Late Maturity Amylase and Preharvest sprouting in Michigan Wheat
Final Report for 18-08-01-AS

Rationale

The following work was carried out to elucidate genetic factors affecting pre-harvest sprouting and alpha-amylase activity to deliver economic benefits across the entire wheat value chain in Michigan. Wheat growers are expected to experience fewer dockages at the elevator and receive the full value of their crop by having accurate information available on variety resistance or susceptibility to PHS. With high quality grain available, flour millers will require less investment of time and resources in blending lower quality grain. The production of high quality grain locally, will minimize the need to purchase soft winter wheat from the Pacific Northwest, thereby reducing shipping costs.

Knowledge of PHS resistance in soft winter wheat will help to mitigate effects of PHS on wheat production in Michigan. The adoption of resistant soft winter wheat varieties by Michigan wheat growers can reduce losses to PHS in the near term. Using the results of this study to develop PHS resistant wheat varieties will provide long-term security to the Michigan wheat industry.

Objectives and Hypotheses

Hypothesis 1: Screen the Michigan State Wheat Performance Trial entries for PHS will identify varieties with high levels of resistance and reduce the risk of PHS for Michigan wheat farmers.
Objective 1: Evaluate the Michigan commercial wheat trial for PHS to provide variety selection information to growers and agribusiness.

Hypothesis 2: Genomic selection can accelerate the development of PHS-resistant varieties.
Objective 2: Evaluate MSU breeding trials for PHS to train prediction models to advance PHS-resistant lines into yield testing at early generations.

Methods

PHS sampling was done in the Michigan State Wheat Performance Trial comprised of ~120 commercial and experimental wheat varieties at Mason, MI. The MSU Wheat Breeding and Genetics Advanced Yield Trial (AYT) the preliminary yield trial (PYT) and the genomic selection model training population (TP) were also sampled at Mason.

At physiological maturity, three spikes were sampled from each plot of each genotype. Spikes were after-ripened in the greenhouse five days. Spikes are misted 20 seconds every two minutes for six days. After six days, spikes were evaluated on a 0 to 9 scale. It was not possible to run a Falling Number test on samples collected in 2019.

