Genome wide association study for wide environmental adaptation in a large spring bread wheat population using genotyping-by-sequencing approach

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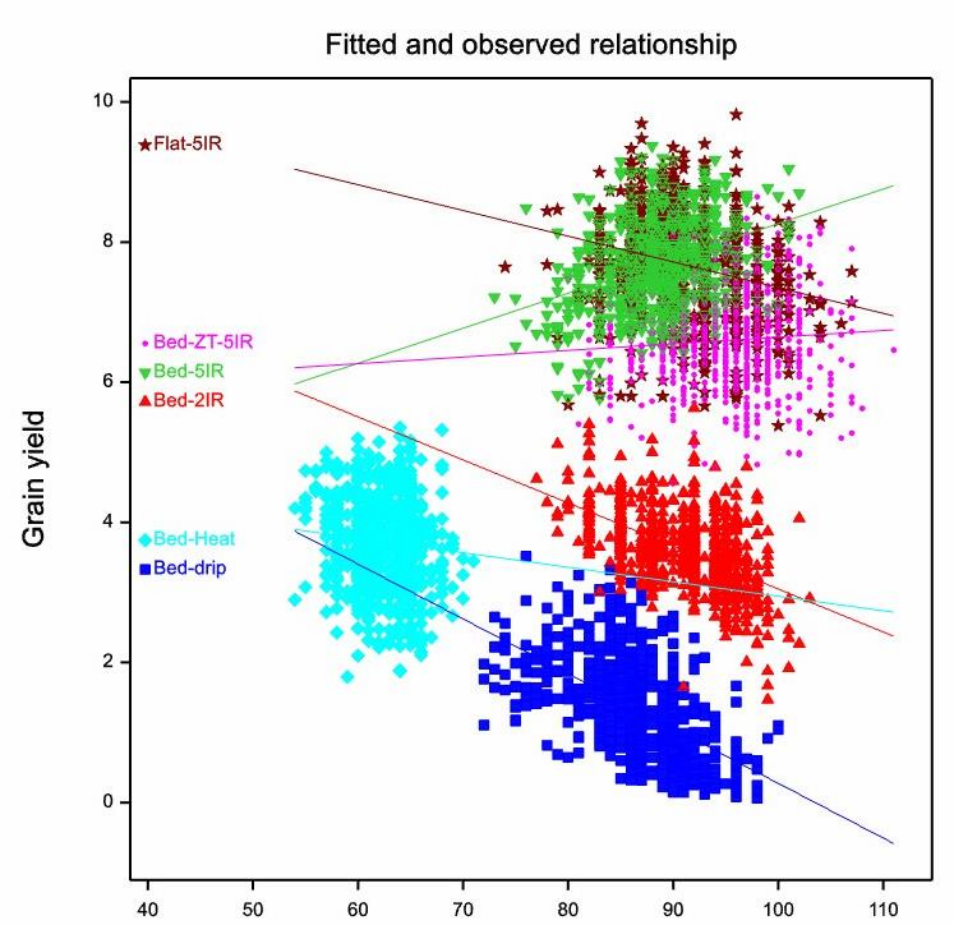
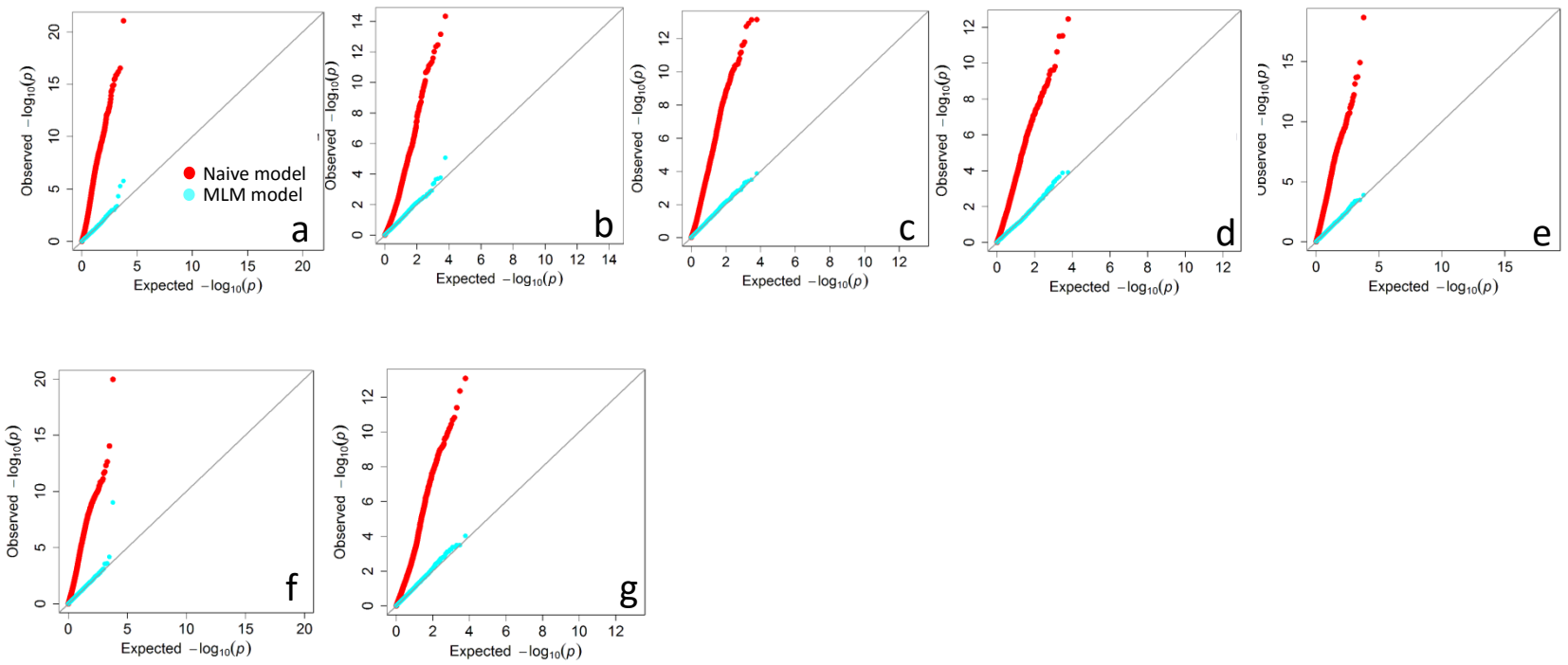
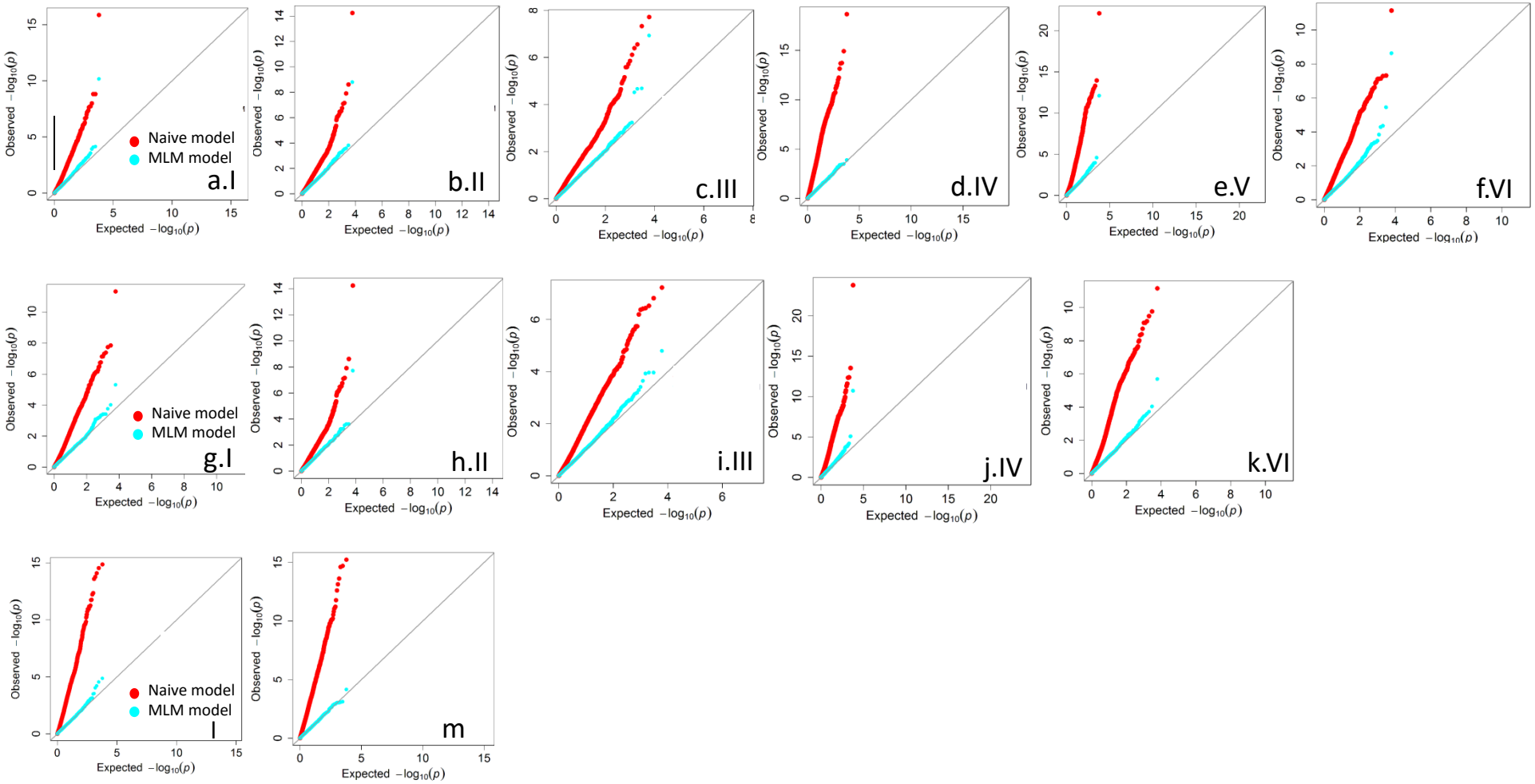


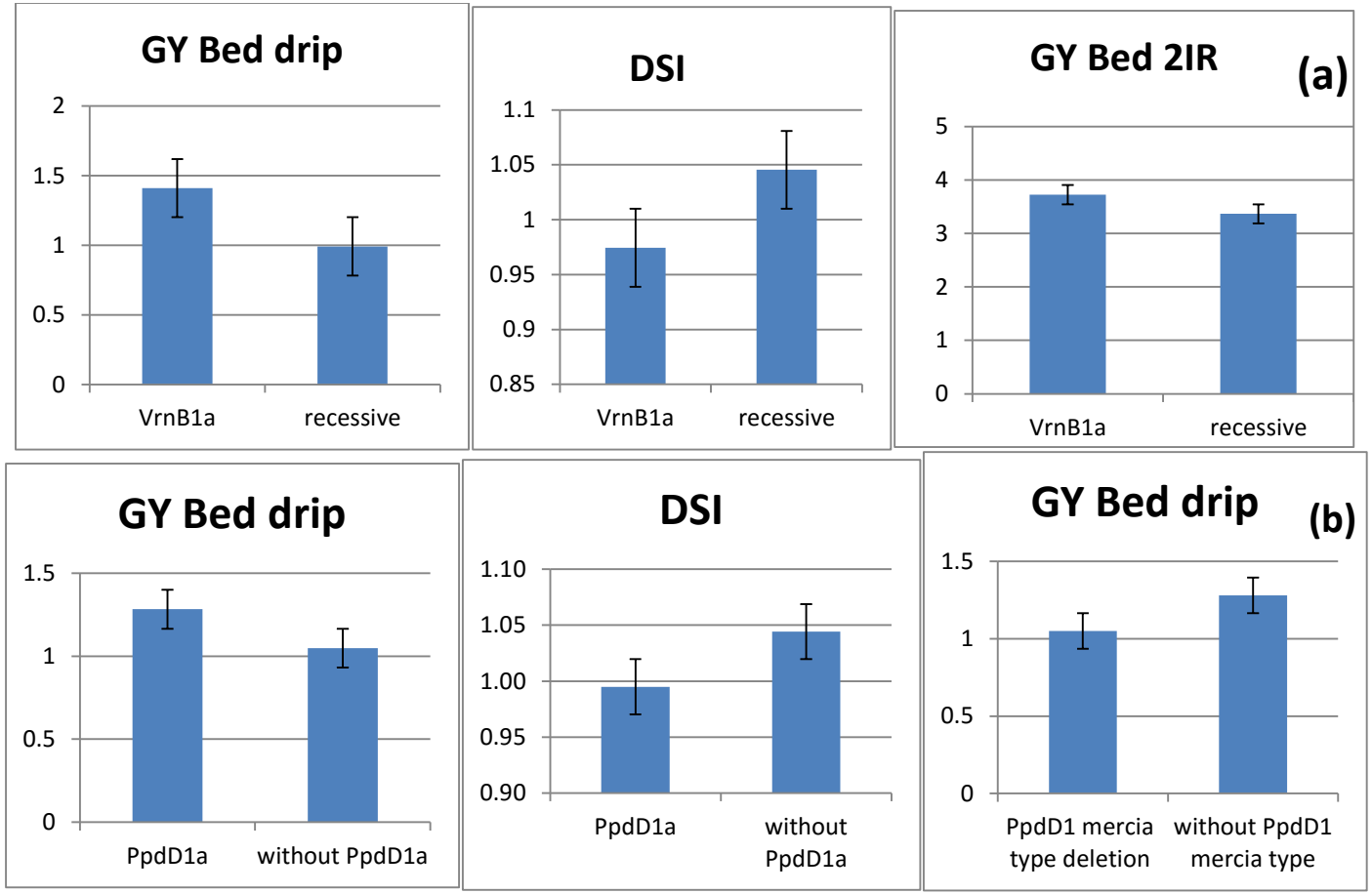
Supplementary Fig. S1 Phenotypic correlations between grain yield and days to heading under different environments



