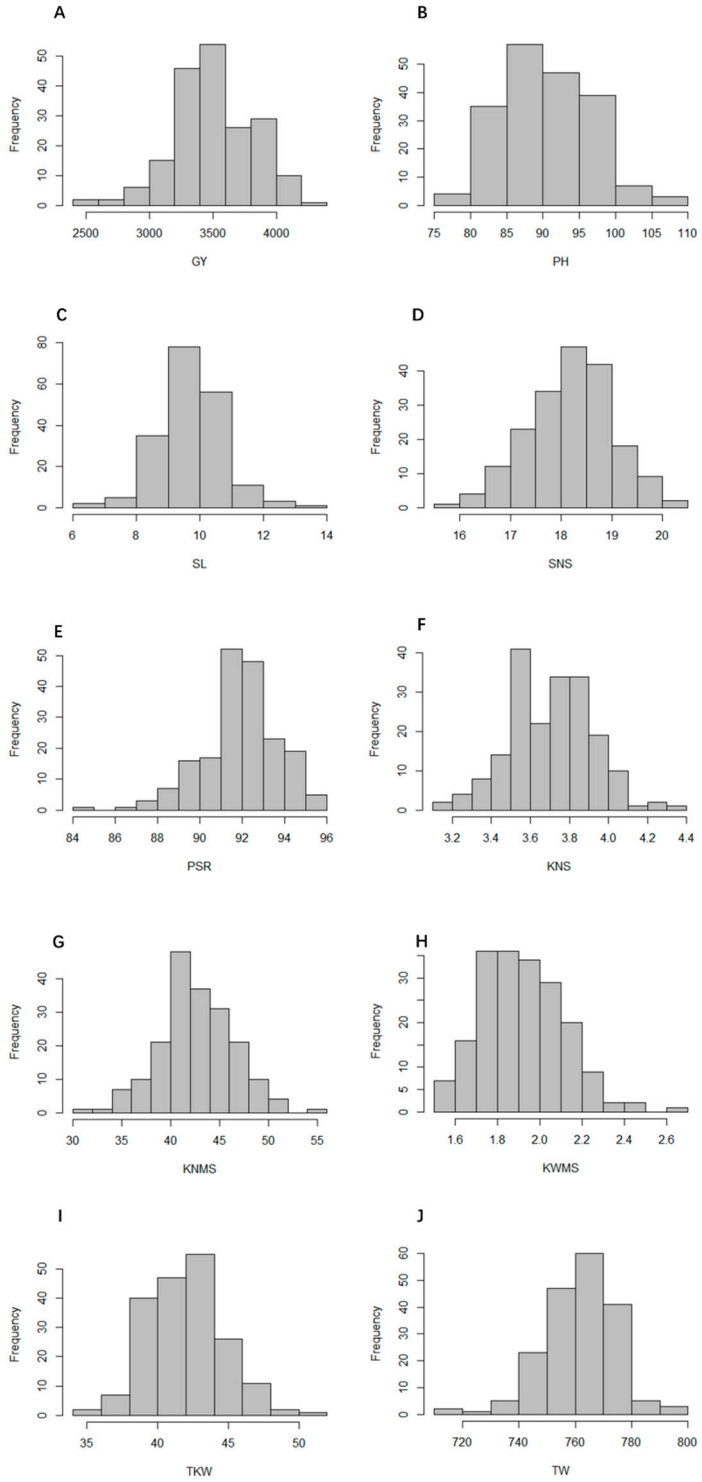
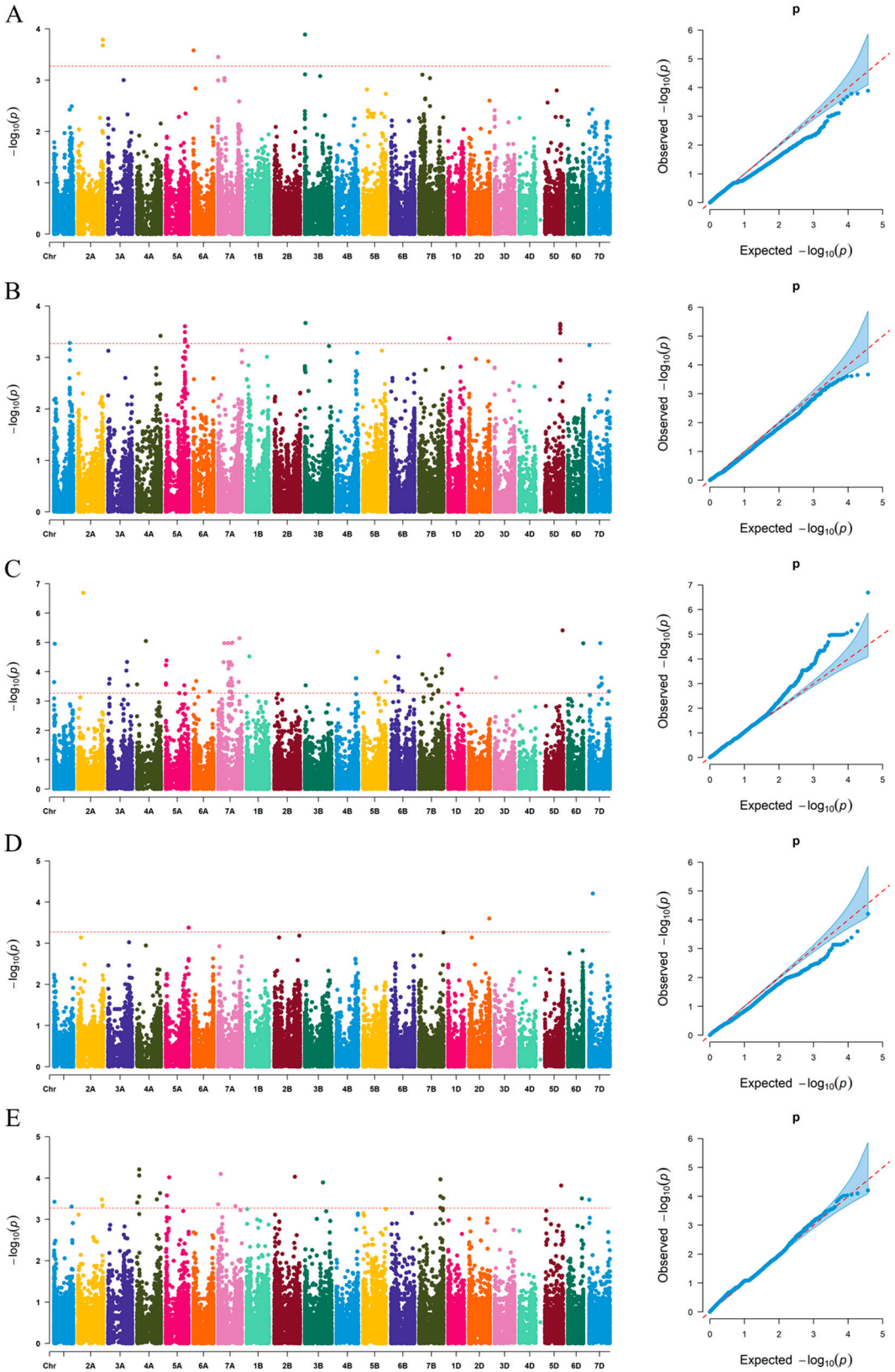


Figure. S1 Frequency distributions of BLUP values of yield and yield-related traits in 192 spring wheat cultivars. GY, grain yield; PH, plant height; SL, spike length; SNS, spikelet number of spike; PSR, productive spikelet rate; KNS, kernel number per spikelet; KNMS, kernel number per main spike; KWMS, kernel weight per main spike; TKW, thousand kernel weight; TW, test weight.


