

Table S1. List of 143 barley accessions used in the present study with information of number of ear rows () and seasonal growth habit (SGH, S=spring type, W=winter type, F=facultative type) of genotypes

No	Name/Origin	Acc. No. ¹	NER ²	SGH ³	No	Name/Origin	Acc. No. ¹	NER	SGH	No	Name/Origin	Acc. No. ¹	NER	SGH
1	England1	71411	2	S	49	Iran/Miyandoab1	72466	2	W	97	Iran/Unknown25	72684	2	F
2	England2	71411	6	W	50	Iran/Unknown1	72472	6	W	98	Iran/Unknown26	72689	2	F
3	Algeria1	71426	2	W	51	Iran/Korand	72480	2	S	99	Iran/Unknown27	72703	6	W
4	Algeria2	71426	2	S	52	Iran/Unknown2	72480	2	W	100	Iran/Unknown28	72712	6	W
5	Iran43	71441	6	W	53	Iran/Unknown3	72488	6	W	101	Iran/Unknown29	72726	6	W
6	USA1	71482	2	S	54	Iran/Ghazvin	72494	6	W	102	China22	72372	2	F
7	Russia1	71530	2	S	55	Iran/Unknown4	72498	2	S	103	China23	72382	2	F
8	Russia2	71530	2	S	56	Iran/Unknown5	72498	2	S	104	Iran/Unknown30	72472	2	F
9	Spain1	71538	6	W	57	Iran/Unknown6	72500	2	S	105	Iran/Unknown31	72472	6	W
10	Spain2	71538	2	S	58	Iran/Bojnord1	72520	2	W	106	Iran/Torbat-E-Jam	72482	6	W
11	Egypt1	71557	2	S	59	Iran/Bojnord2	72522	6	W	107	Iran/Azarbaijan3	72553	6	W
12	Egypt2	71576	6	F	60	Iran/Bojnord3	72524	6	W	108	Iran/Miyandoab3	72588	2	S
13	Egypt3	71576	6	S	61	Iran/Bojnord4	72524	6	W	109	Iran/Unknown32	72646	6	W
14	Egypt4	71576	2	S	62	Iran/Bojnord5	72524	6	W	110	Iran/Unknown33	72646	6	W
15	Egypt5	71591	6	W	63	Iran/Golpayegan1	72545	6	S	111	Iran/Unknown34	72680	2	S
16	Egypt6	71591	6	W	64	Iran/Golpayegan2	72546	2	S	112	Iran/Unknown35	72680	2	F
17	Egypt7	71608	6	W	65	USA2	72550	2	S	113	Iran/Unknown37	72686	2	S
18	Egypt8	71614	6	W	66	Iran/Azarbaijan1	72557	2	S	114	Iran/Unknown38	72704	6	W
19	Egypt9	71614	6	W	67	Iran/Azarbaijan2	72557	6	W	115	Iran/Unknown39	72715	6	W
20	Egypt10	71630	6	W	68	Iran/Tehran	72559	6	W	116	Iran/Unknown40	72715	6	W
21	Egypt11	71630	6	W	69	Iran/Azarbaijan4	72560	6	W	117	Iran/Unknown41	72744	6	W
22	Egypt12	71657	6	W	70	Iran/Kerman1	72562	6	W	118	Iran/Unknown42	72747	2	S
23	India	71663	6	W	71	Iran/Kerman2	72562	6	W	119	CWB117-77		2	S
24	Ethiopia	71704	2	S	72	Iran/Gorgan1	72565	2	W	120	Tokak/Demir-2		2	S
25	Russia3	71850	2	S	73	Iran/Gorgan2	72566	2	S	121	Zarjau-80		6	W
26	Pakistan1	71938	2	S	74	Iran/Gorgan3	72566	2	S	122	AZE-ICB		2	S
27	Pakistan2	71938	2	S	75	Iran/Gorgan4	72566	2	S	123	CWB117-5		2	S
28	China1	72113	6	W	76	Iran/Kerman3	72568	2	S	124	ICB01-1402		2	S
29	China2	72295	2	S	77	Iran/Kerman4	72581	2	W	125	Alpha/Gumhuriyet		2	S
30	China3	72295	6	W	78	Iran/Unknown7	72584	2	W	126	Rihane-03		6	W