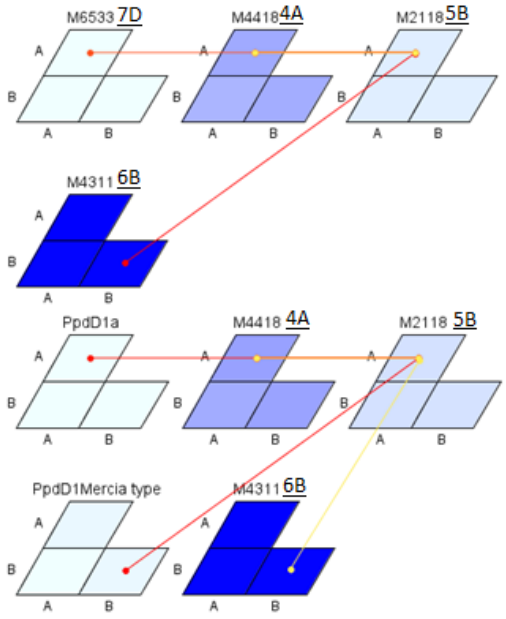
Supplementary Fig. S2 Quantile – Quantile plots for naïve and mixed linear model (using PC, kinship or PC + kinship based on BIC (Bayesian Information Content) for yield stability (a) and grain yield under different environments (b; Bed 5IR, c; Flat 5IR, d; Bed ZT 5IR, e; Bed drip, f; Bed 2IR and g; Bed heat)



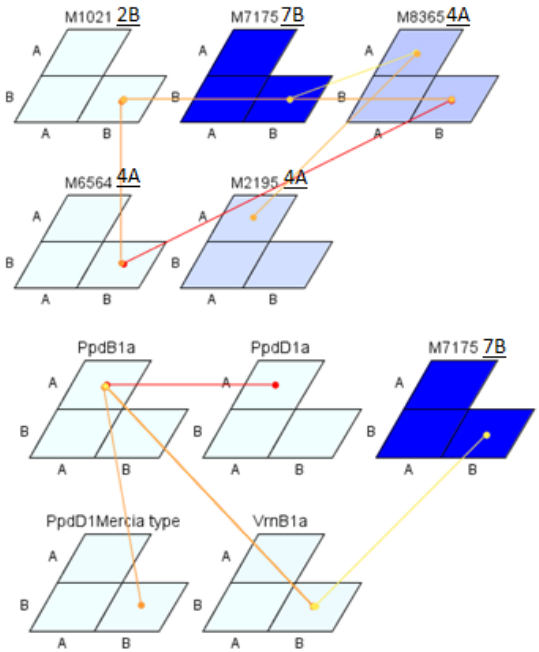
Supplementary Fig. S3 Quantile – Quantile plots for naïve and mixed linear model for days to heading (a-f) and plant height (g-k) in different environments (I; Bed 5IR, II; Bed ZT 5IR, III; Flat 5IR, IV; Bed 2IR, V; Bed drip, and VI; Bed heat) and for DSI (l) and HSI (m)



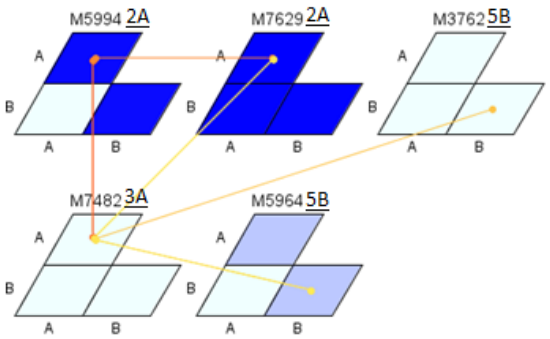
Supplementary Fig. S4 Allelic effects of *Vrn-B1a* on grain yield (GY) under both drought stress environments and drought susceptibility index (DSI) (a) and allelic effects of *Ppd-D1a* (Ciano type deletion conferring photoperiod insensitivity) and *Ppd-D1* Mercia type insertion conferring photoperiod sensitivity on GY under severe drought stress treatment and DSI. Earlier flowering lines carrying dominant spring allele *Vrn-B1a* or photoperiod insensitive allele *Ppd-D1a* are higher yielding under drought stress environments with lower DSI than lines carrying recessive *vrn* allele or photoperiod sensitive allele (Mercia type insertion).



Bed 5IR

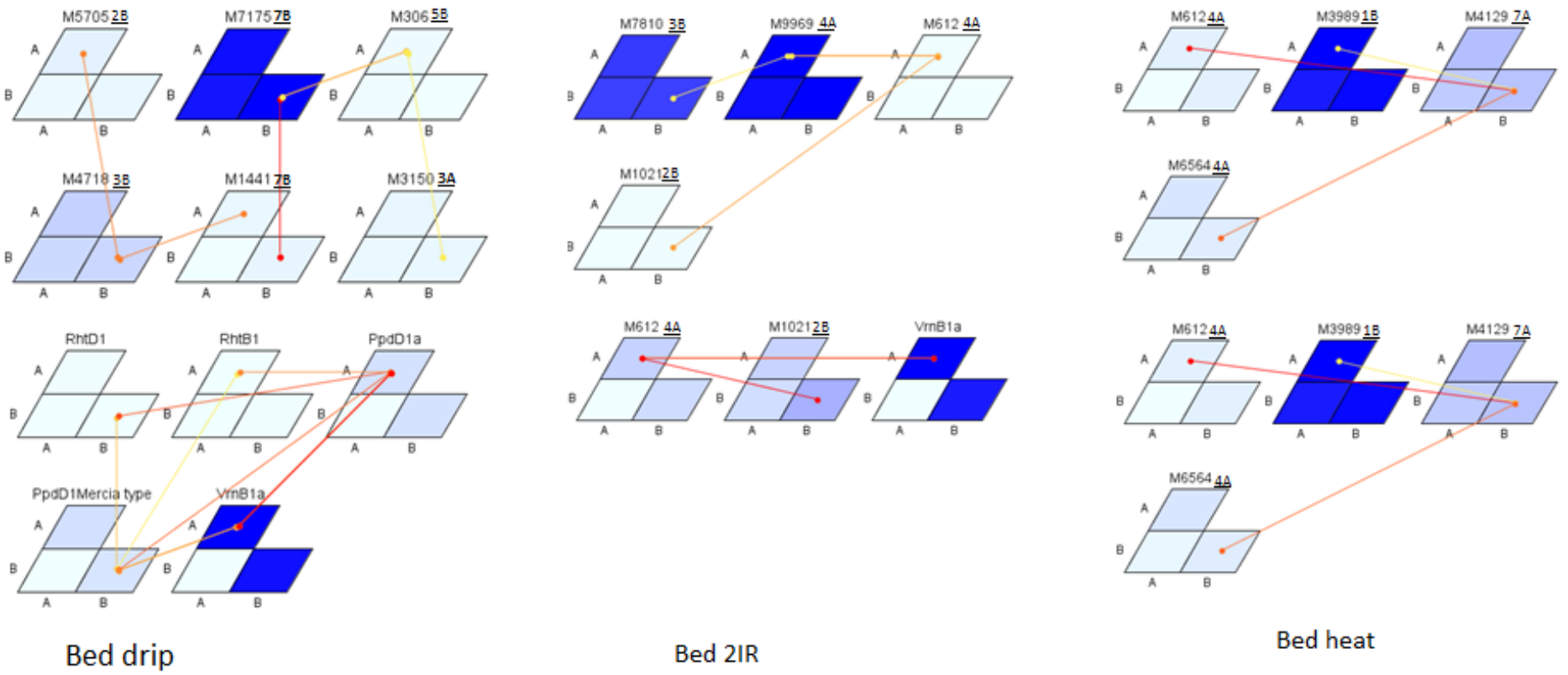


Bed ZT 5IR



Flat 5IR

Supplementary Fig. S5 For each of the irrigated conditions, epistatic interactions are shown among associated markers without (above) and with major genes (below) included in the model. The A and B are the two alleles for each marker. The magnitude of marker effect (F value) is represented with shades of blue from light to dark (higher effect). The magnitude of epistatic interaction is presented with colors from yellow to red (stronger interaction).



Supplementary Fig. S6 For each of the stressed conditions, epistatic interactions are shown without (above) and with major genes (below) included in the model. Each matrix indicates one marker. The A and B are the two alleles for each marker. The magnitude of marker effect (F value) is represented with shades of blue. The magnitude of epistatic interaction is presented with colors from yellow to red (stronger interaction).

Supplementary Table S1 Genotypes used in the present study

S. No.	GID	Cross Name
1	4785245	GAN/AE.SQUARROSA (236)//CETA/AE.SQUARROSA (895)/3/MAIZ/4/INQALAB 91
2	5866000	MEX94.27.1.20/3/SOKOLL//ATTILA/3*BCN
3	5893304	SERI/BAV92//WBLL1
4	5893342	PUB94.15.1.12/FRTL
5	5895861	PASTOR//HXL7573/2*BAU/3/WBLL1
6	5895868	SERI/BAV92//WBLL1
7	6085788	QUAIU #1
8	6085793	QUAIU #1
9	6085804	KIRITATI//HUW234+LR34/PRINIA
10	6174798	MILAN/S87230//BAV92/3/ROLF07
11	6174802	SAUAL/KACHU
12	6174807	SAUAL/KACHU
13	6174819	CNO79//PF70354/MUS/3/PASTOR/4/BAV92/5/TACUPETO F2001*2/BRAMBLING
14	6174820	CNO79//PF70354/MUS/3/PASTOR/4/BAV92/5/TACUPETO F2001*2/BRAMBLING
15	6174828	TACUPETO F2001/3/FRET2/WBLL1//TACUPETO F2001
16	6174847	TACUPETO F2001*2/BRAMBLING//WBLL1*2/BRAMBLING
17	6174858	FRANCOLIN #1/WBLL1
18	6174859	FRANCOLIN #1/WBLL1
19	6174860	FRANCOLIN #1//WBLL1*2/BRAMBLING
20	6174867	WBLL1*2/BRAMBLING/5/WBLL1*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
21	6174868	WBLL1*2/BRAMBLING/5/WBLL1*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
22	6174876	WBLL1*2/BRAMBLING//KACHU
23	6174877	WBLL1*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
24	6174880	BECARD/KACHU
25	6174882	BECARD/KACHU
26	6174884	BECARD/KACHU
27	6174886	BECARD/KACHU
28	6174887	BECARD/KACHU
29	6174889	BECARD/KACHU
30	6174890	BECARD/KACHU
31	6174891	FRANCOLIN #1//WBLL1*2/KIRITATI
32	6174892	FRANCOLIN #1//WBLL1*2/KURUKU
33	6174895	ALTAR 84/AE.SQUARROSA (221)//3*BORL95/3/URES/JUN//KAUZ/4/WBLL1/5/MILAN/S87230//BAV92
34	6174896	ALTAR 84/AE.SQUARROSA (221)//3*BORL95/3/URES/JUN//KAUZ/4/WBLL1/5/MILAN/S87230//BAV92
35	6174901	ALTAR 84/AE.SQUARROSA (221)//3*BORL95/3/URES/JUN//KAUZ/4/WBLL1/5/MILAN/S87230//BAV92
36	6174903	ALTAR 84/AE.SQUARROSA (221)//3*BORL95/3/URES/JUN//KAUZ/4/WBLL1/5/MILAN/S87230//BAV92
37	6174904	ALTAR 84/AE.SQUARROSA (221)//3*BORL95/3/URES/JUN//KAUZ/4/WBLL1/5/MILAN/S87230//BAV92
38	6174926	WBLL1*2/BRAMBLING//HEILO
39	6174927	WBLL1*2/BRAMBLING//FN/2*PASTOR
40	6174949	QUAIU #3//MILAN/AMSEL

41	6174951	QUAIU #3//MILAN/AMSEL
42	6174952	QUAIU #3//MILAN/AMSEL
43	6174993	ATTILA*2/PBW65*2//TOBA97/PASTOR
44	6175002	ATTILA*2/PBW65*2//KRONSTAD F2004
45	6175005	ATTILA*2/PBW65*2//KRONSTAD F2004
46	6175009	KAUZ/PASTOR//PBW343/3/FRET2/KURUKU//FRET2/4/WBLL1*2/BRAMBLING
47	6175010	KAUZ/PASTOR//PBW343/3/FRET2/KURUKU//FRET2/4/WBLL1*2/BRAMBLING
48	6175022	ROLF07*2/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES
49	6175024	TACUPETO F2001/BRAMBLING*2//KACHU
50	6175025	TACUPETO F2001/BRAMBLING*2//KACHU
51	6175030	TACUPETO F2001/BRAMBLING*2//KACHU
52	6175035	TACUPETO F2001/BRAMBLING*2//KACHU
53	6175036	TACUPETO F2001/BRAMBLING*2//KACHU
54	6175038	TACUPETO F2001/BRAMBLING*2//KACHU
55	6175042	WBLL1*2/KKTS/3/FRET2/TUKURU//FRET2/4/WBLL1*2/KURUKU
56	6175044	WBLL1*2/KURUKU/3/FRET2/TUKURU//FRET2/4/WBLL1*2/KURUKU
57	6175046	WBLL1*2/KURUKU/3/FRET2/TUKURU//FRET2/4/WBLL1*2/KURUKU
58	6175048	WBLL1*2/KURUKU/3/FRET2/TUKURU//FRET2/4/WBLL1*2/KURUKU
59	6175056	WBLL1*2/TUKURU//SAUAL/3/WBLL1*2/BRAMBLING
60	6175057	WBLL1*2/VIVITSI//PRINIA/PASTOR/3/WBLL1*2/BRAMBLING
61	6175063	NAC/TH.AC//3*PVN/3/MIRLO/BUC/4/2*PASTOR/5/KACHU/6/KACHU
62	6175067	NAC/TH.AC//3*PVN/3/MIRLO/BUC/4/2*PASTOR/5/KACHU/6/KACHU
63	6175076	NAC/TH.AC//3*PVN/3/MIRLO/BUC/4/2*PASTOR/5/KACHU/6/KACHU
64	6175078	SAUAL/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES/6/KACHU
65	6175127	SITE/MO//PASTOR/3/TILHI/4/WAXWING/KIRITATI/5/PBW343*2/TUKURU
66	6175135	ALTAR 84/AE.SQUARROSA (221)//3*BORL95/3/URES/JUN//KAUZ/4/WBLL1*2/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES
67	6175171	YAV_3/SCO//JO69/CRA/3/YAV79/4/AE.SQUARROSA (498)/5/LINE 1073/6/KAUZ*2/4/CAR//KAL/BB/3/NAC/5/KAUZ/7/KRONSTAD F2004/8/KAUZ/PASTOR//PBW343
68	6175172	YAV_3/SCO//JO69/CRA/3/YAV79/4/AE.SQUARROSA (498)/5/LINE 1073/6/KAUZ*2/4/CAR//KAL/BB/3/NAC/5/KAUZ/7/KRONSTAD F2004/8/KAUZ/PASTOR//PBW343
69	6175173	YAV_3/SCO//JO69/CRA/3/YAV79/4/AE.SQUARROSA (498)/5/LINE 1073/6/KAUZ*2/4/CAR//KAL/BB/3/NAC/5/KAUZ/7/KRONSTAD F2004/8/KAUZ/PASTOR//PBW343
70	6175174	YAV_3/SCO//JO69/CRA/3/YAV79/4/AE.SQUARROSA (498)/5/LINE 1073/6/KAUZ*2/4/CAR//KAL/BB/3/NAC/5/KAUZ/7/KRONSTAD F2004/8/KAUZ/PASTOR//PBW343
71	6175175	YAV_3/SCO//JO69/CRA/3/YAV79/4/AE.SQUARROSA (498)/5/LINE 1073/6/KAUZ*2/4/CAR//KAL/BB/3/NAC/5/KAUZ/7/KRONSTAD F2004/8/KAUZ/PASTOR//PBW343
72	6175176	YAV_3/SCO//JO69/CRA/3/YAV79/4/AE.SQUARROSA (498)/5/LINE 1073/6/KAUZ*2/4/CAR//KAL/BB/3/NAC/5/KAUZ/7/KRONSTAD F2004/8/KAUZ/PASTOR//PBW343
73	6175178	YAV_3/SCO//JO69/CRA/3/YAV79/4/AE.SQUARROSA (498)/5/LINE 1073/6/KAUZ*2/4/CAR//KAL/BB/3/NAC/5/KAUZ/7/KRONSTAD F2004/8/KAUZ/PASTOR//PBW343
74	6175181	WAXWING/KIRITATI//FINSI/3/FRANCOLIN #1
75	6175202	ATTILA*2/PBW65*2//MURGA
76	6175205	ATTILA*2/PBW65*2//MURGA
77	6175208	ATTILA*2/PBW65*2/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES
78	6175209	ATTILA*2/PBW65*2/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES
79	6175210	ATTILA*2/PBW65*2/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES
80	6175211	ATTILA*2/PBW65*2/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES

81	6175212	ATTILA*2/PBW65*2/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES
82	6175213	ATTILA*2/PBW65*2/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES
83	6175216	WAXWING/4/BL 1496/MILAN/3/CROC_1/AE.SQUARROSA (205)//KAUZ/5/FRNCLN
84	6175229	TOBA97/ATTILA/4/CROC_1/AE.SQUARROSA (205)//KAUZ/3/2*PJN/BOW//OPATA/5/THELIN/3/BABAX/LR42//BABAX/4/BABAX/LR42//BABAX
85	6175232	WBLL1*2/KURUKU/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/2*JANZ/7/WBLL1*2/KURUKU
86	6175233	WBLL1*2/KURUKU/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/2*JANZ/7/WBLL1*2/KURUKU
87	6175234	WBLL1*2/KURUKU/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/2*JANZ/7/WBLL1*2/KURUKU
88	6175235	WBLL1*2/KURUKU/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/2*JANZ/7/WBLL1*2/KURUKU
89	6175268	HUW468*2//TOBA97/PASTOR
90	6175279	PBW343*2/KHVAKI*2/4/CROC_1/AE.SQUARROSA (205)//KAUZ/3/2*KAUZ*2/YACO//KAUZ
91	6175280	PBW343*2/KHVAKI*2/4/CROC_1/AE.SQUARROSA (205)//KAUZ/3/2*KAUZ*2/YACO//KAUZ
92	6175284	PBW343*2/KUKUNA*2/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN
93	6175296	UP2338*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/2*WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
94	6175297	UP2338*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/2*WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
95	6175301	UP2338*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/2*WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
96	6175310	SERI.1B*2/3/KAUZ*2/BOW//KAUZ*2/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES
97	6175312	TUKURU//BAV92/RAYON*2/7/YAV_3/SCO//JO69/CRA/3/YAV79/4/AE.SQUARROSA (498)/5/LINE 1073/6/KAUZ*2/4/CAR//KAL/BB/3/NAC/5/KAUZ
98	6175345	TACUPETO F2001/6/OASIS/5*BORL95/5/CNDO/R143//ENTE/MEXI75/3/AE.SQ/4/2*OCI/7/ROLF07
99	6175354	WAXWING/VORB//FRANCOLIN #1
100	6175358	BAV92//IRENA/KAUZ/3/HUITES*2/4/VORB
101	6175359	WBLL1*2/VIVITSI//VORB/3/WBLL1*2/BRAMBLING
102	6175361	WBLL1*2/VIVITSI//VORB/3/WBLL1*2/BRAMBLING
103	6175382	NG8675/CBRD//FN/2*PASTOR/4/THELIN/3/2*BABAX/LR42//BABAX
104	6175409	WAXWING*2/HEILO
105	6175410	WAXWING*2/HEILO
106	6175411	WAXWING*2/HEILO
107	6175412	WAXWING*2/HEILO
108	6175413	WAXWING*2/HEILO
109	6175417	WAXWING*2/HEILO
110	6175431	TOBA97/ATTILA//GONDO/3/FRANCOLIN #1
111	6175439	BAV92//IRENA/KAUZ/3/HUITES/4/GONDO/TNMU/5/BAV92//IRENA/KAUZ/3/HUITES
112	6175440	BAV92//IRENA/KAUZ/3/HUITES/4/GONDO/TNMU/5/BAV92//IRENA/KAUZ/3/HUITES
113	6175442	BAV92//IRENA/KAUZ/3/HUITES/4/GONDO/TNMU/5/BAV92//IRENA/KAUZ/3/HUITES
114	6175444	BAV92//IRENA/KAUZ/3/HUITES/4/GONDO/TNMU/5/BAV92//IRENA/KAUZ/3/HUITES
115	6175454	WBLL1*2/4/YACO/PBW65/3/KAUZ*2/TRAP//KAUZ/5/GONDO/6/WBLL1*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
116	6175471	WBLL1*2/KURUKU//HEILO/3/WBLL1*2/KURUKU
117	6175474	WBLL1*2/KURUKU//HEILO/3/WBLL1*2/KURUKU
118	6175491	SSERI1/CHIBIA/4/BAV92//IRENA/KAUZ/3/HUITES
119	6175493	SSERI1/CHIBIA/4/BAV92//IRENA/KAUZ/3/HUITES
120	6175497	TUKURU//BAV92/RAYON/3/KRONSTAD F2004
121	6175500	ATTILA*2/PBW65//WBLL1*2/VIVITSI

122	6175531	FRET2/TUKURU//FRET2/3/KRONSTAD F2004
123	6175571	TACUPETO F2001/BRAMBLING//KACHU
124	6175573	WBLL1/MUU #1
125	6175606	WBLL1/3/STAR//KAUZ/STAR/4/BAV92/RAYON/5/TRAP#1/BOW/3/VEE/PJN//2*TUI/4/BAV92/RAYON
126	6175608	WBLL1/3/STAR//KAUZ/STAR/4/BAV92/RAYON/5/TRAP#1/BOW/3/VEE/PJN//2*TUI/4/BAV92/RAYON
127	6175609	WBLL1/3/STAR//KAUZ/STAR/4/BAV92/RAYON/5/TRAP#1/BOW/3/VEE/PJN//2*TUI/4/BAV92/RAYON
128	6175610	WBLL1/3/STAR//KAUZ/STAR/4/BAV92/RAYON/5/TRAP#1/BOW/3/VEE/PJN//2*TUI/4/BAV92/RAYON
129	6175651	SAUAL/KRONSTAD F2004
130	6175652	SAUAL/KRONSTAD F2004
131	6175653	SAUAL/KRONSTAD F2004
132	6175657	PRINIA/PASTOR/3/PFAU/WEAVER*2//BRAMBLING
133	6175659	PRINIA/PASTOR/3/PFAU/WEAVER*2//BRAMBLING
134	6175660	PRINIA/PASTOR/3/PFAU/WEAVER*2//BRAMBLING
135	6175662	SITE/MO//PASTOR/3/TILHI/4/WAXWING/KIRITATI
136	6175667	ALTAR 84/AE.SQUARROSA (221)//3*BORL95/3/URES/JUN//KAUZ/4/WBLL1/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES
137	6175668	ALTAR 84/AE.SQUARROSA (221)//3*BORL95/3/URES/JUN//KAUZ/4/WBLL1/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES
138	6175669	ALTAR 84/AE.SQUARROSA (221)//3*BORL95/3/URES/JUN//KAUZ/4/WBLL1/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES
139	6175679	MURGA//WAXWING/KIRITATI
140	6175680	MURGA//WAXWING/KIRITATI
141	6175694	MURGA/KRONSTAD F2004
142	6175697	MURGA/KRONSTAD F2004
143	6175704	MURGA/KRONSTAD F2004
144	6175705	MURGA/KRONSTAD F2004
145	6175707	MURGA/KRONSTAD F2004
146	6175708	MURGA/KRONSTAD F2004
147	6175717	REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES/5/KRONSTAD F2004
148	6175718	REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES/5/KRONSTAD F2004
149	6175720	REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES/5/KRONSTAD F2004
150	6175721	REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES/5/KRONSTAD F2004
151	6175740	ATTILA*2/PBW65//MURGA
152	6175744	ATTILA*2/PBW65//MURGA
153	6175757	BAV92//IRENA/KAUZ/3/HUITES/6/ALD/CEP75630//CEP75234/PT7219/3/BUC/BJY/4/CBRD/5/TNMU/PF85487
154	6175758	BAV92//IRENA/KAUZ/3/HUITES/6/ALD/CEP75630//CEP75234/PT7219/3/BUC/BJY/4/CBRD/5/TNMU/PF85487
155	6175897	WBLL1*2/CHAPIO//HEILO
156	6175899	WBLL1*2/CHAPIO//HEILO
157	6175900	WBLL1*2/CHAPIO//HEILO
158	6175902	WBLL1*2/CHAPIO//HEILO
159	6175930	WBLL1*2/KURUKU//HEILO
160	6175941	WBLL1*2/KURUKU//HEILO
161	6175947	WBLL1*2/KURUKU//HEILO

162	6175958	ATTILA*2/PBW65*2//KACHU
163	6175962	ATTILA*2/PBW65*2//KACHU
164	6175963	ATTILA*2/PBW65*2//KACHU
165	6175970	ATTILA*2/PBW65*2//MESIA
166	6175974	ATTILA*2/PBW65*2/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN
167	6175976	ATTILA*2/PBW65*2/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN
168	6175979	ATTILA*2/PBW65*2/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN
169	6175982	ATTILA*2/PBW65*2/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN
170	6175983	ATTILA*2/PBW65*2/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN
171	6175986	ATTILA*2/PBW65*2/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN
172	6175989	WAXWING*2/4/BOW/NKT//CBRD/3/CBRD
173	6175997	BABAX/LR42//BABAX/3/BABAX/LR42//BABAX/4/PRINIA/PASTOR//HUITES/5/FRET2/WBLL1//TACUPETO F2001
174	6176013	ROLF07/4/BOW/NKT//CBRD/3/CBRD/5/FRET2/TUKURU//FRET2
175	6176017	ROLF07*2/4/BOW/NKT//CBRD/3/CBRD
176	6176021	ROLF07*2/3/PRINIA/PASTOR//HUITES
177	6176022	ROLF07*2/3/PRINIA/PASTOR//HUITES
178	6176023	ROLF07*2/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN
179	6176024	ROLF07*2/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN
180	6176031	WBLL1*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/PFAU/WEAVER//BRAMBLING/6/BAV92//IRENA/KAUZ/3/ HUITES
181	6176039	WBLL1*2/4/YACO/PBW65/3/KAUZ*2/TRAP//KAUZ*2/6/NG8201/KAUZ/4/SHA7//PRL/VEE#6/3/FASAN/5/MILA N/KAUZ
182	6176043	WBLL1*2/KKTS*2//MILAN/AMSEL
183	6176045	WBLL1*2/KUKUNA/5/PSN/BOW//SERI/3/MILAN/4/ATTILA/6/WBLL1*2/KKTS
184	6176047	WBLL1*2/KUKUNA/5/PSN/BOW//SERI/3/MILAN/4/ATTILA/6/WBLL1*2/KKTS
185	6176049	WBLL1*2/KUKUNA/5/PSN/BOW//SERI/3/MILAN/4/ATTILA/6/WBLL1*2/KKTS
186	6176050	WBLL1*2/TUKURU*2/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN
187	6176051	WBLL1*2/TUKURU*2/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN
188	6176054	WBLL1*2/TUKURU*2/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN
189	6176056	WBLL1*2/TUKURU*2/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN
190	6176134	BAV92//IRENA/KAUZ/3/HUITES*2/4/TNMU
191	6176139	BAV92//IRENA/KAUZ/3/HUITES*2/4/TNMU
192	6176149	NORM/WBLL1//WBLL1/3/TNMU/4/WBLL1*2/TUKURU
193	6176173	UP2338*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/MILAN/KAUZ//CHIL/CHUM18/6/UP2338*2/4/SNI/TRAP#1/ 3/KAUZ*2/TRAP//KAUZ
194	6176174	UP2338*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/MILAN/KAUZ//CHIL/CHUM18/6/UP2338*2/4/SNI/TRAP#1/ 3/KAUZ*2/TRAP//KAUZ
195	6176178	UP2338*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/MILAN/KAUZ//CHIL/CHUM18/6/UP2338*2/4/SNI/TRAP#1/ 3/KAUZ*2/TRAP//KAUZ
196	6176187	WAXWING/2*ROLF07
197	6176189	WAXWING/2*ROLF07
198	6176196	BAV92//IRENA/KAUZ/3/HUITES/4/2*ROLF07
199	6176208	BAV92//IRENA/KAUZ/3/HUITES/4/2*ROLF07
200	6176213	BAV92//IRENA/KAUZ/3/HUITES/4/2*ROLF07
201	6176224	FRET2/TUKURU//FRET2/3/MUNIA/CHTO//AMSEL/4/FRET2/TUKURU//FRET2
202	6176225	FRET2/TUKURU//FRET2/3/MUNIA/CHTO//AMSEL/4/FRET2/TUKURU//FRET2