A
B
C
D
E
p
−log10(p)
Observed −log10(p)
Expected −log10(p)
Chr
2A
3A
4A
5A
6A
7A
1B
2B
3B
4B
5B
6B
7B
1D
2D
3D
4D
5D
6D
7D

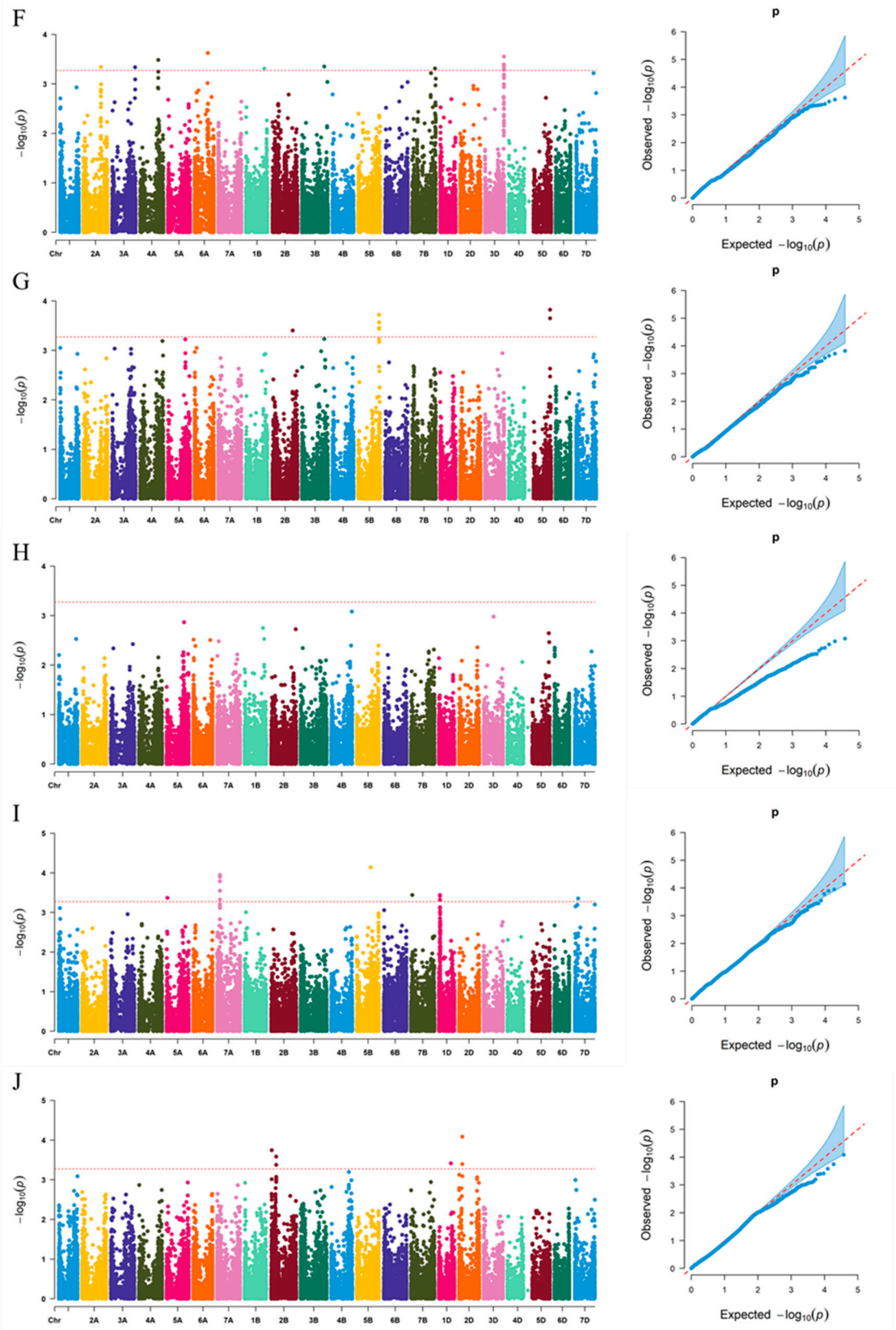


Figure S2 Manhattan and quantile-quantile (Q-Q) plots for yield and yield-related traits identified by genome-wide association analysis based on BLUP values. Horizontal line represents the significance threshold by which markers were considered associated with

a trait (≈3.38). A, grain yield (GY); B, plant height (PH); C, spike length (SL); D, spikelet number of spike (SNS); E, productive spikelet rate (PSR); F, kernel number per spikelet (KNS); G, kernel number per main spike (KNMS); H, kernel weight per main spike (KWMS); I, thousand kernel weight (TKW); J, test weight (TW).

