

### Supplementary Tables

**Table S4:** Summary analysis of interactions between samples and field for manually collected data and spectral indices

Trait	Type	Sample	Field	Sample X Field
TSWV mid season	Manual	***	***	NS
Leaf spot	Manual	***	***	NS
Pod weight	Manual	***	***	*
TSWV late season	Manual	NA	NA	NA
Green Vegetation Index-R (GRV)	RGB	***	***	*
Green Leaf Index (GLI)	RGB	***	***	NS
Visible Atmospherically Resistant Index (VARI)	RGB	***	***	*
Chlorophyll Index-RE (CIRE )	Multi-spectral	***	***	NS
Difference Vegetation Index (DVI )	Multi-spectral	***	***	NS
Green Normalized Difference Vegetation Index (GNDVI )	Multi-spectral	***	***	NS
Normalized Difference Vegetation Index ( NDVI)	Multi-spectral	***	***	NS
Normalized Green (NG )	Multi-spectral	***	***	NS
Optimized Soil Adjusted Vegetation Index ( OSAVI )	Multi-spectral	***	***	NS
Ratio Vegetation Index (RVI )	Multi-spectral	***	***	NS
Soil Adjusted Vegetation Index ( SAVI )	Multi-spectral	***	***	NS
Triangular Vegetation Index ( TVI )	Multi-spectral	***	***	NS
Mid season canopy temperature depression	Thermal	NS	***	NS
End season canopy temperature depression	Thermal	**	***	NS

NS      P > 0.05  
 \*        P ≤ 0.05  
 \*\*       P ≤ 0.01  
 \*\*\*     P ≤ 0.001

**Table S5:** Ranking of the chromosome segment substitution lines (CSSLs) based on Green Normalized Difference Vegetation Index (GNDVI), Visible Atmospherically Resistant Index (VARI) and Green Vegetation Index-R (GRV). The indices generally rank the lines similarly to the manual data, showing their capacity for selection in this population