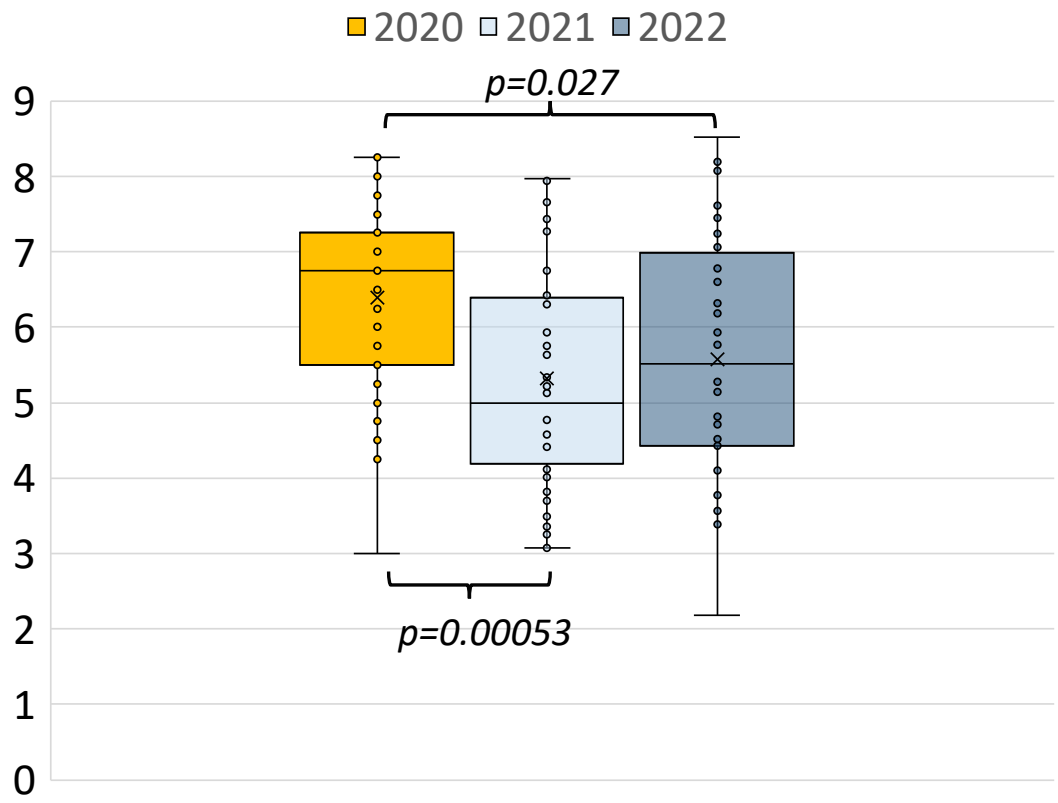
Results and Impact

Overall, 352 wheat genotpyes were evaluated for PHS on a 0 to 9 scale. Results of Michigan State Wheat Performance Trial were reported online at https://varietytrials.msu.edu/wheat/. This data was available for agronomists, seed companies and growers to use in variety planting decisions.

MSU breeding program lines that were evaluated for PHS were used to develop genomic prediction models for advancing new lines for testing and future variety release. Selection was applied in 800 F4 and F5 populations. A total of ~2,200 single plants were selected based on early maturity and agronomic type. Tissue was collected from flag leaves of selected plants. DNA was isolated, normalized and sequence based genotyping was done to generate ~1,300 SNPs per selected plant. SNPs were used to develop genome-estimated breeding values (GEBVs) for PHS in addition to grain yield in 2018 and 2019 for Mason and Richville MI locations as well as DON myotoxin levels.

The correlation between predicted and actual values for PHS was 0.58 in 2019. With the addition of more years to the set of model training data, the prediction accuracy has increased to 0.69.

Genomic selection for PHS resistance has had tremendous impact on the development of resistant varieties. The following figure demonstrates that soft white winter wheat lines selected in 2019 and tested in preliminary yield trials in 2021, have lower overall PHS scores than the 2020 lines that were advanced to replicated yield testing without a genomic selection step for PHS. This trend of lower PHS scores continued in the 20222 entries advanced using genomic selection.



Appendix I. Results of 2019 PHS evaluation

Line	PHS 0-9
0762A1-2-8	3.0

6771 EXP	1.4
AC Mountain	6.4
AgriMAXX 413	2.3
AgriMAXX 438	0.0
AgriMAXX 473	1.8
AgriMAXX 485	0.4
AgriMAXX 486	0.1
AgriMAXX 495	0.3
Agrimaxx Exp 1902	3.8
AgriMAXX Exp 1905	0.0
Ambassador	7.8
AR06037-17-2	0.0
AR07133C-19-4	1.0
Aubrey	6.0
Branson	2.0
Catawba	0.0
CN18-20-2	8.2
CN19-13-4	8.3
CN21-21-1	8.3
CN85-01-1	8.2
D6234	4.5
D8006	8.0
DF 105 R	1.1
DF 109 R	0.1
DF 112 R	4.3
DF 118 R	0.0
DF 119 R	0.5
DF 129 R	2.8
DF 218 W	4.1
DF EX 1901 R	0.2
DF EX 1902 R	0.8
DF EX 1905 R	3.1
DF EX 1906 R	1.1
DF EX 1907 R	0.8
DF EX 1908 R	0.0
DF EX 1909 R	1.4
Diener 505W	0.0
Dyna-Gro 9002	4.1
Dyna-Gro 9070	1.4
Dyna-Gro 9242W	5.8