Table S1 The names and origins of the 192 entries in the association panel

Name	Origin	Name	Origin	Name	Origin
Hongchun wheat	China	2002－59	China	Mengmai 2	China
Fenzhi Wheat	China	SD09－6	China	Nanda 2419	China
Huangkubanke	China	2002-2	China	Ningchun 23	China
Bolan wheat	China	SD05-3	China	Ningchun 32	China
Heitou wheat	China	SD04-6	China	Ningchun 33	China
Fenzhiheimang	China	2002-79	China	Ningchun 35	China
Lankelanmang	China	2001-72	China	Ningchun 37	China
Foshou wheat	China	2000-52	China	Ningchun 39	China
Spring wheat	China	2002-54	China	Ningchun 4	China
Aketuohaer	China	2001-96	China	Qingchun 202	China
Abo	China	CB035	China	Shanxichaodasui	China
Achun 2	China	2002-68	China	Wuchun 3	China
Bachun 5	China	2002-87	China	Xinshuguang 1	China
Bachun 6	China	2001-93	China	Yinchun 2	China
Bachun 9	China	2001-61	China	Yong 753	China
Cangchun 3	China	05-1	China	Yongliang 15	China
Cangchun 4	China	Xinong 2000-6	China	Yulan wheat	China
Cangchun 6	China	0727	China	Yumai 11	China
Hongxingchun wheat	China	Kanghan 1	China	Yumai 39	China
Jiefang 2	China	93－1	China	Zhong 8423	China
Kashibaipi	China	35－2	China	Zhongyin 4	China
Niurui F70	China	2003－6	China	Zifan 3	China
Ourou	China	90-210	China	Heimang	China
Qichun 5	China	93-104	China	Baiguangtou	China
Tuchun 6	China	Y20	China	Muxianbang	China
Tuchun 9	China	Alibidong 43	China	Gedatou	China
Yichun 4	China	Bafeng 5	China	Jinbaoyin	China
Zhongzuo 8131	China	Bainong 606	China	Lan wheat	China
Xinchun 2	China	Ding 8654	China	Baichun wheat	China
Xinchun 3	China	Dongnong 121	China	Wumang Wheat	China
Xinchun 4	China	Dongnong 122	China	Dabai Wheat	China
Xinchun 5	China	Dongnong 123	China	Birebashaer	China
Xinchun 6	China	Du 4	China	Liangshan wheat	China
Xinchun 7	China	Fan 6	China	Heikubanke	China
Xinchun 8	China	Fengmai 24	China	Zhimang	China
Xinchun 9	China	Fengmai 27	China	Dao wheat	China

Xinchun 10	China	Ganchun 11	China	Baimanghong wheat	China
Xinchun 11	China	Ganmai 29	China	Gumaerhan	China
Xinchun 12	China	Gaoyuan 448	China	Kelahei wheat	China
Xinchun 13	China	Gaoyuan 506	China	Aji Wheat	China
Xinchun 14	China	V028	China	Baitulike	China
Xinchun 15	China	Gaoyuandali	China	Xizhang wheat	China
Xinchun 16	China	Gongjiao 1	China	Qilike	China
Xinchun 17	China	Guandong 107	China	Maishenchun wheat	China
Xinchun 18	China	Jinshajiang 1	China	Guerhanman	China
Xinchun 19	China	Jinshajiang 3	China	Akeyazigan	China
Xinchun 20	China	Jinshajiang 5	China	Tulike	China
Xinchun 21	China	Jin 2148	China	Kezimaike	China
Xinchun 22	China	Jinchun 13	China	Mimaimier	China
Xinchun 23	China	Jinchun 15	China	Datoulang	China
Xinchun 24	China	Jing 3494	China	Xiaobaimang	China
Xinchun 25	China	Jing 3500	China	Xiaohongmang	China
Xinchun 26	China	Jing 3592	China	Xiaohong wheat	China
Xinchun 27	China	Jing 4414	China	Baijinbaoyin	China
Xinchun 28	China	Jingchun 9702	China	Tuolike	China
Xinchun 29	China	Jinghong 10	China	Hongjinbaoyin	China
Xinchun 30	China	Jinghong 3504	China	Hongsuiwumang	China
Xinchun 31	China	Kechun 14	China	Akejiake	China
Xinchun 32	China	Liaochun 10	China	Ye wheat	China
Xinchun 33	China	Longmai 26	China	Tuhulu	China
Xinchun 34	China	Lvyeshu	China	Cangmai 2	China
Xinchun 35	China	Menghua 1	China	Jiuchun 2	China
Xinchun 36	China	Mengjian 4	China	Qingchun 5	China
6－45	China	Mengjian 6	China	Mengmai 1	China

Table S2 Analysis of variance for yield and yield components of Chinese spring wheat.

Source of variance	Sum of squares									
	GY	PH	SL	SNS	PSR	KNS	KNMS	KWMS	TKW	BW
genotypes	7455***	361***	6.17***	8.1***	27.2***	0.381***	160***	0.51***	73***	1725***
Locations	863661***	90882***	300.13***	1038***	521.4***	16.949***	19166***	45***	6746***	191635***
Years	78016***	546	61.54***	0.1	419.6***	3.52***	2095***	5.01***	89*	7954***
Genotypes x Environments	3021***	42	0.85*	1.7	8.9	0.122	53	0.16	14	566
Genotypes x Years	1214	65	0.71	1.9	8.5	0.144	42	0.14	10	406
Residual	1691	202	0.65	1.7	10	0.125	68	0.21	16	475

GY, grain yield; PH, plant height; SL, spike length; SNS, spikelet number of spike; PSR, productive spikelet rate; KNS, kernel number per spikelet; KNMS, kernel number per main spike; KWMS, kernel weight per main spike; TKW, thousand kernel weight; TW, test weight.

Table S3 Significant SNPs associated with yield and yield-related traits by genome-wide association study based on BLUP values

Trait	Marker	Chromosome	Position(bp)	*P*-value	R^2(%)
GY	*wsnp_Ex_c63909_62932893*	2A	764103255	1.62E-04	8.11
	wsnp_Ex_c63909_62932669	2A	764104372	1.64E-04	8.09
	wsnp_Ex_c63909_62932437	2A	764104790	2.10E-04	7.67
	BS00090253_51	6A	6735158	2.63E-04	9.04
	BS00109912_51	7A	653949	3.54E-04	8.97
	BS00062677_51	3B	4468969	1.29E-04	8.06
PH	*wsnp_Ex_c534_1058778*	1A	480831300	5.23E-04	6.65
	Excalibur_c2827_227	4A	726446463	3.81E-04	6.86
	wsnp_Ex_c621_1231444	5A	591156150	4.94E-04	6.61
	wsnp_Ex_c2185_4094843	5A	593173030	3.22E-04	7.06
	RAC875_rep_c109969_119	5A	593332277	4.88E-04	6.61
	wsnp_Ex_c44164_50292954	5A	593334252	2.47E-04	7.36
	wsnp_Ex_rep_c109532_92292121	5A	595037357	4.44E-04	8.45
	BS00104107_51	3B	22130062	2.14E-04	9.39
	BS00022595_51	1D	38781555	4.23E-04	8.79
	Excalibur_c24051_502	5D	473342851	2.23E-04	7.44
	GENE-2794_70	5D	473794273	2.46E-04	7.36
	BS00066447_51	5D	473795001	3.36E-04	7.00
	wsnp_RFL_Contig2265_1693968	5D	473796494	2.83E-04	7.19
SL	*Tdurum_contig12156_160*	1A	102	2.28E-04	7.72
	RAC875_c37934_285	1A	20977423	1.12E-05	10.81
	IACX596	2A	165849288	2.05E-07	15.39
	CAP8_c1702_71	3A	36229048	2.55E-04	7.36
	wsnp_CAP12_c2692_1286812	3A	36229048	2.55E-04	7.36
	RAC875_c584_303	3A	50889699	1.76E-04	7.76
	Tdurum_contig31037_205	3A	571407364	9.12E-05	8.46
	Tdurum_contig11714_304	3A	585937902	4.64E-05	11.15
	Tdurum_contig42827_1693	3A	614759902	2.92E-04	7.49
	RAC875_c16277_737	4A	6932724	2.73E-04	7.44
	Tdurum_contig42087_1941	4A	277890095	8.99E-06	11.04
	Ku_c9559_737	5A	8243302	2.50E-04	7.37
	wsnp_Ku_c9559_15999945	5A	8243340	2.77E-04	7.27
	Excalibur_c36501_188	5A	9325567	5.99E-05	8.92
	Tdurum_contig50875_569	5A	25704286	4.13E-05	9.34
	Tdurum_contig10759_260	5A	573813835	2.91E-04	7.21
	BS00109922_51	6A	4678762	3.82E-04	6.92
	Tdurum_contig29137_347	6A	87247380	2.09E-04	7.73
	TA005759-0353	6A	494469681	4.74E-04	6.81
	BS00022369_51	7A	169038205	4.69E-05	9.39
	Kukri_c17556_411	7A	195308345	1.06E-05	10.84
	Excalibur_c16401_1664	7A	304440094	1.06E-05	10.84
	Excalibur_c37700_1016	7A	314410774	2.55E-04	9.44
	RAC875_rep_c105853_75	7A	316537355	1.06E-05	10.84
	wsnp_Ku_c48323_54539687	7A	316537355	2.92E-04	7.49
	wsnp_Ra_c250_526345	7A	321659147	7.72E-05	8.88