Sample	Field	GNDVI	Rank GNDVI	GRV	Rank GRV	VARI	Rank VARI	Pod weight	Rank Pod weight	Leaf spot	Rank leaf spot	TSWV mid season	Rank TSWV mid season	TSWV late season	Rank TSWV late season
CSSL 084	Gibbs	0.76	5	0.16	2	0.25	4	1610.00	1	4.26	6	1.67	5	3.17	4
CSSL 111	Gibbs	0.77	3	0.16	1	0.25	3	1570.67	2	3.51	3	1.33	3	3.50	5
CSSL 100	Gibbs	0.77	2	0.15	5	0.25	2	1276.67	3	3.01	2	0.67	2	2.00	2
Tifguard	Gibbs	0.79	1	0.16	3	0.27	1	1213.33	4	3.01	1	0.67	1	1	1
CSSL 069	Gibbs	0.70	22	0.14	18	0.22	17	1030.67	5	4.84	9	3.67	19	6.17	20
CSSL 022	Gibbs	0.68	29	0.13	27	0.20	27	997.33	6	5.50	17	4.33	27	7.83	28
CSSL 013	Gibbs	0.71	20	0.14	22	0.21	22	920.00	7	6.17	26	3.33	17	6.50	23
CSSL 112	Gibbs	0.72	14	0.15	9	0.22	12	919.33	8	5.52	20	3.00	15	4.83	12
CSSL 060	Gibbs	0.71	19	0.14	15	0.22	16	904.00	9	5.18	13	2.33	8	6.17	18
CSSL 031	Gibbs	0.75	6	0.15	7	0.23	7	878.00	10	5.18	12	2.67	11	4.00	7
CSSL 025	Gibbs	0.71	18	0.14	25	0.21	20	872.00	11	6.03	24	4.00	24	5.67	16
CSSL 051	Gibbs	0.71	17	0.15	8	0.22	10	862.00	12	5.34	15	2.33	9	5.00	13
CSSL 027	Gibbs	0.70	24	0.14	23	0.21	25	860.00	13	6.02	23	3.67	23	6.67	25
CSSL 115	Gibbs	0.72	15	0.14	16	0.21	23	839.33	14	4.51	7	2.00	6	6.33	21
CSSL 058	Gibbs	0.71	21	0.14	19	0.21	21	837.33	15	6.67	28	3.33	18	6.17	19
CSSL 061	Gibbs	0.68	28	0.14	20	0.21	19	832.67	16	7.00	29	4.00	26	7.00	26
CSSL 121	Gibbs	0.72	12	0.15	13	0.22	13	824.67	17	5.50	16	3.33	16	5.67	15
CSSL 014	Gibbs	0.73	8	0.14	21	0.21	18	818.67	18	4.84	10	2.67	10	6.33	22
CSSL 062	Gibbs	0.71	16	0.15	10	0.22	14	801.33	19	5.33	14	2.67	12	5.33	14
CSSL 010	Gibbs	0.70	23	0.14	24	0.21	24	788.00	20	6.03	25	4.00	25	8.17	29
CSSL 113	Gibbs	0.69	26	0.13	26	0.20	28	785.33	21	5.50	18	3.67	21	6.50	24
CSSL 044	Gibbs	0.72	13	0.14	17	0.22	15	765.33	22	5.84	22	2.67	13	4.83	11
Florunner	Gibbs	0.76	4	0.15	4	0.24	5	744.67	23	3.51	4	3	14	2.67	3
CSSL 056	Gibbs	0.73	11	0.14	14	0.22	11	744.00	24	5.67	21	3.67	22	4.67	10
CSSL 009	Gibbs	0.68	27	0.13	28	0.19	29	734.67	25	5.51	19	5.33	29	7.33	27
CSSL 015	Gibbs	0.75	7	0.15	12	0.22	8	709.02	26	3.75	5	1.50	4	3.50	6
Fleur 011	Gibbs	0.69	25	0.13	29	0.20	26	705.33	27	6.36	27	5.00	28	5.67	17
CSSL 055	Gibbs	0.73	9	0.15	6	0.23	6	680.67	28	4.52	8	2.33	7	4.33	8
CSSL 053	Gibbs	0.73	10	0.15	11	0.22	9	540.67	29	5.01	11	3.67	20	4.50	9
CSSL 084	Bowen	0.74	4	0.15	1	0.23	1	1320.00	1	4.17	4	1.00	5	NA	NA
CSSL 111	Bowen	0.70	5	0.12	17	0.18	6	1028.00	2	4.00	3	0.67	3	NA	NA
Florunner	Bowen	0.74	1	0.14	2	0.21	4	859.33	3	4.17	5	0.67	4	NA	NA
Tifguard	Bowen	0.74	2	0.14	3	0.23	2	816.00	4	3.50	1	0.33	2	NA	NA
CSSL 060	Bowen	0.65	23	0.12	22	0.17	24	752.67	5	5.50	7	2.33	11	NA	NA
CSSL 013	Bowen	0.68	13	0.12	11	0.18	11	690.67	6	6.67	22	3.00	20	NA	NA
CSSL 100	Bowen	0.74	3	0.14	4	0.22	3	676.74	7	3.73	2	0.06	1	NA	NA
CSSL 014	Bowen	0.70	7	0.12	19	0.17	20	676.67	8	5.67	9	2.67	15	NA	NA
CSSL 044	Bowen	0.66	19	0.13	9	0.18	12	661.33	9	5.83	12	2.00	9	NA	NA

