Supplementary Table S1 The names and disease index categories of all 169 soybean germplasms.

No.	Variety	Resistance	No.	Variety	Resistance
1	Hefeng47	MR	86	Huajiang4	S
2	Златовласка	R	87	Kenfeng16	S
3	T219H	R	88	Kenfeng22	S
4	Yongjizaodou	MR	89	Hefeng50	S
5	NO10	R	90	Hefeng55	S
6	Suinong43	MR	91	Dongnong50	S
7	Heihe33	HR	92	Jiusan14-70	S
8	Heinong56	MR	93	Dongnong42	S
9	Jiyu94	HR	94	Heihe34	S
10	Suinong26	HS	95	Heihe28	S
11	Beijiao9206	HS	96	Liao small seed2	S
12	Xiaobaidou	HS	97	Longpin13-369	S
13	Daan kidney shaped	HS	98	Jiyu105	S
14	Jiangmodou1	HS	99	Jiyu108	S
15	Longpin12-328	HS	100	Jilin small seed7	S
16	Ha14-2146	HS	101	Ha13-2413	S
17	Jizaohuang	HS	102	Ha13-2958	S
18	Silihuang	HS	103	Ha14-2028	S
19	Kenfeng18	HS	104	Changnong20	S
20	Suinong15	HS	105	Ha13-2187	S
21	HE14	HS	106	Ha12-4891	S
22	Hai6055	HS	107	Toyomosume	S
23	Nattosan	S	108	Jiyu72	S
24	Gongye03-5570	S	109	Hejiao02-69	S
25	L65-540	S	110	Magnolid(US)	S
26	L73-79	S	111	Zhonghuang35	S
27	L65-34	S	112	Zhonghuang10	S
28	L72D-4045	S	113	Heihe21	S
29	Qihuang42	S	114	Heihe23	S
30	Z13-631-2	S	115	Jihuang138	S
31	Ls15	S	116	He00-23	S
32	Z13-631-7	S	117	Heihe24	S
33	Dongda2	S	118	Jinpin42	S
34	Ls18	S	119	Jim	S
35	HLT8	S	120	Tianlong1	S
36	KeC14-732	S	121	Hefeng26	S

37	Fengshou25	S	122	Changnong17	S
38	Чернивецька9	S	123	Jinong18	S
39	Gaillard	S	124	Hefeng35	S
40	Kenfeng7	S	125	Heihe13	S
41	Suinong18	S	126	Heihe44	S
42	Kennong19	S	127	Jilin30	S
43	Hefeng40	S	128	Suinong28	S
44	Suinong14	S	129	Shennen	S
45	Jiufeng10	S	130	Beidou43	S
46	Локус	S	131	Beian1	S
47	Nenfeng20	S	132	Beidou36	S
48	Fengshou27	S	133	Hedou6	S
49	Dongnong76	S	134	Jianong1	S
50	Xingnong12	S	135	Shengdou48	S
51	Longqingdou2	S	136	Suinong44	S
52	H10-2430	S	137	Suinong27	S
53	Suinong68	S	138	Suinong29	S
54	Mushi9	S	139	Suinong50	S
55	Gongye04L-141	S	140	777	S
56	Suinong69	S	141	Suinong41	S
57	Dongsheng3	S	142	Huangjinyuan	S
58	Nong75	S	143	Tiejiazi	S
59	Dongsheng92	S	144	Niumaohuang	S
60	Longken381	S	145	Heinong44	S
61	Suinong67	S	146	Heihe50	S
62	Beijiang91	S	147	Longken332	S
63	Bindou10	S	148	LG2016-2	S
64	Sui07-1077	S	149	No.16	S
65	Ken05-3762	S	150	Heijiao1-1161	S
66	Ha06-3869	S	151	Heihe53	S
67	Ha05-7778	S	152	NT04	S
68	Chohckuzan	S	153	Boige dulotet geronne	S
69	Wangkuilianhua black bean	S	154	Fendou78	S
70	Harwood	S	155	Heijinyuan	S
71	Saikai20	S	156	Ke732	S
72	Xiaobaiqi	S	157	Tiejiasilihuang	S
73	Dalihuang	S	158	Heifu03-56	S
74	Yongfengdou	S	159	Hefeng25	S