Dyna-Gro 9362W	7.8
Dyna-Gro 9552	0.0
Dyna-Gro 9701	0.4
Dyna-Gro 9862	0.8
Dyna-Gro 9932	0.0
Dyna-Gro 9941	4.4
Dyna-Gro WX19711	1.4
Dyna-Gro WX19799W	7.5
E0009	2.6
E2041	6.5
E5024	2.6
E6012	7.3
F0014	6.5
F0036R	5.5
F0039	6.5
F0051R	0.0
F1014	3.5
F1026R	4.5
F1027	4.0
F1047	6.5
F1048	4.5
F2016	4.5
F2019	9.0
F2028R	4.0
F2037	8.5
F2038	9.0
F2039	9.0
GA 081298-16LE1	0.0
Hilliard	2.0
HS 338 R	0.1
HS EX 20W	8.1
HS EX 21W	6.8
HS EX 22W	6.4
HS EX 340R	0.0
HS EX 350R	0.1
IL09-3264	1.0
IL10-21934	0.5
IL10-21937	2.5
IL11-28222	5.0
IL11-6543	5.5

IL12-17257	8.5
IL12-21624	4.5
IL12-8512	3.5
IL13-20616	1.0
ISF 450	3.1
ISF 707	0.0
ISF 718	0.4
ISF 727	0.1
Jupiter	8.1
KWS19X07	0.0
KWS19X09	1.1
KWS258	4.4
KY06C-1178-16-10-3	2.0
KY06C-2067-16-7-1	1.0
KY07C-1145-94-12-5	2.0
LCS3334	0.1
LES15-1066	0.0
LES167617	3.0
MCIA 18001	0.0
MCIA 18002	0.2
MCIA 18003	3.0
MCIA 1801-1	3.1
MCIA 1801-2	0.4
MCIA 1801-3	3.1
MCIA 18W-1J	7.8
MCIA Flipper	4.4
MCIA Harpoon	0.1
MCIA J1701	1.1
MCIA Jonah	0.1
MCIA L 18-2	0.1
MCIA L 18-3	2.8
MCIA L18-1	0.8
MCIA Red Devil	0.8
MCIA Red Dragon	3.4
MCIA S1	0.2
MCIA S2	2.4
MCIA Venus	8.5
MCIA W18M	7.1
MCIA Whale	1.5
MDC07027-12-12	0.0

MI14R0009	3.0
MI14R0011	0.0
MI14R0029	1.0
MI14R0082	0.0
MI14R0109	1.5
MI14R0160	3.0
MI14R0213	4.5
MI14R0267	4.5
MI14R0288	3.5
MI14R0330	1.0
MI14R0421	2.0
MI14R0489	6.5
MI14R0493	5.5
MI14R0593	6.5
MI14R1127	0.5
MI14R1140	2.1
MI14R1152	1.5
MI14W0003	5.0
MI14W0013	8.0
MI14W0054	8.5
MI14W0190	5.2
MI14W0217	8.5
MI14W0245	3.0
MI14W0250	9.0
MI14W0300	6.5
MI14W0334	8.5
MI14W0598	9.0
MI14W0652	6.0
MI14W0742	8.0
MI14W0901	0.5
MI14W0906	0.5
MI14W0928	9.0
MI14W1039	6.9
MI14W1046	4.0
MI15R0068	5.0
MI15R0388	1.5
MI15W0193	8.0
MI15W0461	6.5
MI16R0592	0.5
MI16R0682	1.7

MI16R0699	9.0
MI16R0700	8.7
MI16R0715	0.2
MI16R0716	3.5
MI16R0720	4.2
MI16R0737	0.5
MI16R0742	1.2
MI16R0798	7.3
MI16R0808	0.2
MI16R0811	0.2
MI16R0830	1.2
MI16R0898	0.0
MI16R0905	1.7
MI16R0906	3.7
MI16R1019	2.2
MI16R1021	8.2
MI16R1040	1.7
MI16R1041	8.7
MI16R1172	0.3
MI16R1184	8.5
MI16R1232	1.5
MI16W0102	8.7
MI16W0129	3.5
MI16W0131	8.5
MI16W0133	6.7
MI16W0146	8.3
MI16W0174	8.2
MI16W0252	8.5
MI16W0254	4.7
MI16W0259	0.2
MI16W0327	8.2
MI16W0335	8.2
MI16W0364	9.0
MI16W0522	6.1
MI16W0526	8.7
MI16W0528	6.3
MI16W0560	0.2
MI16W0564	1.2
MI16W0571	8.2
MI16W1097	8.7