No	Name/Origin	Acc. No. ¹	NER ²	SGH ³
31	China4	72295	2	S
32	China5	72322	6	W
33	China6	72322	6	W
34	China7	72322	2	S
35	China8	72322	6	W
36	China9	72368	6	W
37	China10	72368	6	W
38	China11	72368	6	W
39	China12	72368	6	W
40	China13	72372	2	S
41	China14	72372	2	S
42	China15	72397	6	S
43	China16	72397	6	S
44	China17	72406	2	S
45	China18	72406	2	S
46	China19	72439	2	NA
47	China20	72439	2	W
48	China21	72439	2	S

No	Name/Origin	Acc. No. ¹	NER	SGH
79	Iran/Miyandoab2	72587	2	F
80	Iran/Unknown8	72602	6	W
81	Iran/Unknown9	72611	6	W
82	Iran/Unknown10	72646	6	W
83	Iran/Unknown11	72647	2	S
84	Iran/Unknown12	72647	2	S
85	Iran/Unknown13	72649	2	S
86	Iran/Unknown14	72650	2	S
87	Iran/Unknown15	72653	6	W
88	Iran/Unknown16	72655	2	W
89	Iran/Unknown17	72664	2	F
90	Iran/Unknown18	72665	2	F
91	Iran/Unknown19	72666	2	W
92	Iran/Unknown20	72668	2	S
93	Iran/Unknown21	72672	2	S
94	Iran/Unknown22	72673	2	F
95	Iran/Unknown23	72674	2	F
96	Iran/Unknown24	72675	2	S

No	Name/Origin	Acc. No. ¹	NER	SGH
127	Makoe		6	W
128	Sahand		2	S
129	Abidar		2	S
130	Dayton		2	W
131	Yea-168		2	S
132	Denmark		2	S
133	Obruk-86		2	S
134	Gara-Arpa		2	S
135	Ec-79		6	S
136	Bolbol		2	W
137	Dikto		6	W
138	Radical		6	W
139	Dobrynya		6	W
140	Ec-80		6	W
141	Ec-84		6	S
142	Erb-86		2	S
143	Erb-87		2	S

¹ Accession number. ² Number of ear rows: 2=two-rowed, 6=six-rowed. ³ Seasonal growth habit: S=spring type, W=winter type, F=facultative type

Table S2. List of 36 DUS characteristics used in present study

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No.	Ch. code ¹	Type of variable ²	Time of obs. ³	Characteristics	Ch. Abbr. ⁴	Method of measurement/State of expression (Note)
1	I-27	N	00	Grain: color	GC	white (1), yellow (2), green (3), black (4)
2	U-28	O, B	00	Kernel: color of aleurone layer	KCAL	Determined on soaked kernels after 12 hours O: whitish (1), weakly colored (2), strongly colored (3) B: whitish (1), colored (9)
3		C	00	1000-seed weight	SW	Calculated after harvest on samples of cleaned seeds
4		C	05	Radicle length	RL	Measurement on length of radicle (cm) seven days after germination of 20 grains in soaked paper roll at 20°C
5		C	07	Coleoptile length	CL	Measurement on length of coleoptile (cm) seven days after germination of 20 grains in soaked paper roll at 20°C
6		C	10	First leaf length	FLL	Measurement on length of first leaf of seedling (cm) seven days after germination of 20 grains in soaked paper roll at 20°C
7		C	10	Total seedling length (first leaf plus radicle)	TSL	Measurement on total seedling length (including first leaf and radicle) (cm) seven days after germination of 20 grains in soaked paper roll at 20°C
8	U-2	B	25-29	Lowest leaves: hairiness of leaf sheaths	LLHL	Absent (1), present (9)
9	U-1	O	25-29	plant: growth habit	PGH	Erect (1), semi-erect (2), intermediate (3), semi prostrate (4), prostrate (5)
10	U-3	B	45-49	Flag leaf: anthocyanin coloration of auricles	FLAC	Absent (1), present (9)
11	U-4	O	45-49	Flag leaf: intensity of anthocyanin coloration of auricles	FLIA	absent or very weak (1), weak (3), medium (5), strong (7), very strong (9)
12	C-5	O	49-51	Flag leaf: attitude	FLA	erect (1), semi-erect (3), horizontal (5), semi-drooping (7), drooping (9)
13	U-7	C	50-52	Time of ear emergence	TEE	Time (days) from sowing until 50% of the spikelets are visible in each plot
14	U-6	O	50-60	Flag leaf: glaucosity of sheet	FLGS	absent or very weak (1), weak (3), medium (5), strong (7), very strong (9)
15	U-8	B	60-65	Awns: anthocyanin coloration of tips	AACT	Absent (1), present (9)
16	U-9	O	60-65	Awns: intensity of anthocyanin coloration of tips	AIAC	absent or very weak (1), weak (3), medium (5), strong (7), very strong (9)
17	I-13	O, B	60-65	Awn: roughness	AR	O: smooth (3), intermediate (5), rough (7) B: smooth (1), rough (9)
18	U-24	O, B	80-85	Grain: anthocyanin coloration of nerves of lemma	GACN	O: absent or very weak (1), weak (3), medium (5), strong (7), very strong (9) B: absent (1), present (9)
19	U-17	O	80-92	Awn: length (compared to ear)	AL	short (3), medium (5), long (7)