75	Nongan sauce colored bean	S	160	Yapoche	S
76	Heihe6	S	161	H39	S
77	Hefeng29	S	162	Suinong36	S
78	Heinong37	S	163	Suinong10	S
79	Hongfeng11	S	164	Jiyu67	S
80	Beijiang1	S	165	L67-166	S
81	Kennong18	S	166	Small seeded fodder soybean	S
82	L65-1274	S	167	Heihe18	S
83	Heihe35	S	168	Hefeng44	S
84	Heihe39	S	169	L85-144	S
85	Heihe41	S			

HR stands for highly resistant, MR stands for moderately resistant, R stands for resistant, S stands for susceptible, and HS stands for highly susceptible.

Supplementary Table S2 The number of SNPs on each chromosome.

Chromosome	Number of SNPs	Chromosome coverage length(bp)	Average distance(bp)
Chr01	1,775	56,830,090	30,217
Chr02	2,288	48,570,165	21,228
Chr03	2,117	45,721,970	21,597
Chr04	4,044	52,285,568	12,929
Chr05	961	42,116,119	43,825
Chr06	2,744	51,315,427	18,701
Chr07	1,963	44,602,314	22,722
Chr08	1,811	47,794,740	26,391
Chr09	2,871	50,177,462	17477
Chr10	2,438	51,553,957	21,146
Chr11	664	34,728,097	52,301
Chr12	1,194	40,085,315	33,572
Chr13	1,923	45,507,570	23,664
Chr14	1,683	48,932,740	29,074
Chr15	3,869	51,751,663	13,375
Chr16	2,643	37,795,888	14,300
Chr17	2,781	41,577,348	14,950
Chr18	3,547	58,015,888	16,359
Chr19	3,298	50,675,996	15,365
Chr20	2,122	47,896,123	22,571
Total	52,357	947,934,440	18,105

Supplementary Table S3 Information of candidate genes.

Chromosome	Gene	Physical position	PFAM	KOG	KEGG	GO	Function prediction
6	Glyma.06G023900	Chr06:1789190-1792812	Thaumatin				Soybean thaumatin-like protein
6	Glyma.06G024000	Chr06:1800213-1805307					Soybean PSK SIMULATOR 2
6	Glyma.06G024100	Chr06:1806833-1810627	Tubulin.		Tubulin.	Microtubule formation, cytoskeletal components, GTPase activity, protein complexes, and GTP-binding proteins.	Soybean tubulin β chain.
6	Glyma.06G024200	Chr06:1814632-1815829					Growth-promoting plant hormones
6	Glyma.06G024300	Chr06:1820185-1822892					Soybean transcription initiation factor.
6	Glyma.06G024400	Chr06:1825939-1831404	Protein retention in the ER lumen.	Endoplasmic reticulum luminal protein-retaining receptor.		Endoplasmic reticulum retains sequence binding, membrane components, and protein retention within the ER lumen.	Soybean ER luminal protein-retaining receptor.
6	Glyma.06G024500	Chr06:1833924-1835173					Soybean gibberellin-regulated protein.
6	Glyma.06G024600	Chr06:1839001-1843501					Soybean transcript variants

6	Glyma.06G024700	Chr06:1844482-1850566					Soybean WEB family members
6	Glyma.06G024800	Chr06:1855001-1855606					
6	Glyma.06G024900	Chr06:1863007-1866952	E2F_TDP	Transcription factor E2F/dimeric complex (TDP).	E2F3	Endoplasmic reticulum luminal proteins retain receptor, transcription factor activities, sequence-specific DNA binding	Soybean transcription factor E2FC
6	Glyma.06G025000	Chr06:1870106-1873596	TB2_DP1_HVA22	HVA22/DP1 gene product-related protein.	REEP1_2_3_4		HVA22 protein
6	Glyma.06G025100	Chr06:1878566-1884488	Glyco_hydro_9			Hydrolase activity, hydrolysis of ortho-glycosyl compounds, carbohydrate metabolism process, catalytic activity	
6	Glyma.06G025200	Chr06:1888157-1891061	Lysine decarboxylation				Soybean cytokinin nucleoside 5′-monophosphate phosphoribosyl hydrolase
6	Glyma.06G025300	Chr06:1920734-1921556	Auxin induction			Auxin-response	Soybean auxin-responsive protein
6	Glyma.06G025400	Chr06:1933299-1939199					Soybean filamentous vegetable protein

