

Figure S1. PCR result of 22 radish breeding lines ('SJ-1~22') using class I, II kinase domain of SRK (SRK-KD) primer set. (A) PCR amplification of class I SRK-KD using UVSRK-F + UVSRK-R primer set; (B): PCR amplification of class II SRK-KD using KS2 + KA2 primer set; M: 100bp size marker.

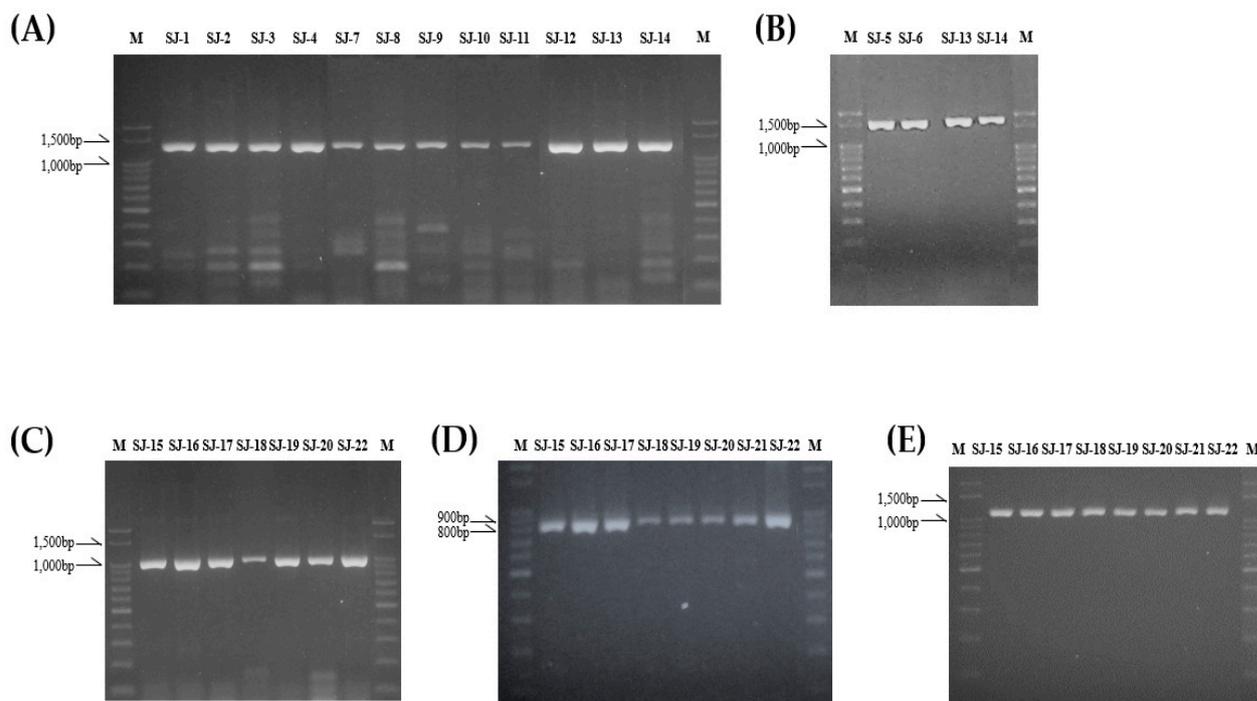


Figure S2. PCR result of 22 radish breeding lines ('SJ-1~22') using class I, II SLG primer set. (A) PCR amplification of class I SLG using SLG-I-F + SLG-I-R primer set; (B): PCR amplification of class I SLG using PS22 + SLG-I-R primer set; (C): PCR amplification of class II SLG using SLG-II-F + SLG-II-R primer set; (D): PCR amplification of class II SLG using Rs9 SLG-F + Rs9 SLG-R primer set; M: 100bp size marker; (E): PCR amplification of class II SLG using UVSLGII-F + UVSLGII-R primer set; M: 100bp size marker.