Sample	Field	GNDVI	Rank GNDVI	GRV	Rank GRV	VARI	Rank VARI	Pod weight	Rank Pod weight	Leaf spot	Rank leaf spot	TSWV mid season	Rank TSWV mid season	TSWV late season	Rank TSWV late season
CSSL 113	Bowen	0.66	20	0.12	21	0.17	21	659.33	10	6.17	14	2.67	16	NA	NA
CSSL 115	Bowen	0.66	18	0.12	23	0.17	23	648.00	11	5.83	13	1.33	7	NA	NA
CSSL 069	Bowen	0.64	27	0.11	28	0.16	29	634.00	12	5.67	10	3.67	24	NA	NA
CSSL 009	Bowen	0.67	15	0.12	16	0.17	18	628.67	13	6.50	19	4.00	28	NA	NA
CSSL 010	Bowen	0.67	17	0.12	18	0.17	16	623.33	14	6.33	17	3.00	18	NA	NA
CSSL 058	Bowen	0.68	10	0.12	13	0.17	15	613.33	15	7.00	26	3.33	22	NA	NA
CSSL 056	Bowen	0.67	16	0.13	7	0.18	7	588.67	16	6.83	23	3.67	25	NA	NA
CSSL 061	Bowen	0.65	24	0.12	20	0.17	17	585.33	17	6.83	24	2.33	14	NA	NA
CSSL 051	Bowen	0.67	14	0.13	8	0.18	9	573.33	18	6.33	18	2.00	10	NA	NA
CSSL 112	Bowen	0.68	12	0.12	24	0.17	19	536.67	19	5.67	11	3.00	17	NA	NA
CSSL 025	Bowen	0.65	25	0.12	26	0.16	25	533.33	20	7.33	28	3.00	21	NA	NA
CSSL 062	Bowen	0.66	21	0.13	6	0.18	8	521.33	21	6.50	20	3.00	19	NA	NA
CSSL 031	Bowen	0.70	6	0.13	10	0.18	13	514.00	22	6.17	15	1.67	8	NA	NA
CSSL 027	Bowen	0.63	28	0.12	15	0.17	22	503.33	23	7.00	27	3.67	27	NA	NA
Fleur 011	Bowen	0.66	22	0.11	29	0.16	28	498.00	24	6.17	16	4.67	29	NA	NA
CSSL 053	Bowen	0.69	8	0.13	5	0.19	5	484.67	25	6.50	21	2.33	13	NA	NA
CSSL 015	Bowen	0.69	9	0.12	14	0.18	14	468.74	26	4.73	6	1.06	6	NA	NA
CSSL 121	Bowen	0.64	26	0.12	25	0.16	26	466.67	27	6.83	25	3.67	26	NA	NA
CSSL 022	Bowen	0.62	29	0.11	27	0.16	27	466.67	28	7.33	29	3.33	23	NA	NA
CSSL 055	Bowen	0.68	11	0.12	12	0.18	10	414.00	29	5.50	8	2.33	12	NA	NA

**Table S6:** The effects of introgressions on the traits that were manually collected. Lines with significant introgression effects are presented. For TSWV late season, CSSL 10, CSSL 84 and CSSL 111 which are not statistically significant are highlighted because of their high numeric effects. The introgression effects were calculated as percentages relative to the cultivated Fleur 11

Sample	Field	Trait	Significance	Introgression effect
CSSL 015	Gibbs	Leaf spot	**	-40.63
CSSL 084	Gibbs	Leaf spot	*	-34.07
CSSL 084	Bowen	Leaf spot	*	-32.43
CSSL 100	Gibbs	Leaf spot	***	-52.42
CSSL 100	Bowen	Leaf spot	**	-39.57
CSSL 111	Gibbs	Leaf spot	***	-44.56
CSSL 111	Bowen	Leaf spot	**	-35.14
CSSL 015	Gibbs	TSWV mid season	*	-70
CSSL 015	Bowen	TSWV mid season	***	-77.25
CSSL 031	Bowen	TSWV mid season	***	-64.29
CSSL 044	Bowen	TSWV mid season	**	-57.14
CSSL 051	Bowen	TSWV mid season	**	-57.14
CSSL 053	Bowen	TSWV mid season	*	-50
CSSL 055	Bowen	TSWV mid season	*	-50
CSSL 060	Bowen	TSWV mid season	*	-50
CSSL 061	Bowen	TSWV mid season	*	-50
CSSL 084	Gibbs	TSWV mid season	**	-66.67
CSSL 084	Bowen	TSWV mid season	***	-78.57
CSSL 100	Gibbs	TSWV mid season	***	-86.67
CSSL 100	Bowen	TSWV mid season	***	-98.68
CSSL 111	Gibbs	TSWV mid season	**	-73.33
CSSL 111	Bowen	TSWV mid season	***	-85.71
CSSL 115	Gibbs	TSWV mid season	*	-60
CSSL 115	Bowen	TSWV mid season	***	-71.43
CSSL 010	Gibbs	TSWV late season	NS	44.12
CSSL 084	Gibbs	TSWV late season	NS	-44.12
CSSL 100	Gibbs	TSWV late season	*	-64.71
CSSL 111	Gibbs	TSWV late season	NS	-38.24
CSSL 069	Gibbs	Pod weight	*	46.12

