

USING MODERN GENOMIC TECHNOLOGIES TO IMPROVE MONTANA SPRING
WHEAT

SUPPLEMENTARY MATERIALS

by

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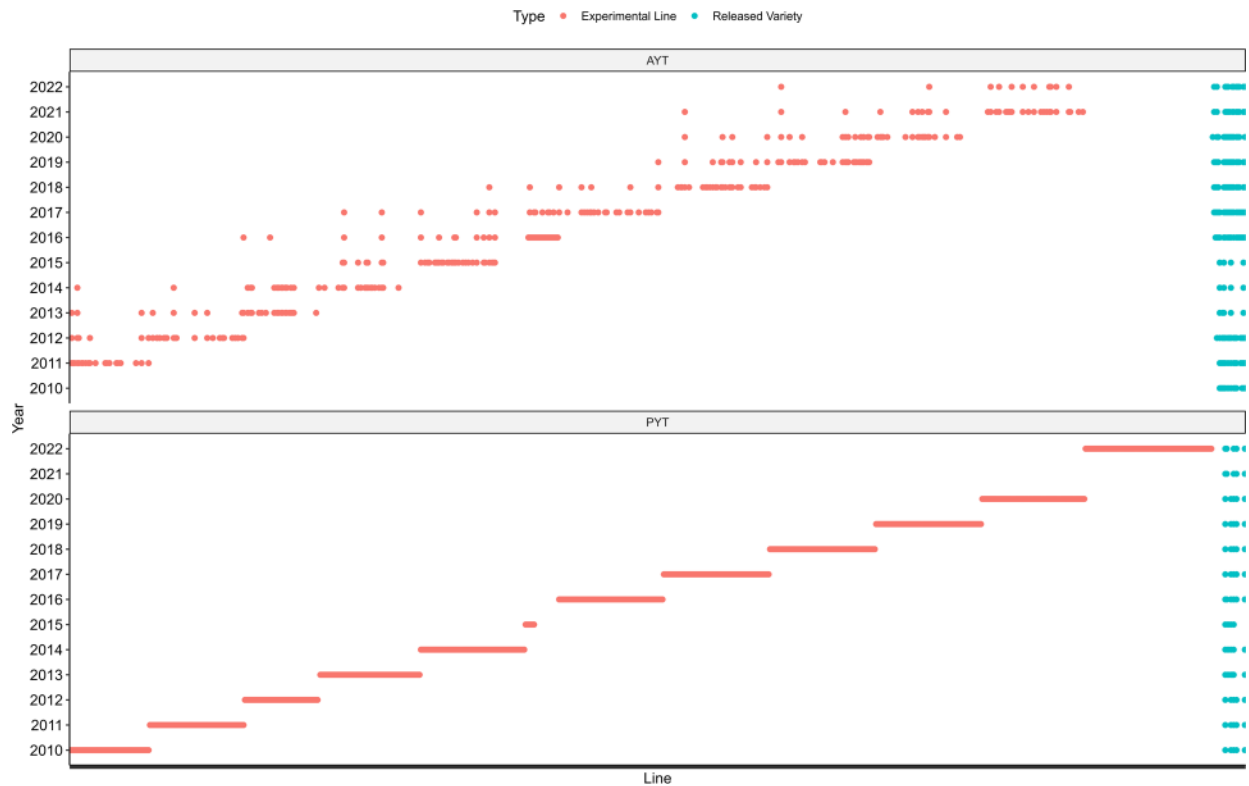
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Supplementary Figure 2.1. Index plot showing the number of experimental lines (red) and released varieties (blue) present in each advanced yield trial (AYT) and preliminary yield trial (PYT) that were both genotyped and phenotyped for end-use quality traits. The x-axis represents each line used in this study, and the y-axis indicates which years a given line was observed. Notably, there were no experimental lines from the 2021 PYT due to a lack of available genotypic information.