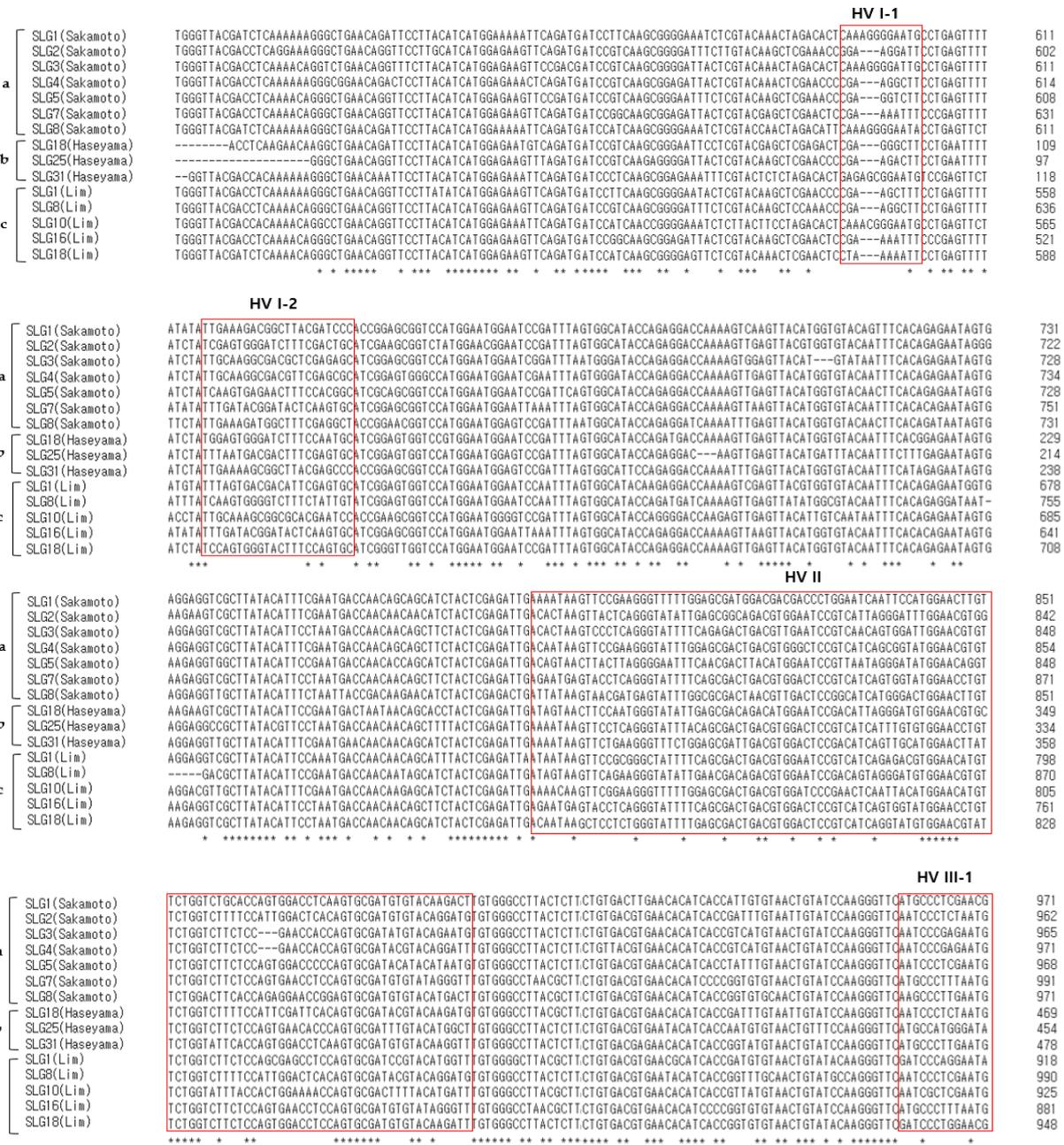


Figure S4. Multiple sequence alignment of the nucleotide sequences of the 15 class I S haplotype SLG alleles; a: S haplotype published by Sakamoto (1998); b: S haplotype published by Haseyama (2018); c: S haplotype published by Lim (2002); Red box: hypervariable region I to III of the SLG; Asterisk: conserved nucleotide.