20	U-15	C, O	80-92	Ear: density	ED	C: calculated from number of spikelets in ear divided by length of rachis O: very lax (1), lax (3), medium (5), dense (7), very dense (9)
21	U-16	C	80-92	Ear: length	EL	Distance (cm) from beginning of rachis to the tip of ear
22	U-13	B	80-92	Ear: number of rows	ENR	two (1), more than two (9)
23	U-14	N	80-92	Ear: shape	ESh	tapering (3), parallel (5), fusiform (7)
24	U-22	B	80-92	Grain: rachilla hair type	GRHT	short (1), long (2)
25	U-12	C	80-92	Plant height	PH	Measurement (cm) on total length of plant (including ear and rows) on a plot basis
26	W-8	N	92	collar: type	CT	recurred (1), platform (2), cup (3)
27	C-19	B	92	Ear: development of sterile spikelets	EDSS	non or rudimentary (1), full (2)
28	U-27	B	92	Grain: disposition of lodicules	GDL	frontal (1), clasping (2)
29	U-23	B	92	Grain: husk	GH	Absent (1), present (9)
30	U-26	B	92	Grain: hairiness of ventral furrow	GHVF	Absent (1), present (9)
31	U-25	O, B	92	Grain: spiculation of inner lateral nerves of dorsal side of lemma	GSLN	O: absent or very weak (1), weak (3), medium (5), strong (7), very strong (9) B: Absent (1), present (9)
32	U-21	O	92	Median spikelet: length of glume and its awn relative to grain	MSLG	shorter (1), equal (2), longer (3)
33	U-19	O	92	Rachis: curvature of first segment	RCFS	absent or very weak (1), weak (3), medium (5), strong (7), very strong (9)
34	U-18	O	92	Rachis: Length of first segment	RLFS	O: Short (3), medium (5), long (7), very long (9)
35	U-20	N	92	Sterile spikelet: attitude (in mid-third of ear)	SSA	Parallel (1), parallel to weakly divergent (2), divergent (3)
36	W-32	N	92	sterile spikelet: tip shape	SSTS	pointed (1), rounded (2), squared (3)

¹ Character code: U=UPOV's DUS test guideline, I=India's DUS test guideline, C=CPVO's DUS test guideline. ² B=Binary variable, O=Ordinal variable, N=Nominal variable, C=Continuous variable. ³ Time of observation: according to Zadoks two-digit growth scale. ⁴ Character abbreviation

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Table S3. Name, type and map location of 149 SSR loci used in present study. Sequence information of forward and reverse primer is available at: <https://wheat.pw.usda.gov/cgi-bin/GG3/browse.cgi?class=locus>

No	Marker name ¹	Map ²	SSR type ³
1	BMAC0032	1H	SSR
2	BMAC0063	1H	SSR
3	BMAC0213	1H	SSR
4	BMAG0149	1H	SSR
5	BMAG0211	1H	SSR
6	BMAG0345	1H	SSR
7	BMAG0382	1H	SSR
8	BMAG0504	1H	SSR
9	EBMAC560	1H	SSR
10	EBMAC659	1H	SSR
11	GBM1143	1H	EST-SSR
12	GBM1216	1H	EST-SSR
13	GBM1336	1H	EST-SSR
14	GBM1411	1H	EST-SSR
15	GBM1451	1H	EST-SSR
16	GBM1461	1H	EST-SSR
17	GBM1480	1H	EST-SSR
18	HVM20	1H	SSR
19	HVM43	1H	SSR
20	SCSSR04163	1H	EST-SSR
21	BMAC0132	2H	SSR
22	BMAC0134	2H	SSR
23	BMAG0114	2H	SSR
24	BMAG0140	2H	SSR
25	BMAG0378	2H	SSR
26	BMAG0518	2H	SSR
27	BMAG0720	2H	SSR
28	BMAG0813	2H	SSR
29	EBMAC0525	2H	SSR
30	EBMAC0558	2H	SSR
31	EBMAC0854	2H	SSR
32	EBMATC0039	2H	SSR
33	GBM1149	2H	EST-SSR
34	GBM1208	2H	EST-SSR
35	GBM1251	2H	EST-SSR
36	GBM1309	2H	EST-SSR
37	GBM1365	2H	EST-SSR
38	GBM1366	2H	EST-SSR
39	GBM1408	2H	EST-SSR
40	GBM1459	2H	EST-SSR
41	GBM1468	2H	EST-SSR