Sample	Field	Trait	Significance	Introgression effect
CSSL 084	Bowen	Pod weight	***	165.06
CSSL 084	Gibbs	Pod weight	***	128.26
CSSL 100	Gibbs	Pod weight	***	81
CSSL 111	Bowen	Pod weight	***	106.43
CSSL 111	Gibbs	Pod weight	***	122.68

NS      P > 0.05  
\*        P ≤ 0.05  
\*\*       P ≤ 0.01  
\*\*\*     P ≤ 0.001

**Table S7:** Summary statistics of all GPR variables

GPR Variable <sup>a</sup>	Pipeline	Field	Significance	Mean	Max	Min	SE <sup>b</sup>	Fleur 11
p1_freq_1	1	Bowen	*	0.37	0.459	0.254	0.009	0.35
p1_freq_2	1	Bowen	***	0.13	0.165	0.106	0.002	0.13
p1_freq_3	1	Bowen	*	0.07	0.085	0.062	0.001	0.07
p1_freq_4	1	Bowen	NS	0.06	0.071	0.055	0.001	0.06
p1_freq_5	1	Bowen	*	0.06	0.072	0.054	0.001	0.06
p1_freq_6	1	Bowen	*	0.06	0.068	0.053	0.001	0.06
p1_freq_7	1	Bowen	***	0.06	0.069	0.054	0.001	0.06
p1_freq_8	1	Bowen	***	0.06	0.068	0.053	0.001	0.06
p1_freq_9	1	Bowen	***	0.06	0.067	0.052	0.001	0.06
p1_freq_10	1	Bowen	***	0.06	0.068	0.051	0.001	0.06
p1_freq_11	1	Bowen	***	0.06	0.067	0.051	0.001	0.06
p1_freq_12	1	Bowen	***	0.06	0.067	0.052	0.001	0.06
p1_freq_13	1	Bowen	**	0.06	0.067	0.052	0.001	0.06
p2_freq_1	2	Bowen	*	0.37	0.464	0.259	0.009	0.35
p2_freq_2	2	Bowen	***	0.12	0.160	0.101	0.002	0.12
p2_freq_3	2	Bowen	*	0.07	0.085	0.060	0.001	0.06
p2_freq_4	2	Bowen	NS	0.06	0.071	0.054	0.001	0.06
p2_freq_5	2	Bowen	*	0.06	0.072	0.053	0.001	0.06
p2_freq_6	2	Bowen	*	0.06	0.069	0.052	0.001	0.06
p2_freq_7	2	Bowen	***	0.06	0.069	0.053	0.001	0.06
p2_freq_8	2	Bowen	**	0.06	0.068	0.052	0.001	0.06

GPR Variable <sup>a</sup>	Pipeline	Field	Significance	Mean	Max	Min	SE <sup>b</sup>	Fleur 11
p2_freq_9	2	Bowen	***	0.06	0.068	0.051	0.001	0.06
p2_freq_10	2	Bowen	***	0.06	0.068	0.050	0.001	0.06
p2_freq_11	2	Bowen	***	0.06	0.068	0.050	0.001	0.06
p2_freq_12	2	Bowen	***	0.06	0.068	0.050	0.001	0.06
p2_freq_13	2	Bowen	*	0.06	0.067	0.051	0.001	0.06
p3_freq_1	3	Bowen	*	0.34	0.438	0.222	0.010	0.32
p3_freq_2	3	Bowen	*	0.09	0.127	0.070	0.002	0.09
p3_freq_3	3	Bowen	*	0.07	0.086	0.058	0.001	0.06
p3_freq_4	3	Bowen	NS	0.06	0.071	0.053	0.001	0.06
p3_freq_5	3	Bowen	NS	0.06	0.071	0.054	0.001	0.06
p3_freq_6	3	Bowen	NS	0.06	0.068	0.053	0.001	0.06
p3_freq_7	3	Bowen	*	0.06	0.069	0.054	0.001	0.06
p3_freq_8	3	Bowen	*	0.06	0.067	0.053	0.001	0.06
p3_freq_9	3	Bowen	*	0.06	0.067	0.051	0.001	0.06
p3_freq_10	3	Bowen	*	0.06	0.067	0.051	0.001	0.06
p3_freq_11	3	Bowen	*	0.06	0.067	0.051	0.001	0.06
p3_freq_12	3	Bowen	*	0.06	0.067	0.051	0.001	0.06
p3_freq_13	3	Bowen	NS	0.06	0.067	0.052	0.001	0.06
p1_freq_1	3	Gibbs	NS	0.29	0.352	0.246	0.0038	0.35
p1_freq_2	1	Gibbs	***	0.15	0.173	0.116	0.0027	0.17
p1_freq_3	1	Gibbs	NS	0.07	0.080	0.067	0.0006	0.08
p1_freq_4	1	Gibbs	NS	0.06	0.069	0.058	0.0005	0.07
p1_freq_5	1	Gibbs	NS	0.06	0.066	0.056	0.0004	0.06
p1_freq_6	1	Gibbs	NS	0.06	0.064	0.055	0.0004	0.06
p1_freq_7	1	Gibbs	NS	0.06	0.065	0.056	0.0004	0.06
p1_freq_8	1	Gibbs	NS	0.06	0.064	0.055	0.0004	0.06
p1_freq_9	1	Gibbs	NS	0.06	0.063	0.054	0.0004	0.06
p1_freq_10	1	Gibbs	NS	0.06	0.062	0.054	0.0004	0.06
p1_freq_11	1	Gibbs	NS	0.06	0.062	0.054	0.0004	0.06
p1_freq_12	1	Gibbs	NS	0.06	0.062	0.053	0.0004	0.06
p1_freq_13	1	Gibbs	NS	0.06	0.062	0.054	0.0004	0.06
p2_freq_1	2	Gibbs	NS	0.29	0.350	0.247	0.0038	0.35