HV III-2

a	SLG1 (Sakanoto)	TGAGCAGCGGGATCTAAGAGACCCGTCAGGTGGGTGTATAAGGAGGCGCGGCTTAGCTGCACTGGT GAT -----GGTTTTACCAAGGATGAAGAAATGAAGTTGCCAGAAACTACGA	1085
	SLG2 (Sakanoto)	TGAGCAGTGGGATCTGAAAAGCTGGTCAGGTGGGTGTATAAGGAGGACGCGCTGAGCTGCACTAGAGAT -----GGTTTTACCAAGGATGAAGAACGTTGCCAGAAACTACGA	1076
	SLG3 (Sakanoto)	TGAGCAGTGGGCTCTGAGAACTCAATAAGTGGGTGTATAAGGAGGACGCGGCTTAGCTGCACTGGT GAT -----GGTTTTACCAAGGATGAAGAAATGAAGTTGCCAGAAACTGCGA	1079
	SLG4 (Sakanoto)	TGAGCAGTGGGCTCTGAGAACTCTCGATAAGTGGGTGTAAAAGGAGGACGCGGCTTAGCTGCACTGGT GATGGTGTGGCTTTACCAAGGATGAAGAAATGAAGTTGCCAGAAACTACGA	1091
	SLG5 (Sakanoto)	TGAGCAGTGGGATCTGAGAGTCTGGGACAGGTGGGTGTATAAGGAGGACGCGCTTAGCTGCACTGGAGAT -----GGTTTTACCAAGGATGAAGAAATGAAGTTGCCAGAAACTACGA	1082
	SLG7 (Sakanoto)	TGCATCAGTGGGATCTGGGAGACGGGTTAGGTGGATGTATAAGGAGGACGCGGCTTAGCTGCACTGGAGAT -----GGTTTTACCAAGGATGAAGAACATGAAGTTGCCAGAAACTACGA	1105
	SLG8 (Sakanoto)	TGAGCAGTGGGATCTGAGAGACGGGTCAGGTGGGTGTATCAGAAAGGACGCGCTGAGCTGCACTGGT GAT -----GGTTTTACCAAGGATGAAGAAATGAAGTTGCCAGAAACTACGA	1085
	SLG18 (Haseyama)	TGAGCAGTGGGATCTGAAAAGCTGGTCAGGTGGGTGTATAAGGAGGACGCGCTTAGCTGCACTGGAGAT -----GGTTTTACCAAGGATGAAGAAATGAAGTTGCCAGAAACTACGA	583
	SLG25 (Haseyama)	AGAGCAGTGGGATCTGAAAAGCCGTCAGGTGGGTGTATAAGGAGGACGCGCTGAGCTGCACTGGT GAT -----AGCTTTACCAAGGATGAAGAAATGAAGTTGCCAGAAACTACGA	588
	SLG31 (Haseyama)	AGAGCAGTGGTATCTGAGAGACTGGTCAAGTGGGTGTACAAGGAGAACGCGCTGAGCTGCACTGGGAT -----GTTTTTACTAGGATGAAGAAATGAAGTTGCCAGAAACTACGA	592
b	SLG1 (Lim)	TGAAAAGTGGAACTGAGATCCCACTCAGTGGGTGTATAAGGAGGACGCGCTGAGCTGCACTGGGAT -----GGTTTTACCAAGGATGAAGAAATGAAGTTGCCAGAAACTACGA	1032
	SLG8 (Lim)	TGAGCAGTGGGATCAGAGATCCTGGTCAGGTGGGTGTATAAGGAGGACGCGCTTAGCTGCACTGGAGAT -----GGTTTTACCAAGGATGAAGAACATGAAGTTGCCAGAAACTACGA	1104
	SLG10 (Lim)	AAAGCAGTGGGCTAGCAAGATTGGTCAAGCAGGTGGGTGTATAAGGAGGACGCGCTGAGCTGCACTGGT GAT -----GGTTTTACCAAGGATGAAGAAATGAAGTTGCCAGAAACTACGA	1039
	SLG16 (Lim)	TGCATCAGTGGGATCTGGGAGACGGGTTAGGTGGATGTATAAGGAGGACGCGCTTAGCTGCACTGGAGAT -----GGTTTTACCAAGGATGAAGAACATGAAGTTGCCAGAAACTACGA	995
SLG18 (Lim)	TGAGCAGTGGGATCTGAGAGCTGGTCAGGTGGGTGTATAAGGAGGACGCGCTTAGCTGCACTAGAGAT -----GGTTTTACCAAGGATGAAGAAATGAAGTTGCCAGAAACTACTA	1062	
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a	SLG1 (Sakanoto)	TGGCTATTGTGACAGGAGATTGGTGTAAAAGAAATGTGAGAGAGGTCCTTAGCGACTGTAATTTGACCGGTTTGCAAATGCGGATATCCGGAATGGTGGACGGGCTGTGTGATTT	1205
