJ	FDK.AIR	FDK.IBOS	NIRFDK1	NIRDON1	NIRFDK2	NIRDON2	INC	SEV	Index	HT rating (0-9)	HD	yeild	DONppm
FDK.VNO	1.00															
FDK.VWT	0.95	1.00														
	<.0001	1														
FDK.ADJ	0.24	0.13	1.00													
	0.0652	0.321	1													
FDK.AIR	0.12	0.02	0.94	1.00												
	0.3686	0.8927	<.0001	1												
FDK.IBOS	-0.04	-0.07	0.39	0.42	1.00											
	0.7502	0.5829	0.0022	0.0009												
NIRFDK1	0.26	0.19	0.17	0.17	0.37	1.00										
	0.0434	0.1475	0.1929	0.184	0.0039	1										
NIRDON1	0.11	0.09	0.14	0.10	0.35	0.84	1.00									
	0.4199	0.5013	0.2911	0.4253	0.0062	<.0001	1									
NIRFDK2	0.28	0.21	0.19	0.18	0.41	0.97	0.83	1.00								
	0.0316	0.1135	0.149	0.1638	0.0013	<.0001	<.0001	1.00								
NIRDON2	0.14	0.13	0.17	0.14	0.38	0.85	0.99	0.84	1.00							
	0.2692	0.3209	0.2069	0.2956	0.0031	<.0001	<.0001	<.0001	1							
INC	0.01	-0.07	-0.07	-0.13	0.07	-0.05	-0.01	-0.04	-0.01	1.00						
	0.9211	0.5752	0.6024	0.3178	0.5913	0.7254	0.94	0.7748	0.9131	1						
SEV	0.23	0.14	0.12	0.13	0.14	0.34	0.23	0.33	0.22	0.36	1.00					
	0.08	0.2762	0.3611	0.3268	0.2948	0.0086	0.0769	0.7748	0.0843	0.00	1					
Index	0.13	0.02	-0.01	-0.04	0.11	0.16	0.12	0.16	0.11	0.83	0.80	1.00				
	0.3307	0.8626	0.9562	0.7427	0.4154	0.2149	0.3691	0.2079	0.4112	<.0001	<.0001	1				
HT	0.25	0.35	0.18	0.19	0.06	-0.04	-0.03	-0.07	-0.03	-0.42	-0.16	-0.38	1.00			
	0.0521	0.0055	0.1642	0.1493	0.6747	0.793	0.8224	0.5813	0.8413	0.00	0.23	0.00	1			
Rating (0-9)	0.04	0.04	-0.25	-0.34	-0.04	-0.04	0.07	-0.02	0.10	0.49	0.15	0.41	-0.45	1.00		
	0.7337	0.7705	0.05	0.0073	0.6918	0.778	0.6085	0.9	0.4633	<.0001	0.26	0.00	0.00	1		
HD	0.28	0.26	0.27	0.19	0.23	0.13	0.08	0.15	0.07	0.38	0.54	0.52	-0.11	0.03	1.00	
	0.0304	0.047	0.0345	0.1468	0.0721	0.3327	0.5451	0.2464	0.5906	0.00	<.0001	<.0001	0.38	0.83	1	
Yeild	-0.18	-0.08	-0.02	-0.04	-0.09	-0.01	0.12	-0.05	0.11	-0.06	-0.16	-0.15	0.27	-0.22	-0.11	1.00
	0.1638	0.5679	0.8955	0.7651	0.5062	0.9527	0.3567	0.6889	0.4097	0.63	0.2116	0.25	0.03	0.10	0.41	1
DONppm	0.22	0.16	0.08	-0.02	0.37	0.1	0.14	0.13	0.17	0.48	0.23	0.44	-0.24	0.46	0.46	-0.1	1
	0.0988	0.2125	0.5321	0.8929	0.0037	0.4341	0.2777	0.3085	0.1966	<.0001	0.0792	0.0004	0.0597	0.0002	0.0002	0.447	1

Table 2: FDK (%) cycle means and standard errors for selected populations at Lexington (LEX), Princeton (PRN), and the scab nursery (SCNUR), 2013.

	LEX				PRN				SCNUR			
Population	C_0	C_1	C_2	C_3	C_0	C_1	C_2	C_3	C_0	C_1	C_2	C_3
11	11.7 ± 3.1	14.4 ± 3.1	11.7 ± 3.1	17.9 ± 3.1	7 ± 2.1	6.6 ± 2.1	6.3 ± 2.1	7.8 ± 2.1	26.7 ± 5.0	14.6 ± 5.0	17.3 ± 5.0	15.3 ± 5.0
15	16.4 ± 3.1	15.3 ± 3.1	11.6 ± 3.1	10.5 ± 3.1	7.4 ± 2.1	8.5 ± 2.1	7.4 ± 2.1	9.7 ± 2.1	12.4 ± 5.0	15.3 ± 5.0	16.9 ± 5.0	13 ± 5.0
17	12.8 ± 3.1	11.7 ± 3.1	15.1 ± 3.1	18.2 ± 3.1	12.4 ± 2.1	7.4 ± 2.1	7.3 ± 2.1	6.3 ± 2.1	25.7 ± 5.0	25.2 ± 5.0	28.2 ± 5.0	26.7 ± 5.0
20	12.5 ± 3.1	11.6 ± 3.1	10.7 ± 3.1	8.7 ± 3.1	6.1 ± 2.1	9 ± 2.1	7.8 ± 2.1	7.2 ± 2.1	25.3 ± 5.0	26 ± 5.0	23 ± 5.0	20.3 ± 5.0

Table 3: Deoxynivalenol (ppm) means and standard errors of C_0 – C_3 in selected populations in the scab nursery, Lexington, KY, 2013.

Population	C_0	C_1	C_2	C_3
6	11.2 ± 4.4	6.5 ± 4.4	5 ± 4.4	8.1 ± 4.4
9	14.4 ± 4.4	11.6 ± 4.4	8.6 ± 4.4	10.8 ± 4.4
11	22.9 ± 4.4	16.1 ± 4.4	17.5 ± 4.4	17.9 ± 4.4
17	11.7 ± 4.4	11 ± 4.4	9.8 ± 4.4	9.8 ± 4.4
18	21.4 ± 4.4	12.8 ± 4.4	13.5 ± 4.4	15.9 ± 4.4
19	9.8 ± 4.4	7.9 ± 4.4	8.5 ± 4.4	7.6 ± 4.4

Results

- FDK measured by the optical sorter (FDK_IBOS) is correlated moderately with DON.
- Some populations had FDK and DON reduction with selection in at least one environment (Tables 2 and 3).
- The reduction in the first three cycles was obvious and occurred in more populations. This might be due to the 2013 calibration which was based on samples from 2012 a very dry year (Tables 2 and 3).
- FDK (%) was different among environments, the highest levels were recorded in the scab.

Conclusions

- The image-based optical sorter may provide a better way to assess FDK and DON (Table 1).
- This device could accelerate reduction in FDK and DON, and be a useful tool for FDK and DON assessment.
- Selection response was pronounced in some population / environment combinations, but not consistent.

References

Balut, A. L. (2012). Validation of Fhb1 and QFhs.nau-2DL in several soft red winter wheat populations. [University of Kentucky Libraries], Lexington, Ky.

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