203	6176228	FRET2/TUKURU//FRET2/3/MUNIA/CHTO//AMSEL/4/FRET2/TUKURU//FRET2
204	6176233	ROLF07*2/KACHU
205	6176235	ROLF07*2/KACHU
206	6176292	ATTILA*2/PBW65*2//MURGA
207	6176296	ATTILA*2/PBW65*2//MURGA
208	6176298	ATTILA*2/PBW65*2//MURGA
209	6176303	ATTILA*2/PBW65*2//MURGA
210	6176308	ATTILA*2/PBW65*2//MURGA
211	6176328	BAV92//IRENA/KAUZ/3/HUITES*2/4/MURGA
212	6176329	BAV92//IRENA/KAUZ/3/HUITES*2/4/MURGA
213	6176330	BAV92//IRENA/KAUZ/3/HUITES*2/4/MURGA
214	6176332	BAV92//IRENA/KAUZ/3/HUITES*2/4/MURGA
215	6176334	ROLF07*2/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES
216	6176335	WBLL1*2/CHAPIO*2//MURGA
217	6176336	WBLL1*2/CHAPIO*2//MURGA
218	6176339	WBLL1*2/CHAPIO*2//MURGA
219	6176341	WBLL1*2/CHAPIO*2//MURGA
220	6176344	WBLL1*2/CHAPIO*2//MURGA
221	6176346	WBLL1*2/KURUKU*2/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES
222	6176355	WBLL1*2/KURUKU*2/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES
223	6176359	WBLL1/FRET2//PASTOR*2/3/MURGA
224	6176360	WBLL1/FRET2//PASTOR*2/3/MURGA
225	6176361	WBLL1/FRET2//PASTOR*2/3/MURGA
226	6176368	KACHU/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN/5/KACHU
227	6176372	KACHU/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN/5/KACHU
228	6176395	KACHU/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES/6/KACHU
229	6176403	SAUAL/4/CROC_1/AE.SQUARROSA (205)//BORL95/3/2*MILAN/5/SAUAL
230	6176409	ATTILA*2/PBW65*2//W485/HD29
231	6176410	ATTILA*2/PBW65*2//W485/HD29
232	6176414	ATTILA*2/PBW65*2//W485/HD29
233	6176421	WAXWING/KIRITATI*2//W485/HD29
234	6176422	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA
235	6176423	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA
236	6176424	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA
237	6176425	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA
238	6176426	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA
239	6176427	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA
240	6176428	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA
241	6176429	BAV92//IRENA/KAUZ/3/HUITES*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA
242	6176431	ROLF07*2/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA
243	6176455	KACHU*2/3/CHUM18/BORL95//CBRD
244	6176472	KACHU/4/CROC_1/AE.SQUARROSA (205)//KAUZ/3/SASIA/5/KACHU
245	6176474	KACHU/4/CROC_1/AE.SQUARROSA (205)//KAUZ/3/SASIA/5/KACHU

246	6176480	KACHU/4/CROC_1/AE.SQUARROSA (205)//KAUZ/3/SASIA/5/KACHU
247	6176482	KACHU/4/CROC_1/AE.SQUARROSA (205)//KAUZ/3/SASIA/5/KACHU
248	6176487	KACHU/4/CROC_1/AE.SQUARROSA (205)//KAUZ/3/SASIA/5/KACHU
249	6176492	KACHU/4/CROC_1/AE.SQUARROSA (205)//KAUZ/3/SASIA/5/KACHU
250	6176502	SAUAL*2/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/2*PASTOR
251	6176506	SAUAL*2/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/2*PASTOR
252	6176509	SAUAL*2/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/2*PASTOR
253	6176522	SAUAL/4/CROC_1/AE.SQUARROSA (205)//KAUZ/3/ATTILA/5/SAUAL
254	6176523	SAUAL/4/CROC_1/AE.SQUARROSA (205)//KAUZ/3/ATTILA/5/SAUAL
255	6176527	SAUAL/4/CROC_1/AE.SQUARROSA (205)//KAUZ/3/ATTILA/5/SAUAL
256	6176533	SAUAL/4/CROC_1/AE.SQUARROSA (205)//KAUZ/3/ATTILA/5/SAUAL
257	6176537	SAUAL/4/CROC_1/AE.SQUARROSA (205)//KAUZ/3/ATTILA/5/SAUAL
258	6176548	ATTILA*2/PBW65*2/4/BOW/NKT//CBRD/3/CBRD
259	6176551	ATTILA*2/PBW65*2/4/BOW/NKT//CBRD/3/CBRD
260	6176553	ATTILA*2/PBW65*2/4/BOW/NKT//CBRD/3/CBRD
261	6176554	ATTILA*2/PBW65*2/4/BOW/NKT//CBRD/3/CBRD
262	6176556	ATTILA*2/PBW65*2/4/BOW/NKT//CBRD/3/CBRD
263	6176557	ATTILA*2/PBW65*2/4/BOW/NKT//CBRD/3/CBRD
264	6176558	ATTILA*2/PBW65*2/4/BOW/NKT//CBRD/3/CBRD
265	6176559	ATTILA*2/PBW65*2/4/BOW/NKT//CBRD/3/CBRD
266	6176581	BAV92//IRENA/KAUZ/3/HUITES*2/4/CHIL/CHUM18
267	6176582	BAV92//IRENA/KAUZ/3/HUITES/4/FN/2*PASTOR/5/BAV92//IRENA/KAUZ/3/HUITES
268	6176583	BAV92//IRENA/KAUZ/3/HUITES/4/FN/2*PASTOR/5/BAV92//IRENA/KAUZ/3/HUITES
269	6176584	BAV92//IRENA/KAUZ/3/HUITES/4/FN/2*PASTOR/5/BAV92//IRENA/KAUZ/3/HUITES
270	6176588	BAV92//IRENA/KAUZ/3/HUITES/4/FN/2*PASTOR/5/BAV92//IRENA/KAUZ/3/HUITES
271	6176590	BAV92//IRENA/KAUZ/3/HUITES*2/4/GONDO/TNMU
272	6176591	BAV92//IRENA/KAUZ/3/HUITES*2/4/GONDO/TNMU
273	6176593	BAV92//IRENA/KAUZ/3/HUITES*2/4/GONDO/TNMU
274	6176600	BAV92//IRENA/KAUZ/3/HUITES*2/4/GONDO/TNMU
275	6176601	BAV92//IRENA/KAUZ/3/HUITES*2/4/GONDO/TNMU
276	6176611	ROLF07*2/4/BOW/NKT//CBRD/3/CBRD
277	6176631	WBLL1/4/HD2281/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/TACUPETO F2001*2/6/NING MAI 9558
278	6176638	WBLL1/KUKUNA//TACUPETO F2001*2/3/SHA3/SERI//SHA4/LIRA
279	6176639	WBLL1/KUKUNA//TACUPETO F2001*2/3/SHA3/SERI//SHA4/LIRA
280	6176640	WBLL1/KUKUNA//TACUPETO F2001*2/3/SHA3/SERI//SHA4/LIRA
281	6176641	WBLL1/KUKUNA//TACUPETO F2001*2/3/SHA3/SERI//SHA4/LIRA
282	6176647	WBLL1*2/4/YACO/PBW65/3/KAUZ*2/TRAP//KAUZ*2/5/GONDO
283	6176652	WBLL1*2/KURUKU*2//TNMU
284	6176653	WBLL1*2/KURUKU*2//TNMU
285	6176689	PFAU/WEAVER*2/4/BOW/NKT//CBRD/3/CBRD
286	6176696	PFAU/WEAVER*2//BRAMBLING/3/KAUZ//TRAP#1/BOW/4/PFAU/WEAVER*2//BRAMBLING
287	6176697	PFAU/WEAVER*2//BRAMBLING/3/KAUZ//TRAP#1/BOW/4/PFAU/WEAVER*2//BRAMBLING
288	6176730	SAUAL//CHIL/CHUM18/3/SAUAL

289	6176747	SAUAL/3/MAYOOR//TK SN1081/AE.SQUARROSA (222)/4/SAUAL
290	6176752	SAUAL/3/MAYOOR//TK SN1081/AE.SQUARROSA (222)/4/SAUAL
291	6176829	SAUAL/3/ACHTAR*3//KANZ/KS85-8-4/4/SAUAL
292	6176841	PBW343*2/KHVAKI*2/3/ACHTAR*3//KANZ/KS85-8-5
293	6176848	BAV92//IRENA/KAUZ/3/HUITES*2/4/YUNMAI 47
294	6176849	BAV92//IRENA/KAUZ/3/HUITES*2/4/YUNMAI 47
295	6176866	WBLL1/KUKUNA//TACUPETO F2001*2/3/CHUANMAI 107
296	6176870	WBLL1*2/4/YACO/PBW65/3/KAUZ*2/TRAP//KAUZ*2/5/DEMAI 4
297	6176887	KACHU/YUNMAI 47//KACHU
298	6176903	WBLL1*2/5/CNO79//PF70354/MUS/3/PASTOR/4/BAV92
299	6176904	WBLL1*2/5/CNO79//PF70354/MUS/3/PASTOR/4/BAV92
300	6176906	MUNAL #1/FRANCOLIN #1
301	6176912	MUNAL #1/FRANCOLIN #1
302	6176914	MUNAL #1/FRANCOLIN #1
303	6176924	PAURAQ/3/KIRITATI//PRL/2*PASTOR
304	6176929	PFAU/SERI.1B//AMAD/3/WAXWING/4/KIRITATI//PRL/2*PASTOR
305	6176982	CNO79//PF70354/MUS/3/PASTOR/4/BAV92/5/WBLL1*2/BRAMBLING
306	6176986	CNO79//PF70354/MUS/3/PASTOR/4/BAV92/5/WBLL1*2/BRAMBLING
307	6176988	CNO79//PF70354/MUS/3/PASTOR/4/BAV92/5/WBLL1*2/BRAMBLING
308	6176995	QUAIU #1/3/MILAN/S87230//BAV92
309	6177005	WBLL1*2/BRAMBLING/5/BABAX/LR42//BABAX*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
310	6177010	WBLL1*2/BRAMBLING/5/BABAX/LR42//BABAX*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
311	6177014	WBLL1*2/BRAMBLING/5/BABAX/LR42//BABAX*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
312	6177015	WBLL1*2/BRAMBLING/5/BABAX/LR42//BABAX*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
313	6177017	WBLL1*2/BRAMBLING/5/BABAX/LR42//BABAX*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
314	6177020	WBLL1*2/BRAMBLING/5/BABAX/LR42//BABAX*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
315	6177024	WBLL1*2/BRAMBLING/5/BABAX/LR42//BABAX*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
316	6177026	WBLL1*2/BRAMBLING/5/BABAX/LR42//BABAX*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
317	6177049	PANDORA/3/KIRITATI//PRL/2*PASTOR
318	6177051	PANDORA/3/KIRITATI//PRL/2*PASTOR
319	6177056	PANDORA//WBLL1*2/BRAMBLING
320	6177057	PANDORA//WBLL1*2/BRAMBLING
321	6177058	PANDORA//WBLL1*2/BRAMBLING
322	6177060	ATTILA*2/PBW65//AKURI
323	6177062	ATTILA*2/PBW65//AKURI
324	6177080	ATTILA*2/PBW65//KBIRD
325	6177095	FRANCOLIN #1/HAWFINCH #1
326	6177099	FRANCOLIN #1/KIRITATI
327	6177100	FRANCOLIN #1/KIRITATI
328	6177126	FRNCLN/TECUE #1
329	6177127	FRNCLN/TECUE #1
330	6177139	TRCH/HUIRIVIS #1
331	6177145	TRCH/HUIRIVIS #1

332	6177147	TRCH/HUIRIVIS #1
333	6177148	TRCH/HUIRIVIS #1
334	6177157	TRCH/KBIRD
335	6177158	TRCH/KBIRD
336	6177159	TRCH/KBIRD
337	6177174	PFAU/SERI.1B//AMAD/3/WAXWING/4/HUIRIVIS #1
338	6177175	PFAU/SERI.1B//AMAD/3/WAXWING/4/MUU
339	6177189	CHIBIA//PRLII/CM65531/3/FISCAL/4/CROSBILL #1
340	6177195	VORB/FISCAL//AKURI #1
341	6177222	MILAN/S87230//BAV92/3/JUCHI
342	6177233	MILAN/S87230//BAV92/3/AKURI #1
343	6177257	PRL/2*PASTOR//CROSBILL #1
344	6177326	ROLF07/MUU
345	6177327	ROLF07/MUU
346	6177342	ROLF07/KINGBIRD #1
347	6177369	WBLL1*2/BRAMBLING//HUIRIVIS #1
348	6177393	BECARD/AKURI
349	6177394	BECARD/AKURI
350	6177395	BECARD/AKURI
351	6177396	BECARD/AKURI
352	6177402	WBLL1*2/KKTS//KINGBIRD #1
353	6177403	WBLL1*2/KKTS//KINGBIRD #1
354	6177404	WBLL1*2/KKTS//KINGBIRD #1
355	6177405	WBLL1*2/KKTS//KINGBIRD #1
356	6177406	WBLL1*2/KKTS//KINGBIRD #1
357	6177407	WBLL1*2/KKTS//KINGBIRD #1
358	6177408	WBLL1*2/KKTS//KINGBIRD #1
359	6177411	WBLL1*2/KKTS//KINGBIRD #1
360	6177412	WBLL1*2/KKTS//KINGBIRD #1
361	6177413	WBLL1*2/KKTS//KINGBIRD #1
362	6177439	KBIRD//WBLL1*2/KURUKU
363	6177447	KBIRD//WBLL1*2/KURUKU
364	6177452	WBLL1/KUKUNA//TACUPETO F2001/6/PVN//CAR422/ANA/5/BOW/CROW//BUC/PVN/3/YR/4/TRAP#1
365	6177453	WBLL1/KUKUNA//TACUPETO F2001/6/PVN//CAR422/ANA/5/BOW/CROW//BUC/PVN/3/YR/4/TRAP#1
366	6177498	KACHU/MUU
367	6177500	KACHU/MUU
368	6177509	KINGBIRD #1/KACHU
369	6177515	KINGBIRD #1/KACHU
370	6177544	MILAN/S87230//BAV92/3/AKURI
371	6177551	TOBA97/PASTOR//KINGBIRD #1
372	6177552	WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/AKURI
373	6177553	WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/AKURI
374	6177554	WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/AKURI