No	Marker name ¹	Map ²	SSR type ³
42	GBMS0160	2H	SSR
43	HVM36	2H	SSR
44	SCSRR12344	2H	EST-SSR
45	SCSSR03381	2H	EST-SSR
46	SCSSR08447	2H	EST-SSR
47	BMAC0209	3H	SSR
48	BMAG0013	3H	SSR
49	EBMAC0541	3H	SSR
50	EBMAC0871	3H	SSR
51	GBM1450	3H	EST-SSR
52	GBM1110	3H	EST-SSR
53	GBM1139	3H	EST-SSR
54	GBM1159	3H	EST-SSR
55	GBM1405	3H	EST-SSR
56	GBMS0183	3H	SSR
57	GMS116	3H	SSR
58	HV13GEIII	3H	SSR
59	HVES1A	3H	SSR
60	SCSSR10559	3H	EST-SSR
61	SCSSR25538	3H	EST-SSR
62	SCSSR25691	3H	EST-SSR
63	GBM1413	7H	EST-SSR
64	BMAC0310	4H	SSR
65	BMAG0375	4H	SSR
66	BMAG0419	4H	SSR
67	BMAG0740	4H	SSR
68	BMAG138	4H	SSR
69	EBMAC0635	4H	SSR
70	EBMAC0788	4H	SSR
71	EBMAC0906	4H	SSR
72	EBMAC679	4H	SSR
73	GBM1221	4H	EST-SSR
74	GBM1299	4H	EST-SSR
75	GBM1388	4H	EST-SSR
76	GBM1422	4H	EST-SSR
77	GBM1482	4H	EST-SSR
78	GBM1525	4H	EST-SSR
79	GMS0089	4H	SSR
80	HVBAMY	4H	SSR
81	HVM0068	4H	SSR
82	HVM40	4H	SSR
83	HVM51	4H	SSR
84	SCSSR14079	4H	EST-SSR
85	SCSSR18005	4H	EST-SSR
86	SCSSR20569	4H	EST-SSR

No	Marker name ¹	Map ²	SSR type ³
87	BMAC0096	5H	SSR
88	BMAC0113	5H	SSR
89	BMAC0163	5H	SSR
90	BMAG0751	5H	SSR
91	BMAG0812	5H	SSR
92	GBM05939	5H	EST-SSR
93	GBM1176	5H	EST-SSR
94	GBM1293	5H	EST-SSR
95	GBM1295	5H	EST-SSR
96	GBM1398	5H	EST-SSR
97	GBM1426	5H	EST-SSR
98	GBM1436	5H	EST-SSR
99	GBM1438	5H	EST-SSR
100	GBM1463	5H	EST-SSR
101	GBM1470	5H	EST-SSR
102	GBM1506	5H	EST-SSR
103	GBM5028	5H	EST-SSR
104	GBM0384	5H	EST-SSR
105	SCSSR02306	5H	EST-SSR
106	SCSSR02503	5H	EST-SSR
107	SCSSR03907	5H	EST-SSR
108	SCSSR10148	5H	EST-SSR
109	SCSSR15334	5H	EST-SSR
110	SCSSR18076	5H	EST-SSR
111	BMAC0040	6H	SSR
112	BMAG0009	6H	SSR
113	BMAG0807	6H	SSR
114	EBMAC0624	6H	SSR
115	GBM1075	6H	EST-SSR
116	GBM1212	6H	EST-SSR
117	GBM1267	6H	EST-SSR
118	GBM1276	6H	EST-SSR
119	GBM1400	6H	EST-SSR
120	GBM1404	6H	EST-SSR
121	GBMS0180	6H	SSR
122	HVM31	6H	SSR
123	HVM74	6H	SSR
124	SCSSR05599	6H	EST-SSR
125	SCSSR09398	6H	EST-SSR
126	BMAC0167	7H	SSR
127	BMAG0507	7H	SSR
128	BMAG0516	7H	SSR
129	EBMAG0794	7H	SSR
130	EBMATC0016	7H	SSR
131	GBM1116	7H	EST-SSR