Excalibur_c1247_306	7A	321659610	1.06E-05	10.84
Ex_c68102_201	7A	323445753	4.69E-05	9.39
wsnp_Ex_c3456_6336435	7A	328988485	2.92E-04	7.49
RAC875_c25834_506	7A	333104149	2.92E-04	7.49
BS00077560_51	7A	335969547	4.69E-05	9.39
wsnp_Ex_rep_c69132_68043811	7A	336757620	4.69E-05	9.39
BS00063933_51	7A	341031768	5.93E-05	10.85
Excalibur_rep_c67835_488	7A	343846344	2.92E-04	7.49
RAC875_c53177_101	7A	343951823	4.69E-05	9.39
Ex_c38707_1039	7A	344679586	2.92E-04	7.49
BS00079591_51	7A	357987389	4.75E-04	6.76
RAC875_rep_c70756_1009	7A	359052318	2.21E-04	7.51
wsnp_Ex_rep_c68227_67012082	7A	359052318	2.45E-04	7.60
Ex_c7569_919	7A	365463900	2.92E-04	7.49
Tdurum_contig31407_132	7A	369529223	2.92E-04	7.49
BS00040156_51	7A	377980995	4.69E-05	9.39
Ra_c40378_557	7A	377981255	2.92E-04	7.49
RAC875_c58527_91	7A	393772979	4.74E-04	6.76
BS00065647_51	7A	401425963	1.67E-04	7.98
Ex_c41740_166	7A	410730462	5.01E-04	8.65
Ra_c9151_404	7A	413118641	2.92E-04	7.49
Ra_c9151_770	7A	413119089	2.92E-04	7.49
Ra_c1333_616	7A	419033966	1.06E-05	10.84
Ra_c19230_1446	7A	426572630	2.92E-04	7.49
Ex_c21222_313	7A	427618281	5.86E-05	10.95
RAC875_rep_c111703_561	7A	428342099	2.92E-04	7.49
RAC875_c29533_594	7A	431251182	2.24E-04	7.65
Tdurum_contig49723_593	7A	435727291	2.92E-04	7.49
wsnp_Ex_c11228_18162713	7A	438170676	3.01E-04	7.18
RAC875_c42827_140	7A	445308166	1.03E-05	10.93
BobWhite_c15497_199	7A	635495885	2.25E-04	7.49
Tdurum_contig8615_683	7A	657020668	7.25E-06	11.27
Tdurum_contig42087_1199	1B	84957263	3.00E-05	9.74
Tdurum_contig82242_224	3B	24788347	2.92E-04	7.49
BS00022430_51	4B	599399623	1.67E-04	8.02
BS00068540_51	4B	611505857	1.67E-04	9.64
Tdurum_contig13784_824	5B	451179330	2.09E-05	10.09
Tdurum_contig59631_417	5B	702941759	2.21E-04	7.51
wsnp_Ex_c7907_13427724	6B	118967499	1.47E-04	7.95
Kukri_c30551_400	6B	223257837	1.69E-04	7.96
Tdurum_contig35251_485	6B	226361465	4.08E-04	7.03
Excalibur_c36650_1557	6B	226362930	3.20E-04	7.33
CAP11_c763_391	6B	228242555	3.11E-05	9.64
JD_c16328_271	6B	349458436	4.58E-04	6.73
Tdurum_contig9751_987	7B	102780200	1.22E-04	8.43
Tdurum_contig12404_620	7B	220131306	1.76E-04	7.76
Ra_c64159_480	7B	296342080	2.92E-04	7.49
BS00066536_51	7B	323850140	2.92E-04	7.49
BS00064189_51	7B	361569890	2.92E-04	7.49
wsnp_Ex_rep_c70294_69236911	7B	371037840	2.92E-04	7.49