375	6177555	WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/AKURI
376	6177558	WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/AKURI
377	6177560	WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/AKURI
378	6177561	WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/TECUE #1
379	6177562	WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/TECUE #1
380	6177563	WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/TECUE #1
381	6177570	WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/TECUE #1
382	6177575	WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/KBIRD
383	6177576	WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/KBIRD
384	6177578	WAXWING/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/KBIRD
385	6177589	KBIRD//INQALAB 91*2/KUKUNA
386	6177595	KINGBIRD #1//INQALAB 91*2/TUKURU
387	6177598	KINGBIRD #1//INQALAB 91*2/TUKURU
388	6177599	KINGBIRD #1//INQALAB 91*2/TUKURU
389	6177600	KINGBIRD #1//INQALAB 91*2/TUKURU
390	6177603	KINGBIRD #1//INQALAB 91*2/TUKURU
391	6177627	PBW343*2/KHVAKI//JUCHI
392	6177636	PBW343*2/KUKUNA//AKURI
393	6177647	PBW343*2/KUKUNA//TECUE #1
394	6177648	PBW343*2/KUKUNA//TECUE #1
395	6177650	PBW343*2/KUKUNA//TECUE #1
396	6177652	PBW343*2/KUKUNA//TECUE #1
397	6177657	PBW343*2/KUKUNA//TECUE #1
398	6177659	PBW343*2/KUKUNA//TECUE #1
399	6177665	PBW343*2/KUKUNA//TECUE #1
400	6177666	PBW343*2/KUKUNA//TECUE #1
401	6177667	PBW343*2/KUKUNA//TECUE #1
402	6177671	PBW343*2/KUKUNA//TECUE #1
403	6177674	JUCHI/HUIRIVIS #1
404	6177675	JUCHI/HUIRIVIS #1
405	6177721	HUIRIVIS #1/KBIRD
406	6177732	PVN//CAR422/ANA/5/BOW/CROW//BUC/PVN/3/YR/4/TRAP#1/6/AKURI #1
407	6177733	PVN//CAR422/ANA/5/BOW/CROW//BUC/PVN/3/YR/4/TRAP#1/6/AKURI #1
408	6177735	PVN//CAR422/ANA/5/BOW/CROW//BUC/PVN/3/YR/4/TRAP#1/6/AKURI #1
409	6177737	FRANCOLIN #1/YANAC
410	6177762	BL2064//SW89-5124*2/FASAN/3/TILHI/5/KAUZ//ALTAR 84/AOS/3/KAUZ/4/SW94.15464
411	6177765	BL2064//SW89-5124*2/FASAN/3/TILHI/5/KAUZ//ALTAR 84/AOS/3/KAUZ/4/SW94.15464
412	6177771	BABAX/LR42//BABAX*2/3/KUKUNA/4/TAM200/PASTOR//TOBA97
413	6177772	BABAX/LR42//BABAX*2/3/KUKUNA/4/TAM200/PASTOR//TOBA97
414	6177773	BABAX/LR42//BABAX*2/3/KUKUNA/4/TINKIO #1
415	6177790	QUAIU/YANAC
416	6177824	TAM200/PASTOR//TOBA97/3/WHEAR
417	6177828	FRNCLN/ROLF07

418	6177829	FRNCLN/ROLF07
419	6177830	FRNCLN/ROLF07
420	6177834	FRNCLN/ROLF07
421	6177837	FRNCLN/BECARD
422	6177838	FRNCLN/BECARD
423	6177841	FRNCLN/BECARD
424	6177844	FRNCLN/BECARD
425	6177845	FRNCLN/BECARD
426	6177846	FRNCLN/BECARD
427	6177851	PARUS/FRANCOLIN #1
428	6177854	PARUS/FRANCOLIN #1
429	6177858	PARUS/FRANCOLIN #1
430	6177860	PARUS/FRANCOLIN #1
431	6177861	PARUS/FRANCOLIN #1
432	6177862	PARUS/FRANCOLIN #1
433	6177869	OASIS/SKAUZ//4*BCN/3/PASTOR/4/KAUZ*2/YACO//KAUZ/5/FRET2/TUKURU//FRET2/6/FRET2/TUKURU//FRET2
434	6177873	OASIS/SKAUZ//4*BCN/3/PASTOR/4/KAUZ*2/YACO//KAUZ*2/5/KRONSTAD F2004
435	6177898	ATTILA*2/PBW65//MUU #1/3/FRANCOLIN #1
436	6177900	ATTILA*2/PBW65//MUU #1/3/FRANCOLIN #1
437	6177920	C80.1/3*BATAVIA//2*WBLL1/3/WBLL1*2/TUKURU/4/FRET2/TUKURU//FRET2
438	6177929	SAUAL/3/C80.1/3*BATAVIA//2*WBLL1/4/SITE/MO//PASTOR/3/TILHI
439	6177930	MURGA/3/GAN/AE.SQUARROSA (408)//2*OASIS/5*BORL95/4/FRANCOLIN #1
440	6177946	UP2338*2/VIVITSI/3/FRET2/TUKURU//FRET2/4/MISR 1
441	6177947	UP2338*2/VIVITSI/3/FRET2/TUKURU//FRET2/4/MISR 1
442	6177950	UP2338*2/VIVITSI/3/FRET2/TUKURU//FRET2/4/MISR 1
443	6177951	UP2338*2/VIVITSI/3/FRET2/TUKURU//FRET2/4/MISR 1
444	6177962	HUIRIVIS #1*2/MURGA
445	6177968	HUIRIVIS #1*2/MURGA
446	6177980	CONI#1/2*HUIRIVIS #1
447	6178005	TECUE #1/2*WAXWING
448	6178012	MUU/4/BAV92//IRENA/KAUZ/3/HUITES/5/BAV92//IRENA/KAUZ/3/HUITES
449	6178013	KIRITATI/4/2*BAV92//IRENA/KAUZ/3/HUITES
450	6178017	KIRITATI/4/2*BAV92//IRENA/KAUZ/3/HUITES
451	6178018	KIRITATI/4/2*BAV92//IRENA/KAUZ/3/HUITES
452	6178019	KIRITATI/4/2*BAV92//IRENA/KAUZ/3/HUITES
453	6178020	KIRITATI/4/2*BAV92//IRENA/KAUZ/3/HUITES
454	6178021	KIRITATI/4/2*BAV92//IRENA/KAUZ/3/HUITES
455	6178029	PFAU/WEAVER//KIRITATI/3/FRET2/TUKURU//FRET2/4/FRET2/TUKURU//FRET2
456	6178040	MUU/5/WBLL1*2/4/YACO/PBW65/3/KAUZ*2/TRAP//KAUZ/6/WBLL1*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
457	6178056	SKAUZ/BAV92//2*WBLL1*2/KKTS
458	6178080	KBIRD//WH 542/2*PASTOR/3/WBLL1*2/BRAMBLING
459	6178095	PVN/5/2*REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES

460	6178118	KZA/5/2*WBLL1/3/STAR//KAUZ/STAR/4/BAV92/RAYON
461	6178123	KZA//WH 542/2*PASTOR/3/BACEU #1
462	6178134	KSW/SAUAL//SAUAL
463	6178136	KSW/SAUAL//SAUAL
464	6178166	KACHU/6/NG8201/KAUZ/4/SHA7//PRL/VEE#6/3/FASAN/5/MILAN/KAUZ/7/KACHU
465	6178176	KACHU/6/NG8201/KAUZ/4/SHA7//PRL/VEE#6/3/FASAN/5/MILAN/KAUZ/7/KACHU
466	6178184	KACHU/6/NG8201/KAUZ/4/SHA7//PRL/VEE#6/3/FASAN/5/MILAN/KAUZ/7/KACHU
467	6178193	TUKURU//BAV92/RAYON*2/3/JUCHI
468	6178199	TUKURU//BAV92/RAYON*2/3/PVN
469	6178200	TUKURU//BAV92/RAYON*2/3/PVN
470	6178201	TUKURU//BAV92/RAYON*2/3/PVN
471	6178205	TUKURU//BAV92/RAYON*2/3/PVN
472	6178206	TUKURU//BAV92/RAYON*2/3/PVN
473	6178225	PBW343/PASTOR*2//K6295.4A
474	6178238	UP2338*2/KKTS*2//YANAC
475	6178240	UP2338*2/KKTS*2//YANAC
476	6178241	UP2338*2/KKTS*2//YANAC
477	6178243	UP2338*2/KKTS*2//YANAC
478	6178244	UP2338*2/KKTS*2//YANAC
479	6178246	TILILA/JUCHI/4/SERI.1B//KAUZ/HEVO/3/AMAD
480	6178247	TILILA/JUCHI/4/SERI.1B//KAUZ/HEVO/3/AMAD
481	6178248	TILILA/JUCHI/4/SERI.1B//KAUZ/HEVO/3/AMAD
482	6178273	WAXWING*2/DIAMONDBIRD
483	6178296	WAXWING/KIRITATI*2//YANAC
484	6178298	WAXWING/KIRITATI*2//YANAC
485	6178331	BAV92//IRENA/KAUZ/3/HUITES*2/4/DIAMONDBIRD
486	6178335	BAV92//IRENA/KAUZ/3/HUITES*2/4/MILAN/KAUZ//CHIL/CHUM18
487	6178362	BAV92//IRENA/KAUZ/3/HUITES*2/4/PVN
488	6178366	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311
489	6178368	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311
490	6178369	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311
491	6178370	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311
492	6178372	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311
493	6178376	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311
494	6178378	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311
495	6178379	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311
496	6178383	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311
497	6178386	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311
498	6178391	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311
499	6178393	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311
500	6178394	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/HAR311
501	6178397	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7
502	6178398	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7

503	6178401	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7
504	6178402	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7
505	6178403	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7
506	6178404	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7
507	6178405	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7
508	6178406	CNO79//PF70354/MUS/3/PASTOR/4/BAV92*2/5/FH6-1-7
509	6178423	ROLF07*2/YANAC
510	6178424	ROLF07*2/YANAC
511	6178426	ROLF07*2/DIAMONDBIRD
512	6178429	ROLF07*2/DIAMONDBIRD
513	6178431	ROLF07*2/DIAMONDBIRD
514	6178459	WBLL1/KUKUNA//TACUPETO F2001*2/3/HAR311
515	6178476	WBLL1/DIAMONDBIRD//WBLL1*2/VIVITSI
516	6178477	WBLL1/DIAMONDBIRD//WBLL1*2/VIVITSI
517	6178484	WBLL1*2/VIVITSI*2/6/PVN//CAR422/ANA/5/BOW/CROW//BUC/PVN/3/YR/4/TRAP#1
518	6178485	WBLL1*2/VIVITSI*2/6/PVN//CAR422/ANA/5/BOW/CROW//BUC/PVN/3/YR/4/TRAP#1
519	6178517	KACHU/KIRITATI//KACHU
520	6178526	SAUAL/YANAC//SAUAL
521	6178527	SAUAL/YANAC//SAUAL
522	6178528	SAUAL/YANAC//SAUAL
523	6178529	SAUAL/YANAC//SAUAL
524	6178530	SAUAL/YANAC//SAUAL
525	6178531	SAUAL/YANAC//SAUAL
526	6178533	SAUAL/YANAC//SAUAL
527	6178534	SAUAL/YANAC//SAUAL
528	6178537	SAUAL/KIRITATI//SAUAL
529	6178538	SAUAL/KIRITATI//SAUAL
530	6178539	SAUAL/KIRITATI//SAUAL
531	6178541	SAUAL/KIRITATI//SAUAL
532	6178556	PRL/2*PASTOR*2//FH6-1-7
533	6178557	PRL/2*PASTOR*2//FH6-1-7
534	6178564	PRL/2*PASTOR*2//K6295.4A
535	6178575	CS/TH.SC//3*PVN/3/MIRLO/BUC/4/URES/JUN//KAUZ/5/HUITES/6/YANAC/7/CS/TH.SC//3*PVN/3/MIRLO/BUC/4/MILAN/5/TILHI
536	6178591	FINSI/METSO//FH6-1-7/3/FINSI/METSO
537	6178600	FINSI/METSO//FH6-1-7/3/FINSI/METSO
538	6178633	PF74354//LD/ALD/4/2*BR12*2/3/JUP//PAR214*6/FB6631/5/NL750/6/PVN/7/TOBA97/PASTOR
539	6178654	PBW343*2/KHVAKI*2/6/PVN//CAR422/ANA/5/BOW/CROW//BUC/PVN/3/YR/4/TRAP#1
540	6178681	C80.1/3*BATAVIA//2*WBLL1/4/CROC_1/AE.SQUARROSA (224)//KULIN/3/WESTONIA/5/WBLL1*2/KURUKU
541	6178701	C80.1/3*BATAVIA//2*WBLL1*2/3/WBLL1*2/TUKURU
542	6178714	WAXWING/KIRITATI*2/3/C80.1/3*BATAVIA//2*WBLL1
543	6178715	WAXWING/KIRITATI*2/3/C80.1/3*BATAVIA//2*WBLL1
544	6178716	WAXWING/KIRITATI*2/3/C80.1/3*BATAVIA//2*WBLL1

545	6178717	WAXWING/KIRITATI*2/3/C80.1/3*BATAVIA//2*WBLL1
546	6178726	BAV92//IRENA/KAUZ/3/HUITES*2/4/WHEAR
547	6178728	BAV92//IRENA/KAUZ/3/HUITES*2/4/WHEAR
548	6178734	BAV92//IRENA/KAUZ/3/HUITES*2/4/WHEAR
549	6178737	BAV92//IRENA/KAUZ/3/HUITES*2/4/WHEAR
550	6178739	BAV92//IRENA/KAUZ/3/HUITES*2/4/WHEAR
551	6178752	FRET2/KIRITATI/3/C80.1/3*BATAVIA//2*WBLL1/4/FRET2/TUKURU//FRET2
552	6178759	KACHU*2/WHEAR
553	6178760	KACHU*2/WHEAR
554	6178763	KACHU*2/WHEAR
555	6178768	KACHU/3/C80.1/3*BATAVIA//2*WBLL1/4/KACHU
556	6178770	KACHU/3/C80.1/3*BATAVIA//2*WBLL1/4/KACHU
557	6178775	KACHU/3/C80.1/3*BATAVIA//2*WBLL1/4/KACHU
558	6178783	SAUAL/WHEAR//SAUAL
559	6178788	SAUAL/WHEAR//SAUAL
560	6178789	SAUAL/WHEAR//SAUAL
561	6178790	SAUAL/WHEAR//SAUAL
562	6178797	SAUAL/3/C80.1/3*BATAVIA//2*WBLL1/4/SAUAL
563	6178819	SAUAL/3/SW89.3064//CMH82.17/SERI/4/SAUAL
564	6178820	SAUAL/3/SW89.3064//CMH82.17/SERI/4/SAUAL
565	6178822	SAUAL/3/SW89.3064//CMH82.17/SERI/4/SAUAL
566	6178824	SAUAL/3/SW89.3064//CMH82.17/SERI/4/SAUAL
567	6178828	SAUAL*2/3/WL6718//2*PRL/VEE#6
568	6178833	SAUAL*2/3/WL6718//2*PRL/VEE#6
569	6178834	SAUAL*2/3/WL6718//2*PRL/VEE#6
570	6178836	SAUAL*2/3/WL6718//2*PRL/VEE#6
571	6178837	SAUAL*2/3/WL6718//2*PRL/VEE#6
572	6178838	SAUAL*2/3/WL6718//2*PRL/VEE#6
573	6178841	SAUAL*2/3/WL6718//2*PRL/VEE#6
574	6178846	SAUAL*2/3/WL6718//2*PRL/VEE#6
575	6178847	SAUAL*2/3/WL6718//2*PRL/VEE#6
576	6178875	ROLF07*2/5/FCT/3/GOV/AZ//MUS/4/DOVE/BUC
577	6178881	WBLL1/4/BOW/NKT//CBRD/3/CBRD/5/WBLL1*2/TUKURU
578	6178888	WBLL1/4/BOW/NKT//CBRD/3/CBRD/5/WBLL1*2/TUKURU
579	6178896	KACHU*2//CHIL/CHUM18
580	6178897	KACHU*2//CHIL/CHUM18
581	6178898	KACHU*2//CHIL/CHUM18
582	6178900	KACHU*2//CHIL/CHUM18
583	6178901	KACHU*2//CHIL/CHUM18
584	6178902	KACHU*2//CHIL/CHUM18
585	6178907	SAUAL/3/SHA3/SERI//SHA4/LIRA/4/SAUAL
586	6178908	SAUAL/3/SHA3/SERI//SHA4/LIRA/4/SAUAL
587	6178918	PBW343/PASTOR*2/6/TURACO/5/CHIR3/4/SIREN//ALTAR 84/AE.SQUARROSA (205)/3/3*BUC