No	Marker name ¹	Map ²	SSR type ³
132	GBM1126	7H	EST-SSR
133	GBM1297	7H	EST-SSR
134	GBM1419	7H	EST-SSR
135	GBM1428	7H	EST-SSR
136	GBM1432	7H	EST-SSR
137	GBM1464	7H	EST-SSR
138	GBM1472	7H	EST-SSR
139	GBM1516	7H	EST-SSR
140	GBMS141	7H	SSR
141	GMS046	7H	SSR
142	HVM49	7H	SSR
143	SCSSR15864	7H	EST-SSR
144	SCSSR7970-1	7H	EST-SSR
145	SCSSR7970-2	7H	EST-SSR
146	EBMAC0225	---	SSR
147	GBM1552	---	EST-SSR
148	HVI3	---	SSR
149	HVLMNO1A	---	SSR

¹See Table 1. ²See Fig. S1 [suppl]. ³SSR: simple sequence repeat; EST: expressed sequence tag

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Table S4. Range and mean values of nine quantitative traits measured on 143 barley genotypes

Trait name	Minimum	Maximum	Average $\pm$ SD
Time of ear emergence, days	65.7	79	72.6 $\pm$ 2.8
Plant height, cm	77.5	105	89.1 $\pm$ 4.7
Ear length, cm	4.7	108	8.4 $\pm$ 1.1
Ear density, grains/cm	2.1	12.6	4.4 $\pm$ 2.4
Thousand-seed weight, g	29.3	56.6	44.4 $\pm$ 6.4
total seedling length, cm	23.9	39.1	33.1 $\pm$ 2.7
First leaf length, cm	10.4	20.1	16.5 $\pm$ 1.4
Radicle length, cm	9.4	20.1	16.6 $\pm$ 1.9
Coleoptile length, cm	3.5	5.8	4.7 $\pm$ 0.4

Table S5. Results of morphological (ordinal, binary, and nominal) variables measured or scored on 143 barley samples

Ch. Abbr. ¹	Type of variable ²	Characteristics	State of expression (no., frequency of varieties)
KCAL	O,B	Kernel: color of aleurone layer	O: whitish (72,0.5), weakly colored (19,0.13), strongly colored (52,0.36) B: whitish (72, 0.5), colored (71, 0.5)
PGH	O	Plant: growth habit	Erect (6,0.04), semi-erect (74,0.52), intermediate (59,0.41), semi prostrate (4, 0.03)
LLHL	B	Lowest leaves: hairiness of leaf sheaths	Absent (138, 0.97), present (5,0.03)
FLAC	B	Flag leaf: anthocyanin coloration of auricles	Absent (58,0.41), present (85,0.49)
FLIA	O	Flag leaf: intensity of anthocyanin coloration of auricles	absent or very weak (58,0.41), weak (49,0.34), medium (35,0.24), strong (1,0.01)
FLA	O	Flag leaf: attitude	erect (77,0.54), semi-erect (58,0.41), horizontal (8,0.06)
FLGS	O	Flag leaf: glaucosity of sheet	weak (36,0.25), medium (92,0.64), strong (15,0.1)
AACT	B	Awns: anthocyanin coloration of tips	Absent (28,0.2), present (115,0.8)
AIAC	O	Awns: intensity of anthocyanin coloration of tips	absent or very weak (28,0.2), weak (82,0.57), medium (25,0.17), strong (8,0.06)
GACN	O,B	Grain: anthocyanin coloration of nerves of lemma	O: absent or very weak (126,0.88), weak (11,0.08), medium (5,0.08), very strong (1,0.01) B: Absent (126,0.08), present (17,0.12)
ENR	B	Ear: number of rows	two (80,0.56), more than two (63,0.44)
ESh	N	Ear: shape	tapering (9,0.06), parallel (134,0.94)
ED	O	Ear: density	Very lax (21,0.15), lax (69,0.48), medium (43,0.3), dense (9,0.06), very dense (1,0.01)
GRHT	B	Grain: rachilla hair type	short (7,0.05), long (136,0.95)
RCFS	O	Rachis: curvature of first segment	absent or very weak (55,0.38), weak (88,0.62)
EDSS	B	Ear: development of sterile spikelets	Full (80,1.00), monomorphic in all 80 two-rowed varieties
SSA	N	Sterile spikelet: attitude (in mid-third of ear)	parallel to weakly divergent (5,0.06), divergent (75,0.94)
MSLG	O	Median spikelet: length of glume and its awn relative to grain	shorter (6,0.04), equal (90,0.63), longer (47,0.33)
GH	B	Grain: husk	present (143,1.00), monomorphic in all 143 varieties
GSLN	O	Grain: spiculation of inner lateral nerves of dorsal side of lemma	O: absent or very weak (16,0.11), weak (53,0.37), medium (48,0.34), strong (18,0.13), very strong (8,0.06) B: Absent (16,0.11), present (127,0.89)
GHVF	B	Grain: hairiness of ventral furrow	Absent (143,1.00), monomorphic in all 143 varieties
AL	O	Awn: length (compared to ear)	short (5,0.03), medium (31,0.22), long (107,0.75)