	CAP8_rep_c3680_203	7B	512354151	1.44E-04	9.90
	RAC875_c570_302	7B	591703260	4.80E-04	6.69
	IACX1805	7B	592362559	4.30E-04	6.79
	Tdurum_contig45585_432	7B	700818624	1.11E-04	10.13
	Tdurum_contig17062_665	7B	700827651	7.91E-05	11.38
	Excalibur_c22642_90	1D	20056978	2.70E-05	10.21
	IAAV5588	1D	424736692	3.99E-04	9.06
	Tdurum_contig29847_479	3D	39301128	1.58E-04	7.86
	BobWhite_c13718_682	5D	543058038	3.89E-06	14.20
	D_GBB4FNX01C3F21_57	6D	471002720	1.08E-05	10.88
	wsnp_Ra_c20371_29633358	7D	296503898	3.25E-04	9.07
	RAC875_c7862_1205	7D	339785114	1.06E-05	10.84
	RAC875_rep_c73101_689	7D	355562660	2.92E-04	7.49
	wsnp_Ex_rep_c70294_69237001	7D	376089968	1.59E-04	7.92
	BS00065352_51	7D	386599450	2.56E-04	9.70
	Kukri_c76449_186	7D	608207227	4.70E-04	8.65
SNS	*CAP12_c1272_334*	5A	704515225	4.16E-04	7.01
	Tdurum_contig56321_232	2D	627978388	2.51E-04	7.48
	Ku_c28770_469	7D	110888815	6.21E-05	8.83
PSR	*Kukri_c24962_123*	1A	9981126	3.77E-04	8.96
	BobWhite_c23632_322	1A	539762811	4.94E-04	8.40
	wsnp_Ex_c11827_18986376	2A	733922282	3.32E-04	7.02
	RAC875_rep_c102485_468	2A	758397306	4.63E-04	8.81
	Tdurum_contig1868_249	4A	11711023	3.93E-04	6.88
	Ra_c108749_837	4A	70798652	6.20E-05	10.76
	wsnp_Ex_rep_c66426_64644630	4A	70813286	8.68E-05	10.32
	wsnp_Ku_c49919_55679171	4A	71253251	2.80E-04	7.18
	BobWhite_c35402_66	4A	614241032	3.28E-04	8.77
	Kukri_c1056_1786	4A	714193193	2.33E-04	7.37
	BS00081120_51	5A	35822927	2.64E-04	7.30
	RAC875_rep_c72709_270	5A	36012373	4.97E-04	6.59
	BS00045284_51	5A	109342918	9.62E-05	10.30
	BobWhite_c232_563	7A	1242408	4.32E-04	8.81
	BS00074229_51	7A	82936732	7.95E-05	8.57
	BS00080365_51	7A	537058999	4.78E-04	8.41
	BobWhite_c19554_544	2B	637574105	9.32E-05	10.40
	RAC875_c6921_1276	3B	556682737	1.28E-04	8.08
	Excalibur_rep_c74234_183	7B	654949817	2.77E-04	9.02
	BS00064146_51	7B	655818477	5.27E-04	6.55
	wsnp_BE6051911_Ta_2_1	7B	657872679	1.08E-04	10.07
	Excalibur_c49685_207	7B	744260654	3.07E-04	7.22
	Kukri_c36429_687	5D	503211071	1.52E-04	9.69
	Excalibur_c38512_265	6D	428252011	3.11E-04	7.07
	BobWhite_c986_263	7D	5336938	3.35E-04	7.15
KNS	*BS00041707_51*	2A	564265261	4.54E-04	6.24
	Excalibur_c51312_218	3A	733044300	4.62E-04	6.24
	Kukri_c4954_664	4A	578537504	3.28E-04	6.55
	Kukri_c56494_585	6A	425737504	2.38E-04	6.88
	BS00040743_51	1B	589976803	4.90E-04	6.19
	Kukri_c4857_3311	3B	710964440	4.46E-04	6.25

	BobWhite_c25708_334	7B	727634303	4.88E-04	6.27
	Kukri_c14943_753	3D	602797481	4.04E-04	6.48
	RAC875_c31922_138	3D	603414487	4.69E-04	6.23
	RAC875_c61950_377	3D	604358441	2.80E-04	6.87
	Kukri_c23354_183	3D	604368095	4.31E-04	6.44
	wsnp_Ex_c14027_21925404	3D	604671735	5.17E-04	6.16
KNMS	*Tdurum_contig35492_150*	2B	647109508	3.97E-04	6.63
	BS00032082_51	5B	670831094	3.65E-04	6.78
	RAC875_c54392_94	5B	671094436	1.90E-04	7.58
	wsnp_BE446509B_Ta_2_6	5B	671094759	2.70E-04	7.05
	Ku_c22523_598	5B	671192911	3.50E-04	6.79
	Kukri_c23100_568	5D	531889534	2.25E-04	7.22
	CAP7_c1979_79	5D	531893232	1.51E-04	7.66
TKW	*Tdurum_contig50875_569*	5A	25704286	4.27E-04	6.53
	RAC875_rep_c105041_121	7A	92892087	1.63E-04	9.72
	Ex_c6196_971	7A	92892096	2.84E-04	6.93
	Excalibur_c6196_668	7A	92892399	1.13E-04	7.92
	RFL_Contig2200_1024	7A	93036212	1.27E-04	7.81
	wsnp_Ex_c20062_29096408	7A	93077391	4.73E-04	8.42
	Tdurum_contig13784_824	5B	451179330	7.21E-05	8.36
	RAC875_rep_c105584_237	7B	43881084	3.65E-04	6.77
	BS00108305_51	1D	33640474	3.64E-04	6.71
	BS00002178_51	1D	33712312	4.81E-04	6.44
	Kukri_rep_c112035_340	1D	37221137	3.84E-04	6.66
	Kukri_c20975_765	7D	101580773	4.45E-04	8.58
TW	*GENE-1018_99*	2B	17783428	1.80E-04	7.95
	wsnp_Ex_c9248_15372536	2B	158618930	4.22E-04	6.92
	BS00092273_51	2B	158622283	2.63E-04	7.47
	IAAV3049	1D	384511578	3.86E-04	8.92
	GENE-1389_396	2D	109700911	8.21E-05	10.82
	Kukri_c22200_1171	2D	109702498	4.02E-04	7.06

GY, grain yield; PH, plant height; SL, spike length; SNS, spikelet number of spike; PSR, productive spikelet rate; KNS, kernel number per spikelet; KNMS, kernel number per main spike; TKW, thousand kernel weight; TW, test weight.

Table S4 Candidate genes identified by genome-wide association study

Trait	SNP	Annotation	Candidate gene	Protein name
GY	*BS00109912_51*	CDS	*TraesCS7A02G000936*	
PH	*RAC875_rep_c112729_702*	intron	*TraesCS7D02G018900*	RGA4
	Kukri_c31479_147	CDS	*TraesCS5A02G370700*	GTD-binding domain-containing protein
	BS00081949_51	CDS	*TraesCS7A02G565100*	Pathogenesis-related protein 1-15
	wsnp_Ex_c621_1231444	CDS	*TraesCS5A02G396400*	
	RAC875_rep_c109969_119	intron	*TraesCS5A02G400400*	Alpha-N-acetylglucosaminidase
	wsnp_Ex_c2185_4094843	CDS	*TraesCS5A02G400100*	CKA1, CKA2, HD6
	wsnp_Ex_c44164_50292954	CDS	*TraesCS5A02G400400*	Alpha-N-acetylglucosaminidase
	wsnp_Ex_rep_c109532_92292121	3′-UTR	*TraesCS5A02G402400*	
	BobWhite_c15758_79	3′-UTR	*TraesCS5A02G402700*	BOS complex subunit TMEM147
	Excalibur_c24051_502	CDS	*TraesCS5D02G409800*	J domain-containing protein
	GENE-2794_70	intron	*TraesCS5D02G410400*	Alpha-N-acetylglucosaminidase
	BS00066447_51	intron	*TraesCS5D02G410400*	Alpha-N-acetylglucosaminidase
	wsnp_RFL_Contig2265_1693968	CDS	*TraesCS5D02G410400*	Alpha-N-acetylglucosaminidase
	Excalibur_c31769_793	intergenic		
	Tdurum_contig29286_319	CDS	*TraesCS5B02G409900*	Protein PHLOEM PROTEIN 2-LIKE A10
SL	*RAC875_c37934_285*	3′-UTR	*TraesCS1A02G037900*	Uncharacterized protein
	IACX596	CDS	*TraesCS2A02G195900*	WNK1
	Tdurum_contig31037_205	3′-UTR	*TraesCS3A02G326100*	FBD domain-containing protein
	Tdurum_contig11714_304	intergenic		
	Tdurum_contig42087_1941	3′-UTR	*TraesCS4A02G148300*	Uncharacterized protein
	Ku_c9559_737	CDS	*TraesCS5A02G012600*	ERD4
	wsnp_Ku_c9559_15999945	CDS	*TraesCS5A02G012600*	ERD4
	Excalibur_c36501_188	CDS	*TraesCS5A02G013400*	Hydroxyproline-rich glycoprotein family protein
	Tdurum_contig10759_260	CDS	*TraesCS5A02G376100*	