6	Glyma.06G025500	Chr06:1948589-1948952	Auxin induction			Auxin-response	
6	Glyma.06G025600	Chr06:1958596-1960432	MRP_L53		MRPL53		Soybean zinc-finger CCCH domain protein
6	Glyma.06G025700	Chr06:1962629-1967722	Metal ion binding				
6	Glyma.06G025800	Chr06:1968736-1974567				Protein binding	Soybean Protein IQ-domain
6	Glyma.06G025900	Chr06:1983752-1991705	RCC1				Soybean protein RCC
6	Glyma.06G026000	Chr06:1998850-2002573					Soybean bZIP transcription factor
6	Glyma.06G026100	Chr06:2006495-2011301	GAGA_bind				Soybean protein basic pentacysteine6
6	Glyma.06G026200	Chr06:2015705-2017331	Glyoxal oxidation				Soybean aldehyde oxidase GLOX1
6	Glyma.06G026300	Chr06:2025052-2027273	Glyoxal oxidation				Soybean aldehyde oxidase GLOX1
6	Glyma.06G026400	Chr06:2035019-2042075	WD40	G protein β-like protein GNB1L, containing WD repeats		Protein binding	

6	Glyma.06G026500	Chr06:2043193-2046391	Antibody hydrolase 1				1-acylglycerol-3-phosphate O-acyltransferase
6	Glyma.06G026600	Chr06:2050651-2054875	LRR_8, LRR_1, tyrosine kinase, LRRNT_2.	Serine/threonine protein kinase.		Protein tyrosine kinase activity, protein binding, ADP binding, protein kinase activity and protein phosphorylation	LRR receptor-like serine/threonine protein kinase.
6	Glyma.06G026700	Chr06:2061354-2067402	Kinesin	Kinesin-like protein.		Microtubule-based movement, ATP binding, microtubule movement, microscopic binding, kinesin complex	Kinesin
6	Glyma.06G026800	Chr06:2072074-2077074	DUF726				Soybean transmembrane and coiled-coil domain proteins
6	Glyma.06G026900	Chr06:2080251-2080822					Glycine-rich RNA binding protein GRP1A.
6	Glyma.06G027000	Chr06:2087091-2088456	ZF-B box			Zinc ion binding	Soy B-box zinc-finger protein 21
6	Glyma.06G027100	Chr06:2095425-2101740	FHA、MCRS_N		MCRS1, INO80Q	Protein binding	
6	Glyma.06G027200	Chr06:2104471-2108449	K-box	MADS box transcription factors	MADS-box transcription factors	Nucleus, ADP binding, transcriptional regulation, DNA templating, transcription factor	Soybean flower homologous protein

						activity, sequence-specific DNA binding, protein dimerization activity	
6	Glyma.06G027300	Chr06:2111882-2113374		Serine/threonine-specific protein phosphatase PP1, catalytic subunit	PPP1C	Hydrolase activity.	Soybean serine/threonine protein phosphatase PP1
6	Glyma.06G027400	Chr06:2118849-2122155	SLAC1			Transmembrane transport, anion channel activity, components of membranes, and cellular ion homeostasis	Soybean *S*-type anion channel SLAH1-like
6	Glyma.06G027500	Chr06:2135506-2138166	DUF702				
6	Glyma.06G027600	Chr06:2147624-2156592	V-atpase I		Atpev0a, ATP6N	Proton transport V-type atpase, vacuolar proton transport v-type atpase, ATP hydrolysis coupled proton transport, hydrogen ion transmembrane transport activity	V-type proton atpase subunit A3
6	Glyma.06G027700	Chr06:2155899-2157973	Peptidase C1		CTSF	Cysteine-type peptidase and proteolysis activity	Soybean cysteine protease
6	Glyma.06G027800	Chr06:2158063-2158495					