MI16W1107	8.2
MI16W1147	8.5
MI16W1157	6.2
MI17R0132	2.7
MI17R0138	2.7
MI17R0211	8.2
MI17R0212	0.2
MI17R0213	0.2
MI17R0221	5.2
MI17R0222	1.7
MI17R0225	0.2
MI17R0229	4.2
MI17R0311	1.7
MI17R0323	0.7
MI17R0324	5.2
MI17R0325	1.2
MI17R0328	0.2
MI17R0332	0.7
MI17R0334	2.7
MI17R0335	4.7
MI17R0336	2.2
MI17R0342	2.7
MI17R0356	2.2
MI17R0357	2.7
MI17R0372	3.7
MI17R0386	1.2
MI17R0388	3.2
MI17R0413	1.7
MI17R0415	0.7
MI17R0422	0.2
MI17R0424	2.7
MI17R0434	8.2
MI17R0435	8.2
MI17R0438	8.2
MI17R0439	8.2
MI17R0471	3.2
MI17R0483	1.2
MI17R0484	1.7
MI17R0485	2.3
MI17R0486	0.7

MI17R0487	1.7
MI17R0489	0.7
MI17W0018	5.7
MI17W0020	8.7
MI17W0047	7.2
MI17W0062	8.2
MI17W0065	2.7
MI17W0099	8.2
MI17W0100	9.0
MI17W0101	8.7
MI17W0118	8.2
MI17W0121	8.2
MI17W0131	8.7
MI17W0133	8.7
MI17W0139	8.2
MI17W0155	5.2
MI17W0176	9.0
MI17W0202	7.7
MI17W0206	8.7
MI17W0214	8.2
MI17W0216	8.7
MI17W0224	8.7
MI17W0234	7.7
MI17W0235	9.0
MI17W0276	8.7
MI17W0282	3.7
MI17W0303	6.2
MI17W0490	8.2
MI17W0492	8.7
MO080104	0.0
NY01016-AN	5.0
NY05158-833	6.5
NY94025-136	8.5
NY99069-249	8.0
NY99069-352	6.0
OH07-264-35	0.5
OH08-180-48	1.5
OH08-235-33	4.5
OH10-219-65	3.5
OH11-118-18	2.0

OH12-104-18	0.5
OH12-113-45	8.5
OH12-118-32	0.5
OH12-126-1	0.0
OH12-133-4	1.5
OH12-140-53	4.0
OH12-195-22	3.5
OH12-253-73	6.0
OH12-279-48	2.0
OH12-285-64	8.0
P25R40	0.2
P25R47	2.5
P25W43	7.0
RS 902	0.4
RS 961	0.8
RS 968	1.1
RS 9xp964	0.0
RS 9xp967	1.4
Shirley	3.0
Starburst	0.0
SY 100	2.1
SY 547	0.4
SY 576	1.4
SY 912	4.8
SY Viper	1.1
TN1704	1.5
TN1803	9.0
U6377-035	9.0
U6711-B-046	0.0
U6711-I-201	8.0
U6714-A-014	6.5
U6718-I-245	8.6
U6719-004	9.0
U6731-028	8.5
U6731-034	8.0
UK Motown 2	7.3
VA05W-139	1.5
VA05W-151	4.5
VA05W-251	2.5
VA06W-412	0.0

VA08MAS-369	0.0
VA08W-176	0.6
VA08W-294	1.0
VA09MAS1-12-5-1-3	1.0
VA09W-192WS-29	3.5
VA09W-52	0.5
VA09W-73	0.0
VA09W-75	4.0
VA10W-21	2.5
VA10W-28	0.5
VA10W-663	0.5
VA11W-106	0.5
VA11W-313	2.5
VA11W-323WS	3.5
VA12W-31	2.0
VA14W-29	0.5
VA15W-63	0.0
Viking 191	0.0
Viking 207	0.0
W 302	1.8
W 304	0.0
W 305	0.4
W 312	3.7
W 314	0.0
W 316	1.2
Whitetail	7.7
WX 909	2.8
X08-1181-61-15-5	0.0
X08C-1077-11-18-3	2.5
Zenda	0.5