SNP	Chromosome	Position (bp)	P-Value	MAF	Effect	Variance Explained	Known Seed Protein Gene	Known Gene Position (bp)
Bake Absorption								
S1B_531857076	1B	531857076	1.55e-07	0.031	1.381	4.2574	HMW glutenin	555765127
S1B_556028292	1B	556028292	2.55e-18	0.037	2.127	4.1059	HMW glutenin	555765127
S1B_641200100	1B	641200100	3.23e-11	0.020	2.115	4.1224	Alpha-amylase/trypsin inhibitor	604700982
S1D_5849672	1D	5849672	1.81e-08	0.186	-0.701	0.9538	LMW glutenin	84681
S2A_18289108	2A	18289108	5.57e-11	0.161	-1.155	0.8639	NA	NA
S4A_643111672	4A	643111672	3.22e-07	0.188	0.727	1.5588	Globulin 3	596304815
S6B_559409888	6B	559409888	1.31e-07	0.450	0.374	0.1939	Alpha-amylase/trypsin inhibitor	518592000
S6D_436239903	6D	436239903	1.59e-07	0.005	-2.868	18.7571	NA	NA
S7B_664400020	7B	664400020	3.33e-12	0.064	5.148	0.0000	Puroindoline-2v	699388914
S7B_666413528	7B	666413528	3.70e-17	0.063	-1.454	186.8942	Puroindoline-2v	699388914
S7B_721574256	7B	721574256	2.56e-07	0.097	0.732	0.4724	Puroindoline-2v	699388914
Bake Time								
S1B_6442739	1B	6442739	5.08e-08	0.120	0.860	1.0996	Gamma gliadin	4843142
S1D_415212882	1D	415212882	1.55e-15	0.074	1.421	2.3660	HMW glutenin	412160786

Supplementary Table 2.1 continued

SNP	Chromosome	Position (bp)	P- Value	MAF	Effect	Variance Explained	Known Seed Protein Gene	Known Gene Position (bp)
S1D_828494	1D	828494	8.17e-15	0.470	-0.842	0.6951	LMW glutenin	84681
S2A_40929984	2A	40929984	1.95e-06	0.070	1.260	0.7281	NA	NA
S2A_58962206	2A	58962206	1.13e-07	0.251	-0.590	0.4326	NA	NA
S2A_761282216	2A	761282216	1.38e-06	0.024	1.697	3.0893	NA	NA
S2B_214125929	2B	214125929	1.94e-06	0.381	-0.539	0.2298	NA	NA
S2B_30298184	2B	30298184	1.31e-06	0.281	0.715	1.2317	Alpha-amylase/trypsin inhibitor	2116046
S3B_777190540	3B	777190540	1.86e-06	0.313	-0.530	0.3894	Alpha-amylase/trypsin inhibitor	801158434
S5A_559090794	5A	559090794	3.72e-12	0.078	1.341	1.4020	NA	NA
S6B_548653569	6B	548653569	1.25e-19	0.225	-1.575	1.6002	Alpha-amylase/trypsin inhibitor	518592000
S6B_579888410	6B	579888410	1.61e-09	0.140	0.764	0.5095	NA	NA
S7B_666413493	7B	666413493	2.38e-10	0.032	2.168	10.0771	Puroindoline-2v	699388914
S7D_574035182	7D	574035182	2.75e-07	0.023	1.788	6.2214	Puroindoline-2v	610764067