6	Glyma.06G027900	Chr06:2158116-2168073	TFIIFβ	TFIIF	TFIIF2, GTF2F2 and TFG2	TFIIF complex, regulation of the transcription initiation and the transcription from the RNA polymerase II promoter	Soybean TFIIFβ
6	Glyma.06G028000	Chr06:2183635-2186994	EamA			Membrane components and transmembrane transporter activity	Walls Are Thin 1
6	Glyma.06G028100	Chr06:2193291-2197224	Phosphorus	Purple acid phosphatase		Metal ion binding activity	Soybean purple acid phosphatase
6	Glyma.06G028200	Chr06:2196937-2202255	Phosphorus	Purple acid phosphatase		Hydrolase activity, acid phosphatase activity, metal ion binding and protein binding activity	Soybean purple acid phosphatase
6	Glyma.06G028300	Chr06:2204385-2205713	AP2			Protein binding, transcription factor activity and transcriptional regulation	Dehydration response element binding protein (DREB)
6	Glyma.06G028400	Chr06:2209305-2212594	CLTH	LisH motif–containing proteins		Protein binding activity	Glucose-Induced Degradation (GID) 8- homologues
6	Glyma.06G028500	Chr06:2217380-2218232	LON_substr_bdg domain			Proteolysis and ATP-dependent peptidase activity	Soybean protease
6	Glyma.06G028600	Chr06:2220716-2222691	Thioredoxin 9	Thioredoxin	trxA	Protein disulfide oxidoreductase activity, regulation of glyceryl ether metabolic process and cellular redox homeostasis	Soybean H-type thioredoxin

6	Glyma.06G028700	Chr06:2223508-2228008	Glyco_hydro_35			Hydrolase activity and regulation of carbohydrate metabolism process	
6	Glyma.06G028800	Chr06:2237125-2239413				Regulation of the fructose-2,6-bisphosphate (F-2,6-P2) metabolism, ADP binding and catalytic activity.	Soybean 6-phosphofructo-2-kinase/fructose-2,6-bisphosphatase (PFKFB)
6	Glyma.06G028900	Chr06:2262637-2269457	Cytokine binding		CKX	Oxidoreductase, cytokinin dehydrogenase, flavin adenine dinucleotide binding and catalytic activity; Regulation of cytokinin metabolic and redox process.	Soybean cytokinin dehydrogenase
12	Glyma.12G129800	Chr12:14477191-14482275	Trehalose PPase domain		TPS	Catalytic activity, regulation of trehalose biosynthesis and metabolic process	α,α-trehalose-phosphate synthase
12	Glyma.12G129900	Chr12:14527787-14529198					
12	Glyma.12G130000	Chr12:14537934-14543293	Fer4_13 domain	Chaperone			Soybean chaperone protein
12	Glyma.12G130100	Chr12:14607193-14607463	zf-RVT				
12	Glyma.12G130200	Chr12:14610786-14613900	Glyco_hydro_1			Hydrolase activity and regulation of carbohydrate metabolism process	Soybean β- glucosidase containing cyanogen

12	Glyma.12G130300	Chr12:14632936-14634415	Inhibitor and Peptidase C1	Cysteine protease cathepsin L		Cysteine-type peptidase activity and proteolysis	Soybean senescence-specific cysteine protease
12	Glyma.12G130400	Chr12:14657765-14658290					
12	Glyma.12G130500	Chr12:14689230-14690546	Inhibitor I29 domain and Peptidase C1			Cysteine-type peptidase activity and proteolysis	
12	Glyma.12G130600	Chr12:14736643-14737771	Inhibitor I29 domain and Peptidase C1			Cysteine-type peptidase activity and proteolysis	
12	Glyma.12G130700	Chr12:14739201-14740428	Inhibitor I29 domain and Peptidase C1			Cysteine-type peptidase activity and proteolysis	
12	Glyma.12G130800	Chr12:14757062-14757409	Cyt-b5		PGRMC1/2		Soybean sterol binding protein
12	Glyma.12G130900	Chr12:14765066-14765526					Soybean glucuronosyltransferase
12	Glyma.12G131000	Chr12:14768538-14773465	Inhibitor I29 domain and Peptidase C1			Cysteine-type peptidase activity and proteolysis	
12	Glyma.12G131100	Chr12:14813703-14814828	Inhibitor I29 domain and Peptidase C1			Cysteine-type peptidase activity and proteolysis	
12	Glyma.12G131200	Chr12:14816479-14817981	Inhibitor I29 domain and Peptidase C1			Cysteine-type peptidase activity and proteolysis	Soybean senescence-specific cysteine protease