AR	B,O	Awn: roughness	B:smooth (39,0.27), rough (104,0.73) O:smooth (9,0.06), intermediate (30,0.21), rough (104,0.73)
SSTS	N	sterile spikelet: tip shape	pointed (35), rounded (45)
CT	N	collar: type	recurred (66,0.46), cup (77,0.54)
GC	N	Grain: color	yellow (106,0.74), green (3,0.02), black (34,0.24)
RLFS	O	Rachis: Length of first segment	Short (26,0.18), medium (90,0.63), long (26,0.18), very long (1,0.01)
GDL	B	Grain: disposition of lodicules	Clasping (143, 1.00), monomorphic in all 143 varieties

¹ Character abbreviation. ² B=Binary variable, O=Ordinal variable, N=Nominal variable

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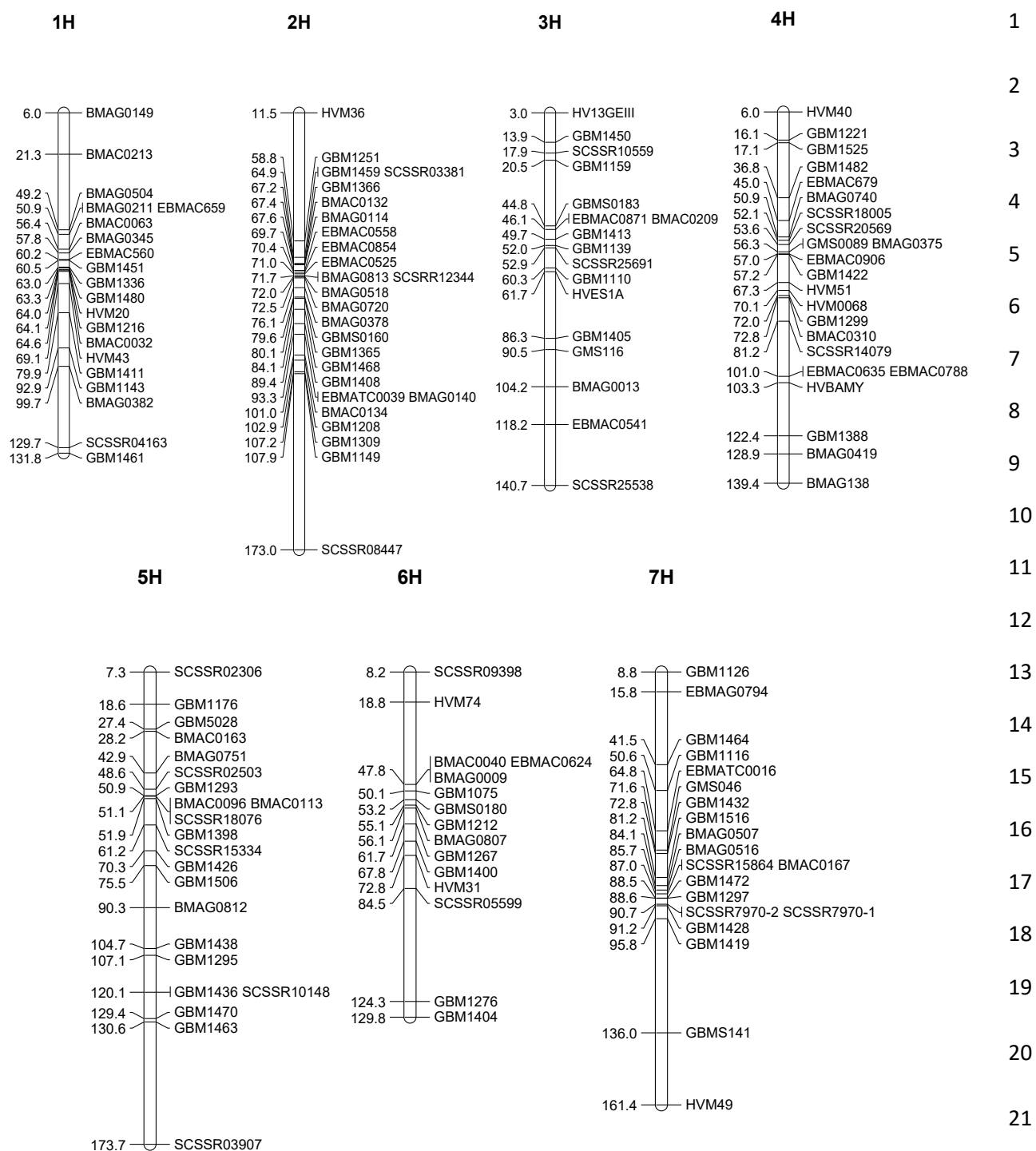