Supplementary Table 2.1 continued

SNP	Chromosome	Position (bp)	P-Value	MAF	Effect	Variance Explained	Known Seed Protein Gene	Known Gene Position (bp)
Flour Ash								
S1A_7517463	1A	7517463	4.87e-08	0.155	-0.007	0.0000	Gamma gliadin	3776339
S2A_18289108	2A	18289108	1.74e-07	0.160	-0.010	0.0001	NA	NA
S2A_335648840	2A	335648840	8.17e-08	0.248	-0.004	0.0000	NA	NA
S2B_38628962	2B	38628962	3.54e-07	0.064	0.010	0.0001	Alpha-amylase/trypsin inhibitor	2116046
S2B_686046706	2B	686046706	6.14e-08	0.046	0.011	0.0001	NA	NA
S2D_649563492	2D	649563492	1.45e-08	0.042	-0.010	0.0001	NA	NA
S3B_109953837	3B	109953837	8.54e-07	0.266	-0.007	0.0000	NA	NA
S4A_701108625	4A	701108625	5.47e-10	0.011	0.024	0.0007	Avenin-like protein	717047083
S4B_22228187	4B	22228187	1.56e-07	0.473	0.004	0.0000	1S globulin	13077784
S4B_610833412	4B	610833412	3.12e-10	0.033	0.012	0.0002	NA	NA
S6A_15436219	6A	15436219	2.05e-06	0.145	-0.006	0.0000	Alpha gliadin	25107550
S6A_586354205	6A	586354205	9.19e-07	0.438	-0.004	0.0000	NA	NA
S6D_424835648	6D	424835648	9.27e-07	0.119	-0.008	0.0000	NA	NA
S7A_34458638	7A	34458638	2.13e-07	0.264	0.004	0.0000	Avenin-like	15639003

Supplementary Table 2.1 continued

SNP	Chromosome	Position (bp)	P- Value	MAF	Effect	Variance Explained	Known Seed Protein Gene	Known Gene Position (bp)
S7A_706131949	7A	706131949	7.63e-08	0.224	0.008	0.0000	Puroindoline-2v	700613778
Flour Protein								
S2B_634409231	2B	634409231	3.53e-08	0.053	0.292	0.1472	NA	NA
S2D_1997293	2D	1997293	1.77e-14	0.067	-0.432	0.2892	NA	NA
S3A_710112270	3A	710112270	7.19e-07	0.200	-0.199	0.0255	NA	NA
S3A_727169594	3A	727169594	1.00e-06	0.150	0.164	0.0592	NA	NA
S3A_745322821	3A	745322821	2.36e-06	0.035	-0.317	0.0241	NA	NA
S4B_666609508	4B	666609508	6.77e-07	0.068	0.211	0.0712	NA	NA
S6B_118028893	6B	118028893	8.46e-21	0.056	-0.819	0.5739	NA	NA
S7B_648660714	7B	648660714	2.95e-07	0.495	-0.108	0.0188	NA	NA
S7B_719825391	7B	719825391	2.18e-06	0.393	-0.170	0.0520	Puroindoline-2v	699388914
Flour Yield								
S1D_21906107	1D	21906107	1.82e-06	0.416	-0.497	0.4355	LMW glutenin	84681
S2A_18289108	2A	18289108	5.30e-08	0.160	-0.924	0.8394	NA	NA
S2B_168634632	2B	168634632	1.23e-06	0.011	-1.694	20.3266	NA	NA

Supplementary Table 2.1 continued

SNP	Chromosome	Position (bp)	P-Value	MAF	Effect	Variance Explained	Known Seed Protein Gene	Known Gene Position (bp)
S2D_651099603	2D	651099603	1.94e-08	0.067	-1.053	0.7774	NA	NA
S3A_627276926	3A	627276926	3.72e-08	0.188	-0.468	0.0750	NA	NA
S3B_798392610	3B	798392610	1.76e-06	0.463	-0.314	0.1491	Alpha-amylase/trypsin inhibitor	801158434
S4A_585354277	4A	585354277	1.58e-07	0.189	0.417	0.2749	Globulin 3	596304815
S4B_543287782	4B	543287782	2.29e-06	0.014	-1.581	2.2461	1S globulin	532438585
S5A_19542610	5A	19542610	1.34e-07	0.288	-0.359	0.1889	Grain softness protein	2414730
S6B_441048252	6B	441048252	1.49e-06	0.021	-0.936	1.9345	NA	NA
S6D_1937476	6D	1937476	4.29e-09	0.012	-1.679	3.0260	Alpha-amylase/trypsin inhibitor	52444
S7D_630502174	7D	630502174	1.29e-06	0.075	-0.881	0.5971	Puroindoline-2v	610764067
Grain Protein								
S2B_620644674	2B	620644674	1.08e-07	0.115	-0.192	0.0528	NA	NA
S2B_773869559	2B	773869559	1.57e-07	0.362	-0.123	0.0128	NA	NA
S2D_1997293	2D	1997293	4.72e-11	0.067	-0.397	0.1405	NA	NA
S3A_1003319	3A	1003319	2.25e-11	0.448	0.155	0.0289	NA	NA