588	6178935	WBLL1*2/TUKURU//FN/2*PASTOR/3/FRET2/KIRITATI
589	6178943	WAXWING/SRTU//WAXWING/KIRITATI
590	6178949	ATTILA*2/PBW65*2//TNMU
591	6178950	ATTILA*2/PBW65*2//TNMU
592	6178964	FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ*2/5/BOW/URES//2*WEAVER/3/CROC_1/AE.SQUARROSA (213)//PGO
593	6178965	FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ*2/5/BOW/URES//2*WEAVER/3/CROC_1/AE.SQUARROSA (213)//PGO
594	6178971	SAAR/2*WAXWING
595	6178972	PFAU/SERI.1B//AMAD/3/WAXWING/4/BABAX/LR42//BABAX*2/3/KURUKU
596	6178973	PFAU/SERI.1B//AMAD/3/WAXWING/4/BABAX/LR42//BABAX*2/3/KURUKU
597	6178974	PFAU/SERI.1B//AMAD/3/WAXWING/4/BABAX/LR42//BABAX*2/3/KURUKU
598	6178981	PFAU/SERI.1B//AMAD/3/WAXWING/4/BABAX/LR42//BABAX*2/3/KURUKU
599	6178996	QUAIU/5/FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
600	6178997	QUAIU/5/FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
601	6178999	QUAIU/5/FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
602	6179000	QUAIU/5/FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ
603	6179010	BABAX/LR42//BABAX*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/WBLL1*2/TUKURU
604	6179012	WBLL1*2/BRAMBLING/4/BABAX/LR42//BABAX*2/3/KURUKU
605	6179013	WBLL1*2/BRAMBLING/4/BABAX/LR42//BABAX*2/3/KURUKU
606	6179017	PFAU/WEAVER*2//BRAMBLING/3/QUAIU
607	6179044	QUAIU/TECUE #1
608	6179047	QUAIU/TECUE #1
609	6179064	WBLL1*2/CHAPIO//HAWFINCH #1
610	6179077	WBLL1*2/KUKUNA//AKURI #1
611	6179078	WBLL1*2/TUKURU//CROSBILL #1
612	6179079	WBLL1*2/TUKURU//CROSBILL #1
613	6179082	WBLL1*2/TUKURU//CROSBILL #1
614	6179087	REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES/5/PVN
615	6179088	REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA (213)//PGO/4/HUITES/5/PVN
616	6179095	PFAU/WEAVER*2//BRAMBLING/3/AKURI #1
617	6179116	PBW343*2/KHVAKI/5/KAUZ//ALTAR 84/AOS/3/KAUZ/4/SW94.15464
618	6179118	PAURAQ/4/PFAU/SERI.1B//AMAD/3/WAXWING
619	6179122	C80.1/3*BATAVIA//2*WBLL1/3/2*FRET2/TUKURU//FRET2
620	6179125	C80.1/3*BATAVIA//2*WBLL1/3/2*FRET2/TUKURU//FRET2
621	6179128	TACUPETO F2001/SAUAL/4/BABAX/LR42//BABAX*2/3/KURUKU
622	6179129	TACUPETO F2001/SAUAL/4/BABAX/LR42//BABAX*2/3/KURUKU
623	6179130	TACUPETO F2001/SAUAL/4/BABAX/LR42//BABAX*2/3/KURUKU
624	6179132	TACUPETO F2001/SAUAL/4/BABAX/LR42//BABAX*2/3/KURUKU
625	6179136	TACUPETO F2001/SAUAL/4/BABAX/LR42//BABAX*2/3/KURUKU
626	6179141	CHEN/AE.SQ//WEAVER/3/SSERI1/4/TOBA97/PASTOR/5/MUU #1
627	6179143	CHEN/AE.SQ//WEAVER/3/SSERI1/4/TOBA97/PASTOR/5/MUU #1
628	6179148	MUU #1/SAUAL//MUU
629	6179151	MUU #1//PBW343*2/KUKUNA/3/MUU

630	6179152	MUU #1//PBW343*2/KUKUNA/3/MUU
631	6179156	MUU #1//PBW343*2/KUKUNA/3/MUU
632	6179159	MUU #1//PBW343*2/KUKUNA/3/MUU
633	6179165	BABAX/LR42//BABAX/3/BABAX/LR42//BABAX/4/ATTILA/2*PASTOR/5/QUAIU #3
634	6179184	OASIS/SKAUZ//4*BCN/3/2*PASTOR/5/FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/6/SAUAL
635	6179185	OASIS/SKAUZ//4*BCN/3/2*PASTOR/5/FRET2*2/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/6/SAUAL
636	6179207	KFA/2*KACHU
637	6179216	KFA/2*KACHU
638	6179218	KFA/2*KACHU
639	6179220	KFA/2*KACHU
640	6179221	KFA/2*KACHU
641	6179222	PBW343*2/KUKUNA*2//FRTL/PIFED
642	6179223	PBW343*2/KUKUNA*2//FRTL/PIFED
643	6179225	PBW343*2/KUKUNA*2//FRTL/PIFED
644	6179226	PBW343*2/KUKUNA*2//FRTL/PIFED
645	6179227	PBW343*2/KUKUNA*2//FRTL/PIFED
646	6179228	PBW343*2/KUKUNA*2//FRTL/PIFED
647	6179236	INQALAB 91*2/KUKUNA*2//PVN
648	6179244	INQALAB 91*2/KUKUNA*2//PVN
649	6179247	KANCHAN*2/JUCHI
650	6179249	KANCHAN*2/JUCHI
651	6179251	TILILA/TUKURU/4/SERI.1B*2/3/KAUZ*2/BOW//KAUZ
652	6179253	WBLL1*2/4/BABAX/LR42//BABAX/3/BABAX/LR42//BABAX
653	6179254	WBLL1*2/4/BABAX/LR42//BABAX/3/BABAX/LR42//BABAX
654	6179255	WBLL1*2/4/BABAX/LR42//BABAX/3/BABAX/LR42//BABAX
655	6179261	BABAX/LR42//BABAX/3/BABAX/LR42//BABAX/4/DIAMONDBIRD/5/FRET2/TUKURU//FRET2
656	6179271	TACUPETO F2001/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/PASTOR/7/ROLF07
657	6179272	TACUPETO F2001/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/PASTOR/7/ROLF07
658	6179273	TACUPETO F2001/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/PASTOR/7/ROLF07
659	6179274	TACUPETO F2001/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/PASTOR/7/ROLF07
660	6179275	TACUPETO F2001/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/PASTOR/7/ROLF07
661	6179276	TACUPETO F2001/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/PASTOR/7/ROLF07
662	6179277	TACUPETO F2001/6/CNDO/R143//ENTE/MEXI_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/PASTOR/7/ROLF07
663	6179286	WBLL1*2/KUKUNA//KIRITATI/3/WBLL1*2/KUKUNA
664	6179291	WBLL1*2/KUKUNA//KIRITATI/3/WBLL1*2/KUKUNA
665	6179293	WBLL1*2/KUKUNA//KIRITATI/3/WBLL1*2/KUKUNA
666	6179294	WBLL1*2/KUKUNA//KIRITATI/3/WBLL1*2/KUKUNA
667	6179296	WBLL1*2/KUKUNA//KIRITATI/3/WBLL1*2/KUKUNA
668	6179298	WBLL1*2/KUKUNA//KIRITATI/3/WBLL1*2/KUKUNA
669	6179318	KAUZ/PASTOR//PBW343/3/HAR311/5/OASIS/SKAUZ//4*BCN/3/PASTOR/4/KAUZ*2/YACO//KAUZ
670	6179322	KAUZ/PASTOR//PBW343/3/HAR311/5/OASIS/SKAUZ//4*BCN/3/PASTOR/4/KAUZ*2/YACO//KAUZ

671	6179325	C80.1/3*BATAVIA//2*WBLL1*2/3/PBW343/PASTOR
672	6179332	WBLL1/KUKUNA//TACUPETO F2001*2/3/C80.1/3*BATAVIA//2*WBLL1
673	6179344	FRANCOLIN #1/4/BABAX/LR42//BABAX*2/3/KURUKU
674	6179345	FRANCOLIN #1/4/BABAX/LR42//BABAX*2/3/KURUKU
675	6179346	FRANCOLIN #1/4/BABAX/LR42//BABAX*2/3/KURUKU
676	6179347	FRANCOLIN #1/4/BABAX/LR42//BABAX*2/3/KURUKU
677	6179348	FRANCOLIN #1/4/BABAX/LR42//BABAX*2/3/KURUKU
678	6179353	PANDORA/4/BABAX/LR42//BABAX*2/3/KURUKU
679	6179362	KSW/5/2*ALTAR 84/AE.SQUARROSA (221)//3*BORL95/3/URES/JUN//KAUZ/4/WBLL1
680	6179370	KSW/5/2*ALTAR 84/AE.SQUARROSA (221)//3*BORL95/3/URES/JUN//KAUZ/4/WBLL1
681	6179386	OTUS/TOBA97//YANAC/3/TOBA97/ATTILA
682	6179403	WBLL1*2/4/BABAX/LR42//BABAX/3/BABAX/LR42//BABAX
683	6179417	CHIL/CHUM18//GONDO
684	6179423	KACHU/3/SHA3/SERI//SHA4/LIRA/4/KACHU
685	6179457	TACUPETO F2001//WBLL1*2/KKTS/3/WBLL1*2/BRAMBLING
686	6179463	WBLL1*2/KURUKU//KRONSTAD F2004/3/WBLL1*2/BRAMBLING
687	6179464	WBLL1*2/KURUKU//KRONSTAD F2004/3/WBLL1*2/BRAMBLING
688	6179465	WBLL1*2/TUKURU*2//KRONSTAD F2004
689	6179466	WBLL1*2/TUKURU*2//KRONSTAD F2004
690	6179469	WBLL1*2/VIVITSI//KRONSTAD F2004/3/WBLL1*2/BRAMBLING
691	6179470	WBLL1/4/HD2281/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/TACUPETO F2001/6/WBLL1*2/KKTS/7/WBLL1*2/BRAMBLING
692	6179471	WBLL1/KUKUNA//TACUPETO F2001/3/KRONSTAD F2004/4/ROLF07
693	6179473	WBLL1/KUKUNA//TACUPETO F2001/3/KRONSTAD F2004/4/ROLF07
694	6179474	WBLL1/KUKUNA//TACUPETO F2001/3/KRONSTAD F2004/4/ROLF07
695	6179475	PRL/2*PASTOR*2//VORB
696	6179479	ATTILA*2/PBW65//KRONSTAD F2004
697	6179481	KAUZ/PASTOR//PBW343/3/KRONSTAD F2004
698	6179497	WBLL1*2/TUKURU//KRONSTAD F2004
699	6179508	YAV_3/SCO//JO69/CRA/3/YAV79/4/AE.SQUARROSA (498)/5/LINE 1073/6/KAUZ*2/4/CAR//KAL/BB/3/NAC/5/KAUZ/7/KRONSTAD F2004
700	6179510	PRL/2*PASTOR//VORB
701	6179526	BAV92//IRENA/KAUZ/3/HUITES*2/6/TURACO/5/CHIR3/4/SIREN//ALTAR 84/AE.SQUARROSA (205)/3/3*BUC
702	6179527	BAV92//IRENA/KAUZ/3/HUITES*2/6/TURACO/5/CHIR3/4/SIREN//ALTAR 84/AE.SQUARROSA (205)/3/3*BUC
703	6179534	TRCH*2/3/WUH1/VEE#5//CBRD
704	6179538	WBLL1*2/4/YACO/PBW65/3/KAUZ*2/TRAP//KAUZ*2/5/CHUANMAI 32
705	6179542	WBLL1*2/KURUKU/4/BABAX/LR42//BABAX*2/3/KURUKU
706	6179543	WBLL1*2/KURUKU/4/BABAX/LR42//BABAX*2/3/KURUKU
707	6179553	MURGA/KRONSTAD F2004//QUAIU #3
708	6179559	KFA/3/PFAU/WEAVER//BRAMBLING/4/PFAU/WEAVER*2//BRAMBLING
709	6179562	PBW343*2/KHVAKI*2//YANAC
710	6179596	BECARD/KACHU
711	6179621	FRET2/TUKURU//FRET2/3/KRONSTAD F2004/4/FRET2/TUKURU//FRET2
712	6179640	MUNAL #1

713	6181746	WBLL1*2/BRAMBLING//JUCHI
714	6181747	BABAX/LR42//BABAX/3/BABAX/LR42//BABAX/4/ATTILA/2*PASTOR/5/QUAIU #3
715	6181748	BABAX/LR42//BABAX/3/BABAX/LR42//BABAX/4/ATTILA/2*PASTOR/5/QUAIU #3
716	6181749	BABAX/LR42//BABAX/3/BABAX/LR42//BABAX/4/ATTILA/2*PASTOR/5/QUAIU #3
717	6181750	KENYA NYANGUMI/3/2*KAUZ/PASTOR//PBW343
718	6181755	TILILA/JUCHI/4/SERI.1B//KAUZ/HEVO/3/AMAD
719	6181759	HEILO/7/IVAN/6/SABUF/5/BCN/4/RABI//GS/CRA/3/AE.SQUARROSA (190)/8/VORB/FISCAL
720	6181760	MUNAL #1

Supplementary Table S2 Trait adjusted means under three irrigation treatments (Bed 5IR, Flat 5IR and Bed ZT 5IR), two drought stress treatments (Bed drip and Bed 2IR) and one heat stress (Bed heat) treatment and their heritabilities across environments