BS00109922_51	CDS	*TraesCS6A02G010200*	RHS16, BRL2,
Excalibur_c37700_1016	CDS	*TraesCS7A02G283100*	
wsnp_Ex_c7907_13427724	CDS	*TraesCS6B02G124000*	Helicase ATP-binding domain-containing protein
Kukri_c30551_400	intergenic		
Tdurum_contig35251_485	CDS	*TraesCS6B02G192000*	TPX2 C-terminal domain-containing protein
Excalibur_c36650_1557	3′-UTR	*TraesCS6B02G192000*	TPX2 C-terminal domain-containing protein
CAP11_c763_391	CDS	*TraesCS6B02G193400*	Lipoxygenase, LOX2.3
Tdurum_contig45585_432	3′-UTR	*TraesCS7B02G433300*	MRH domain-containing protein
Tdurum_contig17062_665	CDS	*TraesCS7B02G433400*	Amino acid transporter AVT6E
Excalibur_c22642_90	CDS	*TraesCS1D02G041400*	PHIP1
BobWhite_c13718_682	exon	*TraesCS5D02G522400*	Uncharacterized protein
D_GBB4FNX01C3F21_57	CDS	*TraesCS6D02G402700*	Cell morphogenesis protein N-terminal domain-containing protein
Excalibur_c56319_61	CDS	*TraesCS7A02G465500*	Uncharacterized protein
RAC875_c525_1372	CDS	*TraesCS7B02G500300*	Prolyl endopeptidase
RAC875_c104604_381	CDS		
D_contig37514_120	intron	*TraesCS7D02G449900*	ARF17
tplb0049k01_89	intergenic		
Kukri_c22576_148	3′-UTR	*TraesCS7D02G450800*	3-hydroxyisobutyrate dehydrogenase
tplb0041e14_1096	CDS	*TraesCS7D02G450800*	3-hydroxyisobutyrate dehydrogenase
Excalibur_c7895_385	CDS	*TraesCS7D02G451000*	RING-CH-type domain-containing protein
D_GBB4FNX02ILZW2_114	CDS	*TraesCS7D02G451200*	Uncharacterized protein
BobWhite_c11549_468	CDS	*TraesCS7D02G451300*	Protein kinase domain-containing protein
Kukri_c101311_72	intergenic		
Kukri_c61816_202	CDS	*TraesCS7D02G451500*	PIRL4, PIK-2
D_contig25474_188	intron	*TraesCS7D02G451900*	Metal transporter
Excalibur_c16804_1108	CDS	*TraesCS7D02G453000*	Uncharacterized protein
tplb0057p21_1365	3′-UTR	*TraesCS7D02G453800*	Anaphase-promoting complex subunit 4-like WD40 domain-containing protein

	tplb0057p21_1042	CDS	*TraesCS7D02G453800*	Anaphase-promoting complex subunit 4-like WD40 domain-containing protein
	BobWhite_c22580_115	CDS	*TraesCS4B02G314000*	Methyltransferase-like protein 1
	tplb0032k20_90	CDS	*TraesCS7D02G030700*	GSTU6
PSR	*wsnp_Ex_c11827_18986376* *Kukri_c24962_123*	3′-UTR intergenic	*TraesCS2A02G505800*	CPR
	BobWhite_c23632_322	CDS	*TraesCS1A02G356900*	Choline kinase N-terminal domain-containing protein
	RAC875_rep_c102485_468 *Ra_c108749_837*	CDS intergenic	*TraesCS2A02G552000*	Vacuolar protein sorting-associated protein 41 homolog
	wsnp_Ex_rep_c66426_64644630	CDS	*TraesCS4A02G072600*	SANT domain-containing protein
	wsnp_Ku_c49919_55679171	CDS	*TraesCS4A02G072800*	Translocase of chloroplast
	BobWhite_c35402_66	3′-UTR	*TraesCS4A02G328900*	FRIGIDA-like protein
	BS00045284_51	CDS	*TraesCS5A02G083600*	UNC93-like protein 3
	BS00080365_51	3′-UTR	*TraesCS7A02G362900*	Elongation factor 1-gamma 2
	BobWhite_c19554_544 *RAC875_c6921_1276*	CDS intergenic	*TraesCS2B02G444700*	Uncharacterized protein
	Excalibur_c49685_207 *Kukri_c36429_687*	CDS intergenic	*TraesCS7B02G491700*	NB-ARC domain-containing protein
KNS	*Kukri_c56494_585*	intergenic		
KNMS	*Tdurum_contig35492_150* *Tdurum_contig4885_1307* *Tdurum_contig4885_1833*	CDS intergenic intergenic	*TraesCS2B02G453400*	CUE domain-containing protein
TKW	*RAC875_rep_c105041_121*	CDS	*TraesCS7A02G141300*	H(+)-exporting diphosphatase
	Ex_c6196_971	CDS	*TraesCS7A02G141300*	H(+)-exporting diphosphatase
	Excalibur_c6196_668	CDS	*TraesCS7A02G141300*	H(+)-exporting diphosphatase
	RFL_Contig2200_1024 *wsnp_Ex_c20062_29096408*	CDS intergenic	*TraesCS7A02G141500*	Nodulin-like domain-containing protein
	Tdurum_contig13784_824	CDS	*TraesCS5B02G266700*	DNA-directed RNA polymerase RBP11-like dimerisation domain-containing protein

	RAC875_rep_c105584_237	CDS	*TraesCS7B02G044200*	Acyl-coenzyme A oxidase
	Kukri_c20975_765	CDS	*TraesCS7D02G153200*	Uncharacterized protein
	Tdurum_contig49575_1237	CDS	*TraesCS7D02G526100*	Mediator complex subunit 15 KIX domain-containing protein
TW	*IAAV3049*	CDS	*TraesCS1D02G286300*	phosphatidate phosphatase
	GENE-1389_396	intron	*TraesCS2D02G165200*	Genome assembly, chromosome: II

GY, grain yield; PH, plant height; SL, spike length; PSR, productive spikelet rate; KNS, kernel number per spikelet; KNMS, kernel number per main spike; TKW, thousand kernel weight; TW, test weight