Supplementary Table 2.1 continued

SNP	Chromosome	Position (bp)	P-Value	MAF	Effect	Variance Explained	Known Seed Protein Gene	Known Gene Position (bp)
S3A_715826446	3A	715826446	6.03e-10	0.419	-0.159	0.0254	NA	NA
S3A_727169594	3A	727169594	3.62e-08	0.150	0.190	0.0437	NA	NA
S3D_23876760	3D	23876760	6.20e-07	0.014	0.628	0.1953	NA	NA
S4D_446108242	4D	446108242	1.76e-10	0.018	-0.612	0.2822	1S globulin	433816146
S5D_424607241	5D	424607241	3.27e-07	0.011	0.735	0.2677	NA	NA
S5D_436978938	5D	436978938	9.84e-10	0.349	-0.160	0.0290	NA	NA
S6B_118028893	6B	118028893	1.95e-21	0.056	-0.871	0.5088	NA	NA
S6B_136939298	6B	136939298	1.49e-10	0.046	0.355	0.1341	NA	NA
S6B_405862957	6B	405862957	2.72e-07	0.270	0.171	0.0336	NA	NA
S7B_603997211	7B	603997211	1.10e-07	0.198	-0.147	0.0286	NA	NA
Loaf Volume								
S1D_415212855	1D	415212855	3.48e-25	0.073	42.321	1497.7917	HMW glutenin	412160786
S1D_828364	1D	828364	2.01e-19	0.470	-21.538	428.9626	LMW glutenin	84681
S6B_33492550	6B	33492550	1.84e-06	0.040	-22.010	693.4993	Alpha gliadin	43520759
S6B_7828591	6B	7828591	1.56e-08	0.461	-10.304	208.1439	Alpha gliadin	43520759

Supplementary Table 2.1 continued

SNP	Chromosome	Position (bp)	P-Value	MAF	Effect	Variance Explained	Known Seed Protein Gene	Known Gene Position (bp)
S7B_651402077	7B	651402077	3.38e-08	0.498	-11.771	83.8225	Puroindoline-2v	699388914
Mix Absorption								
S1B_556028292	1B	556028292	1.03e-19	0.037	2.071	1.9290	HMW glutenin	555765127
S1D_5849672	1D	5849672	2.41e-10	0.186	-0.617	0.4715	LMW glutenin	84681
S2A_18289108	2A	18289108	1.17e-06	0.160	-0.846	0.5033	NA	NA
S2A_769460901	2A	769460901	1.13e-11	0.493	0.556	0.4041	NA	NA
S3B_732615137	3B	732615137	2.35e-07	0.299	0.594	0.2654	NA	NA
S6A_613798856	6A	613798856	1.05e-06	0.256	-0.390	0.1617	NA	NA
S6D_436239903	6D	436239903	3.61e-07	0.005	-2.283	16.5419	NA	NA
S7B_603997211	7B	603997211	4.79e-07	0.198	-0.393	0.2551	NA	NA
Mix Time								
S1A_12687878	1A	12687878	2.87e-07	0.412	0.395	0.0969	Gamma gliadin	3776339
S1B_641200100	1B	641200100	6.55e-10	0.020	0.788	0.7305	Alpha-amylase/trypsin inhibitor	604700982
S1B_6442739	1B	6442739	1.97e-07	0.119	0.278	0.1322	Gamma gliadin	4843142
S1D_414898462	1D	414898462	1.00e-26	0.075	0.741	0.6656	HMW glutenin	412160786