Figure S1. Map locations of 149 SSR markers used in this study across seven barley chromosomes [adapted from Comparative Map Viewer of GrainGenes database from reference set: Barley, Steptoe × Morex, SSR]

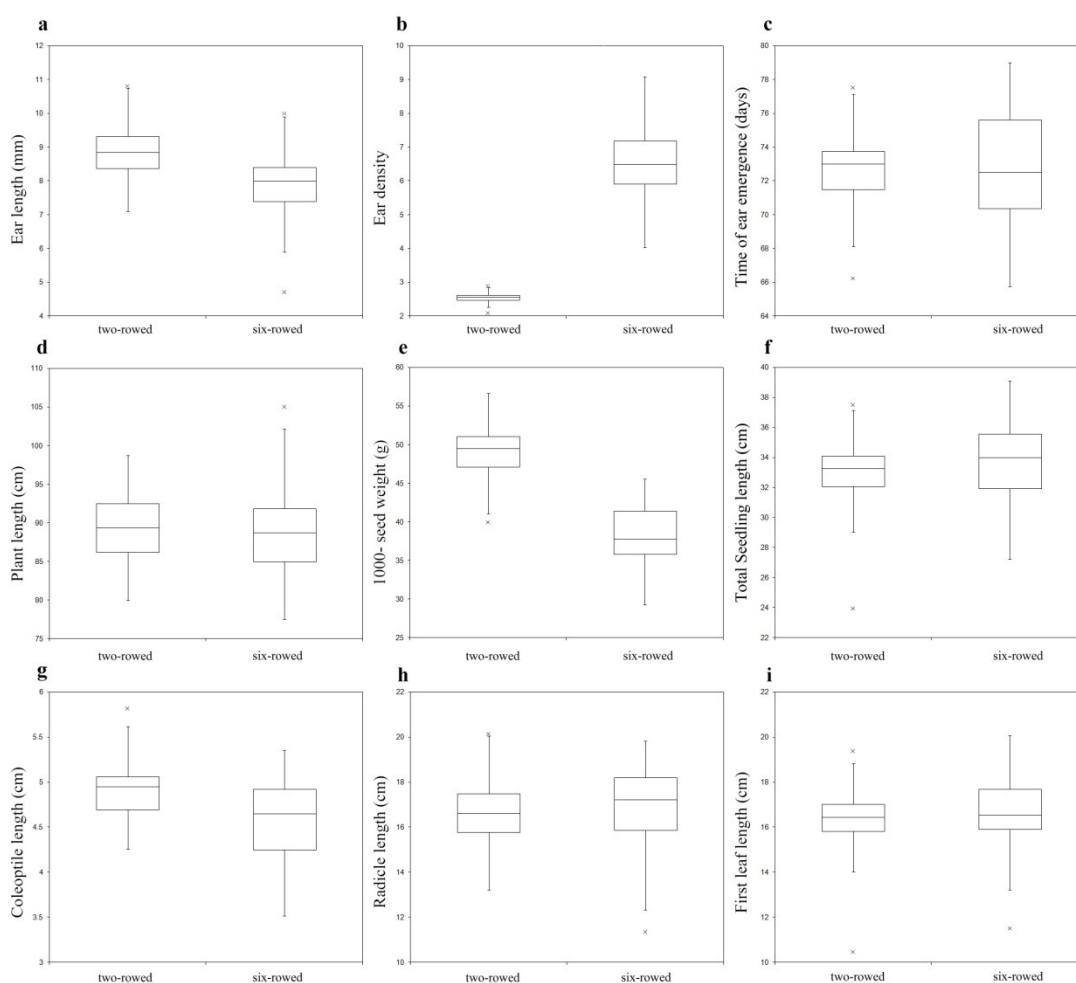


Figure S2. Box plots of nine quantitative DUS traits grouped by the number of ear rows (NER): a: ear length; b: ear density; c: time of ear emergence; d: plant height; e: 1000-seed weight; f: total seedling length; g: coleoptile length; h: radical length; i: first leaf length. The 143 inbred lines were differentiated into two- and six-rowed sub-populations by model-based Bayesian clustering and NJ tree. Student t test was used to estimate the significance of difference between NER means across two years. Four traits (a, b, e, g) were significantly associated with two- and six-rowed groups.