12	Glyma.12G131300	Chr12:14837986-14839212	Inhibitor I29 domain and Peptidase C1			Cysteine-type peptidase activity and proteolysis	Soybean vatamin-B
12	Glyma.12G131400	Chr12:14854898-14856124	Inhibitor I29 domain and Peptidase C1			Cysteine-type peptidase activity and proteolysis	Soybean vatamin-B
12	Glyma.12G131500	Chr12:14878261-14879650	Inhibitor I29 domain and Peptidase C1	Cysteine protease cathepsin L	CEP, CYSEP	Cysteine-type peptidase activity and proteolysis	Soybean vatamin-B
12	Glyma.12G131600	Chr12:14881257-14883462	Ribosome L5	60S ribosomal protein L11	RP-L11e, RPL11	Structural components of ribosomes and involvement in translation	Soybean 60S ribosomal protein
12	Glyma.12G131700	Chr12:14888564-14890785	Ribosome L5	60S ribosomal protein L11	RP-L11e, RPL11	Structural components of ribosomes and involvement in translation	Soybean 60S ribosomal protein L11 (LOC100818410)，mRNA
12	Glyma.12G131800	Chr12:14895223-14897184		Predicted E3 ubiquitin ligase		Zinc ion and protein binding	Soybean E3 ubiquitin protein ligase
12	Glyma.12G131900	Chr12:14915662-14919704					*Glycine soja* TMV resistance protein N-like (LOC114378377)
12	Glyma.12G132000	Chr12:14917753-14921517	LRR_8, NB-ARC, TIR_2 and LRR_3	Adenosine triphosphatase		Signaling transduction, ATP and protein binding	Soybean antiviral gene, *GmRUN1*
12	Glyma.12G132100	Chr12:14924075-14925623					
12	Glyma.12G132200	Chr12:14934826-14945703	TIR_2, NB-ARC, And LRR_3			Signaling transduction, ATP and protein binding	Soybean antiviral gene, *GmRUN1*

Supplementary Table S4 The SNP haplotypes of *Glyma.12G132000*.

Haplotype	Gm12_Hap2a	Gm12_Hap3a	Gm12_Hap5a
14917777	A	G	G
14917855	A	G	G
14917897	C	G	G
14917955	A	T	T
14918050	A	G	G
14918052	T	T	C
14918058	G	G	C
14918059	T	T	C
14918060	T	C	C
14918061	T	A	A
14918078	A	A	C
14918091	T	T	C
14918103	G	G	T
14918104	G	G	C
Frequency	75.74%	7.69%	5.33%
Disease index	52.17	49.50	48.48
Significance	Gm12_Hap3a and Gm12_Hap5a: no significance	Gm12_Hap2a and Gm12_Hap3a: ✱	Gm12_Hap2a and Gm12_Hap5a: ✱

Statistical analyses were performed using SPSS 20.0 software; * represent $p < 0.05$.

Supplementary Table S5 The SNP haplotypes of *Glyma.12G132200*.

Haplotype	Gm12_Hap2b	Gm12_Hap3b	Gm12_Hap8b
14935130	A	A	T
14935243	G	G	A
14935273	G	T	G
14935288	G	G	A
14935327	T	T	C
14935339	T	T	C
14935343	A	A	G
14935348	A	A	T
14935349	C	C	T
Frequency	60.36%	12.43%	5.92%
Disease index	49.76	48.87	49.93
Significance	Gm12_Hap2b and Gm12_Hap3b: no significance	Gm12_Hap2b and Gm12_Hap8b: no significance	Gm12_Hap3b and Gm12_Hap8b: no significance

Statistical analyses were performed using SPSS 20.0 software.

Supplementary Table S6 The SNP haplotype of *Glyma.06G02660*.

Haplotype	Gm6_Hap1	Gm6_Hap2	Gm6_Hap6
2051124	C	C	T
2053363	C	G	C
Frequency	64.50%	6.51%	5.92%
Disease index	52.30	49.58	48.56
Significance	Gm6_Hap1 and Gm6_Hap2: **	Gm6_Hap1 and Gm6_Hap6: **	Gm6_Hap2 and Gm6_Hap6: no significance

Statistical analyses were performed using SPSS 20.0 software; ** represent $p < 0.01$.