Table S5 *P*-values of *t*-tests for the efficacy of different alleles on yield-related traits

Trait	SNP	Allele		Number		*P*_value					
						2012ES	2012SHZ	2012ZS	2013ES	2013SHZ	2013ZS
GY	*BS00109912_51*	CC	TT	22	114	0.771	0.001	0.081	0.455	0.009	——
PH	*RAC875_rep_c112729_702*	CC	TT	118	4	0.378	0.808	0.533	0.726	0.990	0.104
	Kukri_c31479_147	CC	TT	17	121	0.122	0.000	0.463	0.558	0.068	0.463
	BS00081949_51	AA	GG	102	37	0.720	0.054	0.346	0.968	0.522	0.544
	wsnp_Ex_c621_1231444	CC	TT	106	33	0.010	0.000	0.578	0.008	0.000	0.000
	RAC875_rep_c109969_119	CC	TT	37	102	0.001	0.000	0.215	0.001	0.000	0.000
	wsnp_Ex_c2185_4094843	CC	TT	104	35	0.004	0.000	0.413	0.012	0.000	0.000
	wsnp_Ex_c44164_50292954	GG	TT	104	36	0.001	0.000	0.369	0.007	0.000	0.000
	wsnp_Ex_rep_c109532_92292121	AA	AG	106	32	0.002	0.682	0.455	0.008	0.000	0.000
	BobWhite_c15758_79	AA	GG	29	110	0.003	0.700	0.697	0.015	0.000	0.000
	Excalibur_c24051_502	CC	TT	35	104	0.004	0.000	0.413	0.012	0.000	0.000
	GENE-2794_70	AA	GG	36	103	0.001	0.000	0.315	0.008	0.000	0.000
	BS00066447_51	AA	GG	103	37	0.002	0.000	0.211	0.003	0.000	0.000
	wsnp_RFL_Contig2265_1693968	AA	GG	36	104	0.001	0.000	0.369	0.007	0.000	0.000
	Excalibur_c31769_793	CC	TT	35	104	0.004	0.001	0.413	0.003	0.000	0.000
	Tdurum_contig29286_319	CC	TT	107	31	0.016	0.008	0.854	0.074	0.001	0.000
SL	*RAC875_c37934_285*	AA	GG	2	136	0.083	0.000	0.306	0.130	0.033	0.034
	IACX596	CC	TT	137	1	0.002	0.000	——	0.004	——	——
	Tdurum_contig31037_205	AA	GG	134	4	0.247	0.011	0.971	0.809	0.422	0.036
	Tdurum_contig11714_304	AA	GG	3	135	0.205	0.924	0.888	0.501	0.176	0.033
	Tdurum_contig42087_1941	CC	TT	136	2	0.835	0.000	0.854	0.749	0.324	0.108
	Ku_c9559_737	AA	GG	8	130	0.322	0.132	0.888	0.336	0.082	0.049
	wsnp_Ku_c9559_15999945	GG	TT	130	8	0.322	0.137	0.888	0.336	0.082	0.049
	Excalibur_c36501_188	AA	GG	6	132	0.208	0.022	0.847	0.409	0.117	0.145
	Tdurum_contig10759_260	CC	TT	136	2	0.676	0.000	0.592	0.484	0.375	0.240
	BS00109922_51	AA	GG	1	137	0.437	0.000	0.847	0.800	0.965	0.353

	Excalibur_c37700_1016	AA	GG	135	2	0.063	0.014	0.420	0.281	0.296	0.421
	wsnp_Ex_c7907_13427724	CC	TT	40	97	0.009	0.911	0.776	0.197	0.017	0.006
	Kukri_c30551_400	CC	TT	3	135	0.815	0.000	0.800	0.511	0.336	0.515
	Tdurum_contig35251_485	AA	GG	3	135	0.815	0.000	0.800	0.511	0.336	0.515
	Excalibur_c36650_1557	CC	TT	135	3	0.815	0.000	0.800	0.511	0.336	0.515
	CAP11_c763_391	GG	TT	137	1	0.284	0.000	0.947	0.480	0.178	0.182
	Tdurum_contig45585_432	CC	TT	2	135	0.969	0.179	0.606	0.544	0.214	0.230
	Tdurum_contig17062_665	CC	TC	100	29	0.489	0.565	0.054	0.783	0.970	0.645
	Excalibur_c22642_90	AA	GG	1	137	0.010	0.023	0.781	0.224	0.028	0.977
	BobWhite_c13718_682	AG	GG	110	23	0.752	0.107	0.351	0.441	0.965	0.847
	D_GBB4FNX01C3F21_57	CC	TT	2	136	0.020	0.000	0.180	0.019	0.246	0.408
	Excalibur_c56319_61	AA	CC	133	5	0.001	0.653	0.906	0.036	0.000	0.503
	RAC875_c525_1372	CC	TT	22	116	0.213	0.073	0.562	0.393	0.203	0.073
	RAC875_c104604_381	CC	TT	4	133	0.171	0.108	0.376	0.499	0.054	0.506
	D_contig37514_120	AA	GG	5	133	0.001	0.098	0.906	0.036	0.000	0.503
	tplb0049k01_89	GG	TT	5	133	0.010	0.098	0.906	0.036	0.000	0.503
	Kukri_c22576_148	CC	TT	5	133	0.010	0.098	0.906	0.036	0.000	0.503
	tplb0041e14_1096	CC	TT	5	132	0.001	0.603	0.909	0.036	0.000	0.511
	Excalibur_c7895_385	CC	TC	5	132	0.001	0.603	0.909	0.036	0.000	0.511
	D_GBB4FNX02ILZW2_114	CC	TT	5	133	0.001	0.604	0.906	0.036	0.000	0.503
	BobWhite_c11549_468	AA	GG	133	5	0.001	0.655	0.906	0.036	0.000	0.503
	Kukri_c101311_72	CC	TT	5	133	0.001	0.655	0.906	0.036	0.000	0.503
	Kukri_c61816_202	AA	GG	133	5	0.001	0.098	0.906	0.036	0.000	0.503
	D_contig25474_188	AA	CC	133	5	0.001	0.098	0.906	0.036	0.000	0.503
	Excalibur_c16804_1108	AA	GG	5	133	0.001	0.098	0.906	0.036	0.000	0.503
	tplb0057p21_1365	AA	GG	133	5	0.001	0.649	0.906	0.036	0.000	0.503
	tplb0057p21_1042	AA	GG	133	5	0.001	0.368	0.906	0.036	0.000	0.503
	BobWhite_c22580_115	AA	GG	108	29	0.423	0.307	0.169	0.747	0.291	0.937
	tplb0032k20_90	AA	GG	9	129	0.096	0.238	0.661	0.190	0.120	0.015
PSR	*wsnp_Ex_c11827_18986376*	GG	TT	91	49	0.025	0.015	——	0.759	0.051	——