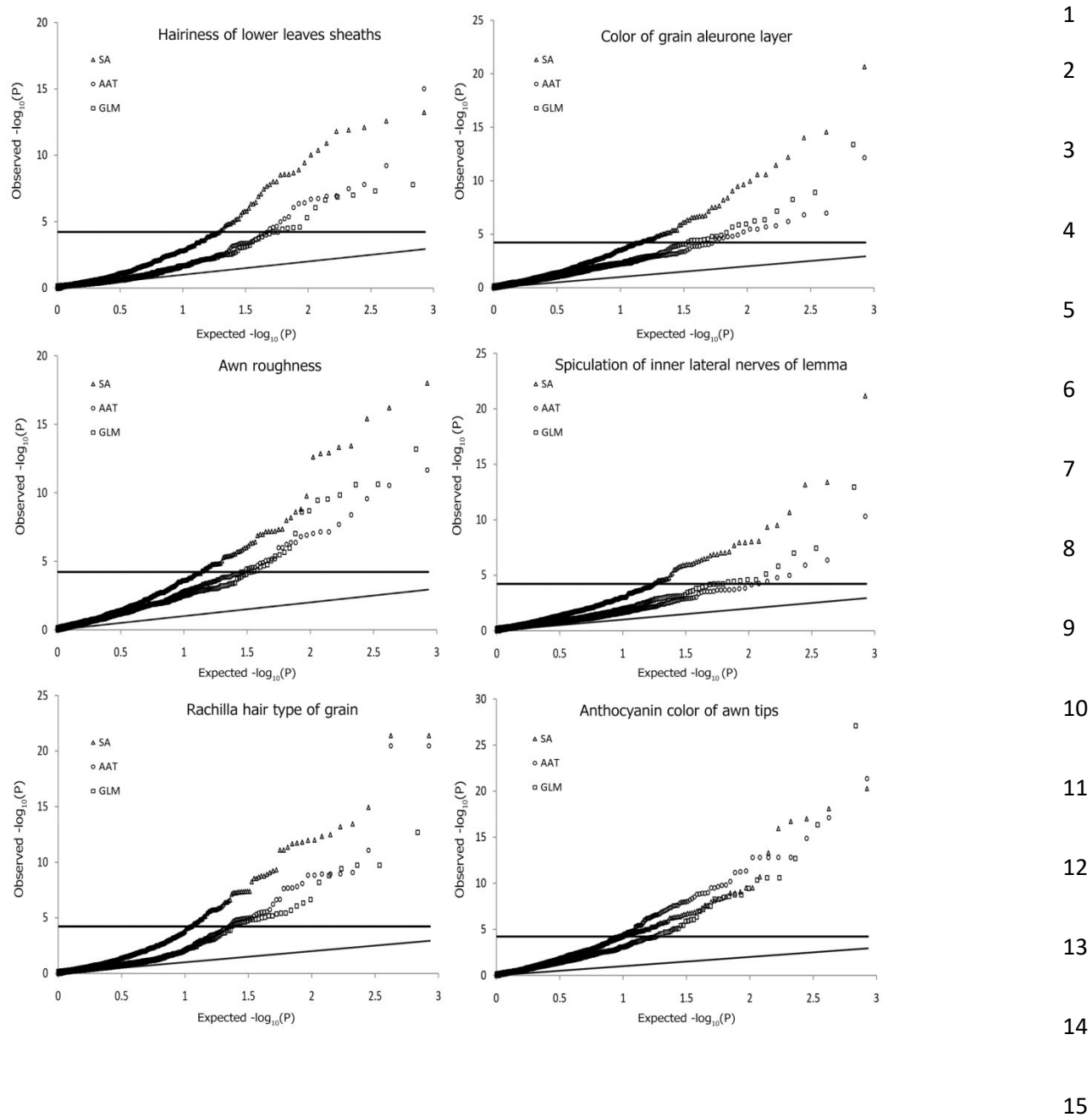


Figure S3. Q-Q plots for six binary traits obtained from three GLM (square), AAT (circle), and SA (triangle) analyses in which expected vs. observed p values are plotted. The $x = y$ line and Bonferroni corrected $p = 0.05$ significance threshold ($y = 4.22$) are indicated