GPR Variable <sup>a</sup>	Pipeline	Field	Significance	Mean	Max	Min	SE <sup>b</sup>	Fleur 11
p2_freq_2	2	Gibbs	***	0.14	0.163	0.108	0.0026	0.16
p2_freq_3	2	Gibbs	NS	0.07	0.079	0.065	0.0007	0.08
p2_freq_4	2	Gibbs	NS	0.06	0.069	0.057	0.0005	0.07
p2_freq_5	2	Gibbs	NS	0.06	0.066	0.056	0.0004	0.06
p2_freq_6	2	Gibbs	NS	0.06	0.064	0.054	0.0004	0.06
p2_freq_7	2	Gibbs	NS	0.06	0.064	0.056	0.0004	0.06
p2_freq_8	2	Gibbs	NS	0.06	0.064	0.055	0.0004	0.06
p2_freq_9	2	Gibbs	NS	0.06	0.062	0.054	0.0004	0.06
p2_freq_10	2	Gibbs	NS	0.06	0.062	0.054	0.0004	0.06
p2_freq_11	2	Gibbs	NS	0.06	0.062	0.054	0.0004	0.06
p2_freq_12	2	Gibbs	NS	0.06	0.062	0.053	0.0004	0.06
p2_freq_13	2	Gibbs	NS	0.06	0.063	0.053	0.0004	0.06
p3_freq_1	3	Gibbs	NS	0.23	0.266	0.206	0.0026	0.27
p3_freq_2	3	Gibbs	*	0.09	0.113	0.074	0.0017	0.11
p3_freq_3	3	Gibbs	NS	0.07	0.077	0.063	0.0007	0.07
p3_freq_4	3	Gibbs	NS	0.06	0.071	0.057	0.0006	0.07
p3_freq_5	3	Gibbs	NS	0.06	0.068	0.054	0.0006	0.06
p3_freq_6	3	Gibbs	NS	0.06	0.066	0.053	0.0006	0.06
p3_freq_7	3	Gibbs	NS	0.06	0.066	0.054	0.0005	0.06
p3_freq_8	3	Gibbs	NS	0.06	0.065	0.053	0.0005	0.06
p3_freq_9	3	Gibbs	NS	0.06	0.064	0.052	0.0006	0.06
p3_freq_10	3	Gibbs	NS	0.06	0.064	0.051	0.0006	0.06
p3_freq_11	3	Gibbs	NS	0.06	0.064	0.051	0.0006	0.06
p3_freq_12	3	Gibbs	NS	0.06	0.064	0.052	0.0006	0.06
p3_freq_13	3	Gibbs	NS	0.06	0.065	0.052	0.0006	0.06