Trait	Environments																		
	Bed 5 IR (2009-2010)			Flat 5IR (2010-2011)			Bed ZT 5IR (2010-2011)			Bed drip (2010-2011)			Bed 2IR (2010-2011)			Bed Heat (2010-2011)			h^2 (combined environments)
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	
GY	5.87	9.19	7.70	4.82	9.22	7.64	4.53	8.34	6.62	0.01	2.91	1.26	1.51	5.15	3.59	1.90	5.15	3.73	0.54
DH	73	102	88.55	74	107	91.78	80	111	95.16	72	99	86.54	77	100	91.11	54	71	62.39	0.94
PH	87	120	104.8	95	127	113.0	77	121	99.82	-	-	-	56	98	77.65	55	95	76.40	0.76

GY Grain yield in tons per hectare

DH Days to heading

PH Plant height

Supplementary Table S3 Descriptive statistics of susceptibility indices and yield stability coefficient P_i

Index	Min	Max	Average
DSI	0.70	1.23	1.00
HSI	0.51	1.66	1.02
Yld St (P_i)	0.34	3.55	1.42

DSI Drought susceptibility index

HSI Heat susceptibility index

P_i Superiority index

Supplementary Table S4 Pearson correlation coefficient (r) of grain yield (GY) with days to heading (DH) and plant height (PH) under multiple environments

Traits	Bed 5IR (2009-2010)	Bed ZT 5IR (2010-2011)	Flat 5IR (2010-2011)	Bed drip (2010-2011)	Bed 2IR (2010-2011)	Bed heat (2010-2011)
GY and DH	0.358 P<0.0001	0.158 P<0.05	-0.347 P<0.0001	-0.641 P<0.0001	-0.568 P<0.0001	-0.091 P<0.01
GY and PH	0.243 P<0.001	0.502 P<0.001	0.035 NS	-	0.549 P<0.01	0.514 P<0.01

NS non-significant at P<0.05

Supplementary Table S5 Correlation between traits and population structure from multiple regression analysis

Traits	Environments					
	Bed 5IR	BedZT 5IR	Flat 5IR	Bed drip	Bed 2IR	Bed heat
DH	4.9*	5.0	6.6	7.0	5.9	4.1
	0.007**	0.001	0.05	0.008	0.001	0.009
GY	7.0	7.5	6.1	9.2	7.6	6.3
	0.001	0.005	0.001	0.01	0.01	0.006
PH	15.8	17.3	16.0	-	16.4	14.2
	0.001	0.001	0.05		0.006	0.05

*R^2 in %

** *P* value

Supplementary Table S6 Marker-trait associations for grain yield under different environments using MLM and MLMM analyses

SNP code	Clone ID	Chromosome	Position (cM)	Bed 5IR	BedZT 5IR	Flat 5IR	Bed drip	Bed 2IR	Bed heat	DSI	HSI	Comment*
M3989[a]	1195316	1B	137.71						-0.116		0.030	Novel
M4026[b]	1404300	1B	202.01						-0.112		0.035	Novel
M7629[b]	1199138	2A	18.22	0.099		**0.139**						Known[15]
M5994[a]	1024649	2A	19.21			**0.109**						
M2018[a]	1013903	2B	140.01	-0.135								Known[15]
M2386[b]	988728	2B	22.41				**0.141**			**-0.025**		Novel
M1021[b]	1121362	2B	147.53		-0.183			**-0.146**	-0.223			Known[17]
M8374[a]	2309600	2B	147.53						**-0.194**		**0.060**	
M5705[a]	1386000	2B	150.25		-0.115		**0.148**			**-0.025**		
M3150[b]	996372	3A	137.76		**-0.124**	**0.172**	**-0.141**	**-0.183**	**-0.114**	0.023		Known[17, 32, 33]
M7482[b]	2265707	3A	242.72		0.089	**0.156**		**0.129**				Novel
M4479[a]	1095926	3B	94.94	0.099								Known[13, 34]
M4718[a]	1228289	3B	297.56				**-0.187**			**0.035**		Known[15, 34]
M7810[a]	1098221	3B	297.56				0.101	**0.119**		**-0.017**		
M4418[b]	1003553	4A	177.34	0.086			**-0.124**			**0.025**		Known[17]
M9969[a]	2266806	4A	177.34					**-0.121**				
M2195[b]	992502	4A	233.75		**0.129**			0.063	**0.069**			Known[13, 15, 17, 35]
M8365[b]	1192194	4A	53.74		**0.148**			0.138	**0.136**			Novel
M6564[b]	2255707	4A	48.95		**0.180**				**0.199**		**-0.037**	
M612[b]	977534	4A	48.95		0.120			**0.141**	0.126			
M2118[a]	1125898	5B	156.57	0.132								Known[13, 15]
M5964[b]	1255792	5B	153.69		**-0.101**	**-0.102**		**-0.108**				
Vrn-B1[b]		5B	165.80				-0.157	-0.231		0.027		
M3762[a]	1109166	5B	55.28			**0.135**						Known[15]
M3487[a]	1001679	5B	55.28					-0.094				
M306[a]	976877	5B	82.46				**-0.138**			**0.024**		Novel

Supplementary Table S6 (contd) Marker-trait associations for grain yield under different environments using MLM and MLMM analyses

SNP code	Clone ID	Chromosome	Position (cM)	Bed 5IR	BedZT 5IR	Flat 5IR	Bed drip	Bed 2IR	Bed heat	DSI	HSI	Comment*
M6272 [b]	2266544	5B	82.77		**-0.121**		**-0.089**					
M4010 [a]	1205840	6A	188.83						-0.179			Known[13, 15]
M7096 [a]	2256226	6A	165.94						0.160		-0.052	Novel
M4311 [a]	1200675	6B	5.21	-0.172								Known[13]
M8490 [a]	2267049	7A	170.91		0.095		0.074	0.068				Known[13, 15]
M4129 [a]	1194387	7A	173.30						**0.135**		**-0.050**	Known[13, 15]
M7175 [b]	1092695	7B	202.20		0.143		0.106		0.150		-0.030	Novel
M1441 [b]	989685	7B	112.24			**-0.136**	-0.076					Novel
M845 [a]	1072804	7B	188.81				-0.101			0.017		Known[15, 38]
M7896 [a]	1119182	7B	242.06						**-0.192**		**0.044**	Known[15]
M6533 [a]	2242441	7D	224.31	**0.184**								Known
M4711 [a]	1111392	7D	213.42	**0.181**								Known
Ppd-D1 Ciano type [b]							-0.247			0.047		
Ppd-D1 Mercia type [b]							0.222			-0.045		

For each marker, chromosome, position, and allelic effects (All Eff) are presented. Underlined markers represent same genomic region on a chromosome. Values after marker positions represent allelic effects of the markers under different environments. Values in bold represent allelic effects of the markers that survived covariate analysis with DH genes.

[a, b] signs in superscript indicate markers identified only in MLM analysis (superscript a) and in both MLM and MLMM analyses (superscript b)

* Markers identified here are categorized into novel and known genomic regions. Since the average LD decay across genome was 5cM, the markers were identified within 5cM of known QTL are reported as known and the corresponding reference has been superscripted. For markers belonging to same genomic region/QTL, the comment has been put only on the first marker reported from that genomic region.

Supplementary Table S7 Marker-trait associations identified for grain yield (GY) and Yield Stability Coefficient (Yld St) exclusively in multi-locus mixed-model analysis

SNP code	Clone ID	Chr	Pos (cM)	Yld St *P* value (EBIC)	GY						
					Flat 5IR	Bed ZT 5IR	Bed drip	Bed heat	DSI	HSI	Comment
M4782	992333	1B	158.78					1.583e-07		1.631e-08	Novel
M2337	1220556	3A	203.85					2.538e-06		2.538e-06	Novel
M3962	1035788	3B	159.02	5.400e-06		7.714e-05					Known[13]
M2683	1217870	3B	175.53				1.288e-05		1.461e-04		Novel
M9699	2288336	7B	194.87	2.802e-05		3.688e-05					Known[15, 38]
M7958	985691	7B	195.73		1.456e-04						Known[15, 38]

Underlined markers belong to same genomic region/QTL

Supplementary Table S8 GBS sequences of markers associated with yield stability coefficient

Marker ID	SNP ID	Sequence
M1021	1121362|F|0--17:G>A	TGCAGTGCAACACACACGCGGCCACGCATGCAGCAGGCATTGCGACAAAACATCACGCTCGCGGCCTGC
M5705	1386000|F|0--27:C>G	TGCAGCAGCTCTACTTCTGCTCATCTCCAAAGGAAGAAAGTACTACTTCTGCGCCTCCGCTGCATCAAC
M3150	996372|F|0--17:T>C	TGCAGGTGGCCCCACTTTCCACTTCGTATTGGATTCCTTCTGCACTTTTCACCATTTGTCAGCTATATA
M7482	2265707|F|0--17:G>C	TGCAGCAGGCACAACAGGTTGGAACATGGGCGCCAGAGCCGCTCCATCCGTCCTCGATCGGTCACACTT
M7810	1098221|F|0--6:A>G	TGCAGCAGAAGCAGAGTAGGAGGATGGCGGCGGGAGTGGTGCGCCGCCGCCTCGCCCTCGCCGAGATCG
M6564	2255707|F|0--67:G>A	TGCAGCTATTTGTGCATGCTTCGTCGTCGTCGACGGTGTGAAGGCATTTTTCGACGGCTACCCCGAAGC
M612	977534|F|0--37:G>C	TGCAGCGATAAGTAGTAGTAGTACTTAGTGTTGTAATGACACTTAACTATCAACAGTAACCGAGATCGG
M8365	1192194|F|0--49:A>G	TGCAGCAGAACTCGCTAATACTACGTTACAAAAAAAAACTCTTATGAACAGGCAAAACTGTAGACCCCC
M2195	992502|F|0--6:C>A	TGCAGACTTGCCGCCATGACCTTTCTATCTACTGATTTGATTGGATGTCATGCTCGGCGGGATCCCTCG
M5964	1255792|F|0--52:C>G	TGCAGCTCGGCCAGACGCCGCTGGTGGTGGTGTCGTCCAAGGAGACGGCGCGCCTGGTGCTCAAGACCC
M6272	2266544|F|0--57:G>C	TGCAGCCGAGAAAGCCAGGGTCACATCAAAGTTTGTGTAACGTACTCAGGAAATCCAGGTACTCGAGCT
M306	976877|F|0--25:G>A	TGCAGTGATGAATAAACAGAGAGGCGATTTTGGATCCCTTATGATTTGCTCGTACTTTGCTAATCTCTC
M8490	2267049|F|0--35:T>C	TGCAGTACAAATCTCCTCCACTTCGTGATAACATGTGTTAAAAACAAGAAAGATCCGTCGAGCAGGCAG
M7175	1092695|F|0--44:G>C	TGCAGCGGAGCATCCTCGCGCTGAACGGAAAGGCTGCTTAAAACGCTCGTGCAGTCCAGTTGCAGCGAG
M1441	989685|F|0--12:A>G	TGCAGTGTCTCCACGCGACCCACCCCGATGCAGGCCGCGTGAAGGCCGCCGTACTGGGACGCCAGGGAC

Supplementary Table S9 Marker-trait associations for days to heading under different environments using MLM and MLMM analyses

SNP code	Clone ID	Chromosome	Position (cM)	Bed 5IR	BedZT 5IR	Flat 5IR	Bed drip	Bed 2IR	Bed heat
M3150 [b]	996372	3A	137.76	1.74	1.99	2.10		1.77	1.04
M7482 [a]	2265707	3A	242.72			-1.49			
M6882 [a]	2276075	3A	210.94			-1.27			
M6946 [a]	1164647	3A	55.90				-1.12	-0.95	
M9867 [a]	1053955	3B	94.98					-0.97	
M9969 [b]	2266806	4A	177.34	0.91	1.42	1.16		1.08	
M262 [a]	1071810	4A	178.31					1.21	
M7022 [a]	1696122	4B	86.87		-2.16				
Vrn-B1a [b]		5B	165.80	2.19	2.20	2.26	3.59	3.19	1.37
M6414 [a]	2283173	5B	66.66			-1.81			
M306 [b]	976877	5B	82.46				1.19		0.82
M6460 [b]	2267368	5B	152.32					-1.23	-0.81
M2222 [a]	1093026	6A	122.86	1.02				1.05	
M5183 [b]	1050270	6A	122.86	1.01				1.17	
M4216 [b]	1082949	6A	168.41	-1.17	-1.62		-1.60	-1.34	-0.96
M3870 [a]	997146	7B	242.25		1.08	1.09		0.92	
Ppd-D1a (Ciano type) [b]							2.79		1.14
Ppd-D1 (Mercia type) [b]							-2.43		-1.26
Ppd-B1a [b]								-0.75	

Underlined markers represent same genomic region on a chromosome. Values after marker positions represent allelic effects of the markers under different environments

[a, b] signs in superscript indicate markers identified only in MLM analysis (superscript a) and in both MLM and MLMM analyses (superscript b)

Supplementary Table S10 Marker-trait associations for plant height under different environments using MLM and MLMM analyses

SNP code	Clone ID	Chromosome	Position (cM)	Bed 5IR	BedZT 5IR	Flat 5IR	Bed 2IR	Bed heat
M3183 [b]	1125541	2B	117.77					1.788
M245 [a]	978657	2B	118.92					2.026
M3657 [a]	1021699	2B	116.12					1.281
M2120 [a]	1128199	2B	114.33					1.427
M6270 [a]	2262002	3B	142.00	-2.853				
M6607 [b]	2264129	3B	94.94	1.378				
M5976 [a]	1011847	5B	49.46			-1.119		
Rht-2 [b]				3.017			4.087	3.424
Rht-1 [b]				-2.348	-2.500	-2.287	-3.698	

Underlined markers represent same genomic region on a chromosome. Values after marker positions represent allelic effects of the markers under different environments

[a, b] signs in superscript indicate markers identified only in MLM analysis (superscript a) and in both MLM and MLMM analyses (superscript b)

Supplementary Table S11 Map positions of major genes on consensus map

Gene	Chromosome	Position (cM)
Ppd-A1	2A	51.42
Ppd-B1	2B	60.34
Rht-B1	4B	37.75
Vrn-A1	5A	168.64
Vrn-B1	5B	165.80
Vrn-D3	7D	109.43

Supplementary Table S12 Marker-trait associations identified for days to heading (DH) exclusively in multi-locus mixed-model analysis. For PH none of the markers was exclusive to MLMM analysis