Supplementary Table 2.1 continued

SNP	Chromosome	Position (bp)	P- Value	MAF	Effect	Variance Explained	Known Seed Protein Gene	Known Gene Position (bp)
S1D_828494	1D	828494	5.89e- 13	0.470	-0.284	0.0986	LMW glutenin	84681
S2A_46107693	2A	46107693	2.24e- 07	0.025	0.592	0.5440	NA	NA
S2D_63627599	2D	63627599	7.74e- 08	0.014	1.018	0.5334	NA	NA
S3B_31994039	3B	31994039	2.23e- 06	0.480	0.175	0.0551	NA	NA
S6A_270645281	6A	270645281	4.10e- 10	0.357	-0.271	0.0526	NA	NA
S6B_600787446	6B	600787446	5.38e- 07	0.156	0.246	0.1148	NA	NA
S7B_666413493	7B	666413493	7.47e- 15	0.032	0.793	0.8583	Puroindoline- 2v	69938891 4
Mix Tolerance								
S1D_414898462	1D	414898462	1.65e- 20	0.075	0.523	0.3667	HMW glutenin	412160786
S1D_828418	1D	828418	3.65e- 15	0.470	-0.258	0.0865	LMW glutenin	84681
S2A_18289108	2A	18289108	2.93e- 32	0.160	0.765	0.3600	NA	NA
S3A_68930615	3A	68930615	7.11e- 07	0.015	0.479	0.2918	NA	NA
S3B_26689882	3B	26689882	1.26e- 08	0.403	0.169	0.0294	NA	NA
S4A_685850066	4A	685850066	2.75e- 09	0.192	-0.225	0.0402	Avenin- like protein	717047083
S4B_424751972	4B	424751972	2.60e- 08	0.483	-0.175	0.0288	NA	NA

Supplementary Table 2.1 continued

SNP	Chromosome	Position (bp)	P-Value	MAF	Effect	Variance Explained	Known Seed Protein Gene	Known Gene Position (bp)
S6A_25643435	6A	25643435	3.30e-	0.433	-0.271	0.0819	Alpha gliadin	25107550
S6A_581459653	6A	581459653	5.88e-09	0.015	-0.705	0.4135	NA	NA
S6B_548653518	6B	548653518	9.32e-12	0.229	-0.342	0.0525	Alpha-amylase/trypsin inhibitor	518592000
Single Kernel Hardness								
S1A_572160406	1A	572160406	1.05e-06	0.069	2.180	10.6763	Purothionin	563608918
S3A_8267019	3A	8267019	2.71e-09	0.278	1.937	8.6097	NA	NA
S3B_109953724	3B	109953724	1.09e-10	0.260	-2.863	4.3288	NA	NA
S4B_466588800	4B	466588800	6.00e-08	0.041	3.160	11.6279	NA	NA
S4D_455472196	4D	455472196	2.82e-10	0.008	-9.601	192.8405	1S globulin	433816146
S5A_84647851	5A	84647851	2.27e-06	0.017	-5.037	12.7410	NA	NA
S6A_615887442	6A	615887442	5.51e-08	0.416	-1.528	2.1722	NA	NA
S6D_327985344	6D	327985344	3.89e-09	0.029	4.330	23.4108	Alpha-amylase/trypsin inhibitor	343617028
Wheat Ash								
S2A_662902163	2A	662902163	1.71e-10	0.157	0.036	0.0008	NA	NA
S6B_118028893	6B	118028893	3.93e-07	0.056	-0.050	0.0017	NA	NA

Supplementary Table 2.1 continued

SNP	Chromosome	Position (bp)	P- Value	MAF	Effect	Variance Explained	Known Seed Protein Gene	Known Gene Position (bp)
S6D_79490830	6D	79490830	4.28e-08	0.011	0.097	0.0062	NA	NA
S7D_613716881	7D	613716881	1.77e-	0.254	-0.025	0.0003	Puroindoline-2v	610764067

Supplementary Table 2.1. Table of all significant GWAS results (marker p-value < Bonferroni threshold) for twelve end-use quality traits obtained using all available training data. Models were fit using the BLINK method from GAPIT v.3, and marker positions were from the IWGSC RefSeq v1.0 reference genome. Column 9 indicates genes annotated to be in the seed protein family that were within 1 Mb of a significant marker, and column 10 gives the starting forward position of that gene.