NS
P > 0.05

\*
P ≤ 0.05

\*\*
P ≤ 0.01

\*\*\*
P ≤ 0.001

<sup>a</sup>
GPR variables range from 0 to 1

<sup>b</sup>
Standard error

**Table S8:** Comparison of CSSL ranking ability between manual pod weight data and GPR variables that showed significant correlations with pod weight in Bowen and Gibbs. The CSSLs are ranked based on pod weight performance. The ranking by the GPR variables is indicated in the respective columns for each variable. Green font indicates top 10 CSSLs as ranked by pod weight, while purple font indicates bottom 10 CSSLs as ranked by pod weight

[illegible]



Line	Field	Pod	p1_fr	p2_fr	p3_fr	p3_fr	p3_fr	p3_fr	p3_fr	p3_fr	p3_fr	p3_fr	p3_fre	p3_fre	p3_fre	p3_fre
		weigh	eq_1	eq_1	eq_1	eq_3	eq_4	eq_5	eq_6	eq_7	eq_8	eq_9	q_10	q_11	q_12	q_13
		t														
CSSL 100	Gibbs	3	2*	2*	2*	7*	4*	2*	2*	2*	2*	2*	2*	2*	2*	2*
Tifguard	Gibbs	4	1*	1*	7*	5*	3*	3*	3*	3*	3*	3*	4*	4*	4*	3*
CSSL 069	Gibbs	5	20	18	11	14	18	24	20	22	22	22	22	22	22	22
CSSL 022	Gibbs	6	24	24	26	11	11	11	12	10*	12	12	11	11	11	12
CSSL 013	Gibbs	7	16	22	19	20	15	16	16	17	17	16	15	15	15	16
CSSL 112	Gibbs	8	17	16	8	16	12	15	14	12	11	13	14	13	14	13
CSSL 060	Gibbs	9	10	12	14	27	24	21	23	21	21	20	18	18	18	20
CSSL 031	Gibbs	10	18	17	15	25	26	26	26	26	26	26	26	26	26	26
CSSL 025	Gibbs	11	27	27	25	21	14	12	13	13	13	11	10	9	10	11
CSSL 051	Gibbs	12	12	11	17	12	21	20	24	24	24	24	24	23	24	24
CSSL 027	Gibbs	13	22	19	18	29	29	29	29	29	29	29	29	29	29	29
CSSL 115	Gibbs	14	7	7	4	1	5	7	5	7	7	8	9	8	9	6
CSSL 058	Gibbs	15	19	20	12	23	28	28	28	28	28	28	28	28	28	28
CSSL 061	Gibbs	16	11	13	20	19	22	22	19	18	18	18	20	20	20	18
CSSL 121	Gibbs	17	21	21	10	18	8	8	7	5	5	5	3	3	3	5
CSSL 014	Gibbs	18	4	4	1	10	17	18	18	20	20	21	21	21	21	21
CSSL 062	Gibbs	19	6	6	9	24	23	23	22	19	19	19	19	19	19	19
CSSL 010	Gibbs	20	9	9	13	3	7	13	10	14	14	15	17	16	16	14
CSSL 113	Gibbs	21	25**	26**	27**	28**	27**	27**	27**	27**	27**	27**	27**	27**	27**	27**
CSSL 044	Gibbs	22	26**	25**	22**	22**	20**	14	15	15	15	14	13	14	13	15
Florunner	Gibbs	23	14	14	23**	17	19	17	17	16	16	17	16	17	17	17
CSSL 056	Gibbs	24	28**	28**	28**	13	9	6	8	6	6	6	5	6	5	7
CSSL 009	Gibbs	25	23**	23**	24**	15	13	9	11	9	9	9	6	7	7	9
CSSL 015	Gibbs	26	8	8	16	8	10	10	9	11	10	10	12	12	12	10
Fleur 011	Gibbs	27	29**	29**	29**	26**	25**	25**	25**	25**	25**	25**	25**	25**	25**	25**
CSSL 055	Gibbs	28	5	5	6	6	2	4	6	8	8	7	8	10	8	8
CSSL 053	Gibbs	29	15	15	21**	9	16	19	21**	23**	23**	23**	23**	24**	23**	23**

\*GPR variable ranking among the top 10 consistent with manual pod weight

\*\*GPR variable ranking among the bottom 10 consistent with manual pod weight