	Kukri_c24962_123	CC	TC	46	93	0.201	0.634	——	0.307	0.977	——
	BobWhite_c23632_322	AA	GG	118	21	0.011	0.572	——	0.102	0.042	——
	RAC875_rep_c102485_468	AA	GG	7	134	0.137	0.000	——	0.151	0.399	——
	Ra_c108749_837	AA	GG	8	133	0.050	0.011	——	0.914	0.136	——
	wsnp_Ex_rep_c66426_64644630	CC	TT	133	8	0.050	0.011	——	0.914	0.136	——
	wsnp_Ku_c49919_55679171	GG	TT	8	133	0.050	0.000	——	0.914	0.136	——
	BobWhite_c35402_66	GG	TG	124	17	0.067	0.684	——	0.603	0.969	——
	BS00045284_51	GG	TT	122	18	0.187	0.003	——	0.829	0.591	——
	BS00080365_51	AA	CC	8	132	0.507	0.338	——	0.918	0.776	——
	BobWhite_c19554_544	AA	AG	132	8	0.935	0.767	——	0.216	0.846	——
	RAC875_c6921_1276	CC	TT	133	8	0.050	0.000	——	0.914	0.136	——
	Excalibur_c49685_207	CC	TT	132	4	0.391	0.000	——	0.451	0.126	——
	Kukri_c36429_687	AA	GG	17	122	0.034	0.386	——	0.004	0.083	——
KNS	*Kukri_c56494_585*	AA	CC	139	49	——	0.000	——	0.031	0.024	——
KNMS	*Tdurum_contig35492_150*	AA	GG	2	137	0.028	0.090	0.259	0.722	0.217	0.837
	Tdurum_contig4885_1307	CC	TT	1	137	0.031	0.001	0.211	0.583	0.307	0.321
	Tdurum_contig4885_1833	AA	GG	1	133	0.033	0.003	0.213	0.587	0.309	0.329
TKW	*RAC875_rep_c105041_121*	CC	TC	118	20	0.958	0.214	0.003	0.712	0.577	0.002
	Ex_c6196_971	AA	GG	118	21	0.769	0.272	0.010	0.687	0.740	0.011
	Excalibur_c6196_668	AA	GG	20	118	0.864	0.216	0.003	0.654	0.656	0.002
	RFL_Contig2200_1024	CC	TT	118	20	0.864	0.162	0.003	0.654	0.656	0.002
	wsnp_Ex_c20062_29096408	CC	TT	20	116	0.807	0.131	0.004	0.568	0.726	0.003
	Tdurum_contig13784_824	CC	TT	138	1	0.400	0.010	0.852	0.589	0.452	0.995
	RAC875_rep_c105584_237	AA	GG	118	21	0.607	0.379	0.018	0.283	0.978	0.003
	Kukri_c20975_765	AA	AG	109	28	0.024	0.083	0.107	0.068	0.338	0.073
	Tdurum_contig49575_1237	AA	GG	140	1	0.481	0.000	0.957	0.839	0.404	0.093
TW	*IAAV3049*	AG	GG	102	36	0.021	0.004	0.335	0.163	0.304	0.069
	GENE-1389_396	AA	AC	65	74	0.005	0.002	0.308	0.000	0.001	0.312

GY, grain yield; PH, plant height; SL, spike length; PSR, productive spikelet rate; KNS, kernel number per spikelet; KNMS, kernel number per

main spike; TKW, thousand kernel weight; TW, test weight

Table S6 Haplotypes with different alleles in the blocks

Trait	Chr	Interval (Mb)	Block	SNP	Haplotype		Number of cultivars	
					superior	inferior	superior	inferior
PH	5A	591-598	Block1	*CAP11_c3209_76/wsnp_Ex_c18754_27630557/wsnp_Ex_c17476_26190830/wsnp_Ku_c6977_12078791/wsnp_Ku_c6977_12078885/Excalibur_c31769_793*	CC/CC/GG/TT/AA/CC	TT/AA/AA/CC/GG/TT	45	121
			Block2	*Excalibur_c24051_1028/wsnp_Ex_c2185_4094843/RAC875_rep_c109969_119/wsnp_Ex_c44164_50292954/Excalibur_c54774_408*	GG/TT/CC/TT/TT	AA/CC/TT/GG/CC	19	113
			Block3	*RFL_Contig316_572/BobWhite_c15758_79/wsnp_Ex_c8543_14357385/JD_c15758_288/wsnp_Ex_c8543_14357051/BS00059098_51/wsnp_CAP11_rep_c4073_1924782/BS00108474_51*	AA/AA/TT/GG/AA/AA/CC/GG	GG/GG/CC/TT/CC/CC/AA/AA	30	72
	5D	470-477	Block1	*IAAV8629/Excalibur_c26671_282/Excalibur_c26671_282*	CC/GG/TT	TT/AA/CC	54	123
			block2	*Excalibur_c24051_502/GENE-2794_70/BS00066447_51/*	CC/AA/GG/AA	TT/GG/AA/GG	54	125

PH, Plant height

Key Points of Spring Wheat Planting Technology

1. Seeding time: Begin sowing when the top layer of soil thaws to a depth of 5-7cm, and ensure that the seeds are planted at a depth of 3-4cm. The sowing times for Er'shi, Shihezi, and Zhaosu in this study are February 25th, March 28th, and April 12th, respectively.

2. Seeding method: manual sowing, with a row spacing of 25 cm and a plant spacing of 10 cm. The recommended sowing amount is 20-22 kg per mu.

3. Seedling management: Water should be applied during the 3-leaf stage of wheat. On plots with a sufficient amount of base fertilizer, there is no need for topdressing during the seedling stage. When the base fertilizer amount is insufficient, apply 8-10 kg of urea per mu in combination with irrigation.

4. Management during jointing and booting period: The time between the initial watering and the second watering should not exceed 12 days to prevent the floor panels from cracking. When the second internode of wheat forms and the non-productive tillers die off, the third watering is applied, with an irrigation volume of 70-80 m^3 per mu. Apply 10-15 kg of urea per mu in conjunction with irrigation. During the jointing stage of wheat, use Cycocel spray.

5. Flowering and Maturity Period Management: The recommended irrigation amount during the wheat flowering and filling period is 70-80m3 per mu. Apply 5 kg of topdressing per mu during the heading and flowering periods. The period from wheat heading to grain filling is critical for the occurrence and damage caused by various diseases and pests, such as stripe rust and wheat aphids. Triadimefon or carbendazim should be mixed properly with pyrethroid pesticides for effective prevention and control.

6. Harvest: Harvest and vacate the land in a timely manner during the late stage of wheat ripening. The cutting height should not exceed 15 cm. The harvesting times for Er'shi, Shihezi, and Zhaosu in this study are July 8th, July 16th, and September 5th, respectively.