Trait	SNP code/gene allele	Clone ID	Chromosome	Position (cM)	*P* value					
					Bed 5IR	Flat 5IR	Bed ZT 5IR	Bed drip	Bed 2IR	Bed heat
DH	M6121	990721	2D	36.14		9.478e-05	3.107e-07			
	Vrn-D3	-	7D	109.43	1.056e-07	3.107e-07	4.560e-08	2.239e-06	2.649e-06	2.571e-07

Supplementary Table S13 Epistatic interactions for grain yield and yield stability coefficient among markers with and without main effects under different treatments

Treatment	Locus combination	Markers and gene alleles involved in epistasis	Percentage variation explained by interaction (%)
Bed 5IR	2	M1644(AA) M2145(AA)	3.1
	2	M2145(AA) M4418(BB)*	3.2
	2	M1281(BB) M4418(AA)*	3.2
	3	M9211(BB) M1401(AA) M7283(BB)	3.0
	3	M1401(AA) M7283(BB) M8358(AA)	3.0
	3	M330(AA) M1644(AA) M2145(AA)	3.1
	3	M330(AA) M2145(AA) M4418(BB)*	3.2
	3	M1644(AA) M2145(AA) M4418(BB)*	3.2
	3	M6411(AA) M2145(AA) M4418(BB)*	2.9
	3	M2138(BB) M1281(BB) M4418(AA)*	3.1
	3	M5437(BB) M1281(BB) M4418(AA)*	3.5
	3	M1487(AA) M1281(BB) M4418(AA)*	2.9
Bed ZT 5IR	2	M2403(AA) M2716(AA)	3.5
	2	M3159(BB) M2716(AA)	3.7
	2	M3598(BB) M2716(AA)	3.6
	2	M2716(BB) M1436(AA)	3.6
	2	M2716(AA) M2195(AA)*	3.3
	3	M332(AA) M1436(AA) M3526(BB)	3.6
	3	M6564(BB)* M5011(AA) M2716(BB)	3.6
	3	M5011(AA) M2716(BB) M1436(AA)	4.0
	3	M5011(AA) M1436(AA) M3526(BB)	3.6
	3	M5011(AA) M3526(BB) M8365(BB)*	3.6
	3	M3598(BB) M2716(AA) M4759(BB)	3.5
	3	M3598(BB) M2716(AA) M2195(AA)*	3.5
	3	M8728(BB) M3526(BB) M8365(BB)*	4.2
Flat 5IR	2	-	-
	3	-	-
Bed drip	2	M7130(BB) M3125(AA)	3.6
	2	M42(AA) M3125(AA)	3.5
	2	M6636(AA) M3125(AA)	3.5
	2	M3125(AA) M4718(BB)*	3.4
	3	M42(AA) M3050(BB) M3125(AA)	4.0
	3	M42(AA) M7804(BB) M3125(AA)	4.4
	3	M42(AA) M3125(AA) M4718(BB)*	4.9
Bed 2IR	2	M4407(AA) M612(AA)*	2.5
	3	M4104(BB) M4407(AA) M612(AA)*	2.5
	3	M4538(BB) M4407(AA) M612(AA)*	2.6
	3	M750(AA) M4407(AA) M612(AA)*	2.5
	3	M6895(BB) M4407(AA) M612(AA)*	2.6
	3	M4407(AA) M7482(BB) M612(AA)*	2.6
	3	M4407(AA) M1021(BB)* M612(AA)*	2.4
	3	M4407(AA) M612(AA)* M3150(BB)*s	2.4

Treatment	Locus combination	Markers and gene alleles involved in epistasis	Percentage variation explained by interaction (%)
Bed heat	2	M1659(AA) M692(BB)	3.1
	2	M1659(AA) M4129(BB)*	3.2
	2	M612(AA)* M4129(BB)*	3.2
	2	M692(BB) M4782(AA)	3.0
	2	M4782(AA) M2337(BB)	3.0
	2	M4782(AA) M4129(BB)*	3.1
	2	M4129(BB)* M6564(BB)*	3.2
	3	M1659(AA) M4787(BB) M4129(BB)*	3.0
	3	M1659(AA) M692(BB) M4782(AA)	3.0
	3	M1659(AA) M692(BB) M2337(BB)	3.1
	3	M1659(AA) M4782(AA) M4129(BB)*	2.9
	3	M1659(AA) M3989(AA) M4129(BB)*	3.0
	3	M4787(BB) M612(AA)* M4129(BB)*	3.0
	3	M10214(BB) M612(AA)* M692(BB)	4.1
	3	M612(AA)* M4782(AA) M4129(BB)*	3.1
	3	M612(AA)* M3989(AA) M4129(BB)*	3.0
	3	M692(BB) M4782(AA) M2337(BB)	2.9
	3	M4782(AA) M4129(BB)* M6564(BB)*	3.1
Yield stability coefficient	2	M1436(AA) M3125(BB)	8.1
	2	M5456(AA) M3125(AA)	8.2
	2	M6957(AA) M3125(BB)	8.0
	2	M6706(BB) M3125(AA)	8.2
	2	M2264(AA) M3125(AA)	8.8
	2	M3125(BB) M612(AA)*	8.3
	3	M1436(AA) M6957(AA) M3125(BB)	9.5
	3	M1436(AA) M6957(AA) M2716(BB)	8.9
	3	M6957(AA) M2337(BB) M3125(BB)	9.4
	3	M6957(AA) M3125(BB) M612(AA)*	9.2
	3	M6957(AA) M3125(BB) M6564(BB)*	8.9

The underlined marker indicates the main epistatic locus identified and asterisk sign indicates markers with main effects

Supplementary Table S14 Epistatic interactions for grain yield and yield stability coefficient among markers without main effects

Treatment	Locus combination	Marker alleles involved in epistasis	Percentage variation explained by interaction (%)
Bed 5IR	2	M1401(AA) M3204(BB)	3.2
	2	M1401(AA) M3303(BB)	3.1
	2	M1401(AA) M1281(BB)	3.1
	2	M1644(AA) M2145(AA)	3.3
	3	M9211(BB) M1401(AA) M7283(BB)	3.0
	3	M1401(AA) M7283(BB) M8358(AA)	3.0
	3	M330(AA) M1644(AA) M2145(AA)	3.1
Bed ZT 5IR	2	M2403(AA) M2716(AA)	3.5
	2	M3159(BB) M2716(AA)	3.7
	2	M3598(BB) M2716(AA)	3.3
	2	M2716(BB) M1436(AA)	3.6
	3	M332(AA) M1436(AA) M3526(BB)	3.6
	3	M5011(AA) M2716(BB) M1436(AA)	3.4
	3	M5011(AA) M1436(AA) M3526(BB)	3.2
	3	M3598(BB) M2716(AA) M4759(BB)	3.5
Flat 5IR	2	M6636(AA) M2259(BB)	4.1
	2	M282(AA) M2259(BB)	4.0
	2	M2259(BB) M2773(AA)	4.0
	2	M2259(BB) M9968(BB)	3.6
	2	M2259(BB) M7617(BB)	3.8
	2	M2259(BB) M1757(BB)	4.0

Treatment	Locus combination	Marker alleles involved in epistasis	Percentage variation explained by interaction (%)
Flat 5IR	2	M2259(BB) M4169(BB)	3.8
	3	M6636(AA) M282(AA) M2259(BB)	4.1
	3	M6636(AA) M2259(BB) M2808(AA)	4.2
	3	M6636(AA) M2259(BB) M1069(AA)	4.0
	3	M282(AA) M2259(BB) M2209(BB)	4.0
Bed drip	2	M7130(BB) M3125(AA)	3.5
	2	M42(AA) M3125(AA)	3.5
	2	M3050(BB) M3125(AA)	3.4
	2	M7804(BB) M3125(AA)	3.4
	2	M6636(AA) M3125(AA)	3.5
	3	M7130(BB) M42(AA) M3125(AA)	3.5
	3	M7130(BB) M1786(BB) M3125(AA)	3.5
	3	M7130(BB) M3125(AA) M4962(BB)	3.0
	3	M42(AA) M1786(BB) M3125(AA)	3.4
	3	M42(AA) M3050(BB) M3125(AA)	3.4
	3	M3050(BB) M6636(AA) M3125(AA)	3.4
Bed 2IR	2	M2493(AA) M4407(BB)	2.5
	3	M2493(AA) M6528(BB) M4407(BB)	2.4
	3	M2493(AA) M4607(BB) M4407(BB)	2.5
	3	M2493(AA) M262(BB) M4407(BB)	2.4
	3	M2493(AA) M1013(BB) M4407(BB)	2.1

Treatment	Locus combination	Marker alleles involved in epistasis	Percentage variation explained by interaction (%)
Bed heat	2	M1659(AA) M692(BB)	3.1
	2	M692(BB) M4782(AA)	3.0
	2	M4782(AA) M2337(BB)	3.0
	3	M692(BB) M4782(AA) M2337(BB)	3.0
Yield stability coefficient	2	M1436(AA) M3125(BB)	9.0
	2	M5456(AA) M3125(AA)	9.2
	2	M6957(AA) M3125(BB)	8.9
	2	M6706(BB) M3125(AA)	8.2
	2	M2264(AA) M3125(AA)	8.8
	3	M1436(AA) M6957(AA) M3125(BB)	8.7
	3	M1436(AA) M6957(AA) M2716(BB)	8.9
	3	M6957(AA) M2337(BB) M3125(BB)	9.4

The underlined marker indicates the main epistatic locus

Supplementary Table S15 Lines identified with best allelic combination of the four significant markers identified by forward stepwise regression analysis

GID	M3125	M6564	M3150	M1021	P_i	Mean GY (tons/ha)	DSI	HSI
6177498	A	A	B	B	1.96	4.7	1.00	0.98
6177599	A	A	B	B	1.83	4.9	0.99	0.97
6177657	A	A	B	B	1.29	5.1	0.91	0.77
6177659	A	A	B	B	1.18	5.2	0.94	0.98
6177665	A	A	B	B	1.31	5.2	0.96	1.00
6178397	A	A	B	B	1.18	5.2	0.96	0.85
6178398	A	A	B	B	1.13	5.3	0.84	0.97
6178403	A	A	B	B	1.09	5.2	0.98	1.00
6178404	A	A	B	B	1.16	5.2	0.98	1.00
6178527	A	A	B	B	1.13	5.2	0.91	0.90
6178528	A	A	B	B	1.24	5.2	0.90	0.71
6178541	A	A	B	B	1.42	5.0	0.93	0.86
6178556	A	A	B	B	1.26	5.2	0.80	1.00
6179132	A	A	B	B	0.67	5.6	0.92	1.00
6179216	A	A	B	B	0.65	5.6	1.00	0.95
6179220	A	A	B	B	0.66	5.6	1.00	0.96
6179510	A	A	B	B	1.15	5.2	0.98	0.97
6179543	A	A	B	B	1.00	5.3	0.95	0.91
6181747	A	A	B	B	1.48	5.0	1.00	0.98
6181755	A	A	B	B	1.68	4.4	0.86	0.98
6181760	A	A	B	B	1.55	5.0	0.90	1.00

P_i Yield stability coefficient

DSI Drought susceptibility index

HSI Heat susceptibility index

Supplementary Table S16 *In silico* candidate gene analysis of significant markers identified by stepwise regression analysis

SNP code	Allele	Blast Hit Accession	Consequence	Gene description	Interpro-ID (Description/Domain)
M1021	C	AT4G27590.2	3'UTRvariant	Heavy metal transport/detoxification superfamily protein LENGTH=332	IPR006121 (Heavy metal-associated domain, HMA)
M3150	T	AT5G18750.1	Downstream gene variant	DNAJ heat shock N-terminal domain-containing protein LENGTH=884	IPR024593 (Domain of unknown function DUF3444)

Supplementary Table S17 Allele specific SNP and STS markers for major genes controlling phenology and plant height used in the present study

Gene-specific allele	Marker type*	Function/Effect	Source/Reference
Vrn-A1a	SNP	Spring growth habit	CerealsDB; Yan et al. (2004)
Vrn-A1b	SNP	Spring growth habit	CerealsDB; Yan et al. (2004)
Vrn-A1b (Jagger type)	SNP	Short vernalizing	CerealsDB; Chen et al. (2009)
Vrn-A1v/w	CAPS	Winter growth habit	----------
Vrn-B1a	STS	Spring growth habit	MASWHEAT; Fu et al. 2005
Vrn-B1b	STS	Spring growth habit	Santra et al. (2009)
Vrn-D1	SNP	Spring growth habit	CerealsDB;
Vrn-D3	SNP	Spring growth habit	Gina Brown, USDA (Pers. commun.); (Chen et al. 2010)
Ppd-A1a (GS-100 type)	SNP	Photoperiod insensitivity	CerealsDB; (Wilhelm et al. 2009)
Ppd-A1a (GS-105 type)	SNP	Photoperiod insensitivity	CerealsDB; (Wilhelm et al. 2009)
Ppd-A1 (Capelle-Desprez deletion) null allele	SNP	Photoperiod insensitivity	CerealsDB; (Beales et al. 2007)
Ppd-A1b (Intron-5 insertion)	SNP	Photoperiod sensitivity	Gina Brown, USDA (Pers. commun.)
Ppd_B1a (Chinese Spring retrotransposon exon 7)	SNP	Photoperiod insensitivity	CerealsDB; (Beales et al. 2007)
Ppd-B1a (Chinese Spring exon 3)	SNP	Photoperiod insensitivity	Gina Brown, USDA (Pers. commun.)
Ppd-B1b (Chinese Spring Line Element SNP4)	SNP	Photoperiod insensitivity	Gina Brown, USDA (Pers. commun.)
Ppd-B1b (Chinese Spring SNP5)	SNP	Photoperiod insensitivity	Gina Brown, USDA (Pers. commun.)
Ppd-B1a (Sonora 64 type deletion)	SNP	Photoperiod insensitivity	Gina Brown, USDA (Pers. commun.)
Ppd-D1a (Ciano67 type deletion)	SNP	Photoperiod insensitivity	CerealsDB; (Beales et al. 2007)
Ppd-D1b (Mercia type Intron 1 insertion)	SNP	Photoperiod sensitivity	CerealsDB; (Beales et al. 2007)
Ppd-D1b (Norstar type deletion in exon 7)	SNP	Photoperiod sensitivity	CerealsDB; (Beales et al. 2007)
Rht-B1	SNP	Semi-dwarf	CerealsDB; Ellis et al (2002)
Rht-D1	SNP	Semi-dwarf	CerealsDB; Ellis et al (2002)

* Genotyping was carried out in the CIMMYT laboratory using allele-specific SNP or sequence tagged site (STS) markers for each gene