	SLG2 (Sakanoto)	TGGCTATTGTGACAGGAGATTGGTGTAAAAGAAATGTGAGAGAGGTCCTTAGCGACTGTAATTTGACCGGTTTGCAAATGCGGATATCCGGAATGGTGGACGGGCTGTGTGATTT	1196
	SLG3 (Sakanoto)	TGGCTATTGTGACAGGAGATTGGTGTAAAAGAAATGTGAGAGAGGTCCTTAGCGACTGTAATTTGACCGGTTTGCAAATGCGGATATCCGGAATGGTGGACGGGCTGTGTGATTT	1199
	SLG4 (Sakanoto)	TGGCTATTGTGACAGGAGATTGGTGTAAAAGAAATGTGAGAGAGGTCCTTAGCGACTGTAATTTGACCGGTTTGCAAATGCGGATATCCGGAATGGTGGACGGGCTGTGTGATTT	1211
	SLG5 (Sakanoto)	TGGCGACTGTGACAGGAGATTGGTGTAAAAGAAATGTGAGAGAGGTCCTTAGCGACTGTAATTTGACCGGTTTGCAAATGCGGATATCCGGAATGGTGGACGGGCTGTGTGATTT	1202
	SLG7 (Sakanoto)	TGGCGACTGTGACAGGAGATTGGTGTAAAAGAAATGTGAGAGAGGTCCTTAGCGACTGTAATTTGACCGGTTTGCAAATGCGGATATCCGGAATGGTGGACGGGCTGTGTGATTT	1225
	SLG8 (Sakanoto)	TGGCGACTGTGACAGGAGATTGGTGTAAAAGAAATGTGAGAGAGGTCCTTAGCGACTGTAATTTGACCGGTTTGCAAATGCGGATATCCGGAATGGTGGACGGGCTGTGTGATTT	1205
	SLG18 (Haseyama)	TGGCTATTGTGACAGGAGATTGGTGTAAAAGAAATGTGAGAGAGGTCCTTAGCGACTGTAATTTGACCGGTTTGCAAATGCGGATATCCGGAATGGTGGACGGGCTGTGTGATTT	703
	SLG25 (Haseyama)	TGGCGACTGTGACAGGAGATTGGTGTAAAAGAAATGTGAGAGAGGTCCTTAGCGACTGTAATTTGACCGGTTTGCAAATGCGGATATCCGGAATGGTGGACGGGCTGTGTGATTT	688
	SLG31 (Haseyama)	TGGCAATTGTGACAGGAGATTGGTGTAAAAGAAATGTGAGAGAGGTCCTTAGCGACTGTAATTTGACCGGTTTGCAAATGCGGATATCCGGAATGGTGGACGGGCTGTGTGATTT	712
b	SLG1 (Lim)	TGGCGACTGTGACAGGAGATTGGTGTAAAAGAAATGTGAGAGAGGTCCTTAGCGACTGTAATTTGACCGGTTTGCAAATGCGGATATCCGGAATGGTGGACGGGCTGTGTGATTT	1152
	SLG8 (Lim)	TGGCGACTGTGACAGGAGATTGGTGTAAAAGAAATGTGAGAGAGGTCCTTAGCGACTGTAATTTGACCGGTTTGCAAATGCGGATATCCGGAATGGTGGACGGGCTGTGTGATTT	1221
	SLG10 (Lim)	TGGCGACTGTGACAGGAGATTGGTGTAAAAGAAATGTGAGAGAGGTCCTTAGCGACTGTAATTTGACCGGTTTGCAAATGCGGATATCCGGAATGGTGGACGGGCTGTGTGATTT	1159
	SLG16 (Lim)	TGGCGACTGTGACAGGAGATTGGTGTAAAAGAAATGTGAGAGAGGTCCTTAGCGACTGTAATTTGACCGGTTTGCAAATGCGGATATCCGGAATGGTGGACGGGCTGTGTGATTT	1115
SLG18 (Lim)	TGGCGACTGTGACAGGAGATTGGTGTAAAAGAAATGTGAGAGAGGTCCTTAGCGACTGTAATTTGACCGGTTTGCAAATGCGGATATCCGGAATGGTGGACGGGCTGTGTGATTT	1182	
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a	SLG1 (Sakanoto)	GGACGGAGAGCTCGAGGATATCCGGACCTACCTTGCTGACGGTCAAGATCTTTATGTCGATTGGCTGCTGCTGACCTTGTTT	1289
	SLG2 (Sakanoto)	GGACGGAGAGCTCGAGGATATCCGGACCTACCTTGCTGACGGTCAAGATCTTTATGTCGATTGGCTGCTGCTGACCTTGTTT	1280
	SLG3 (Sakanoto)	GGACGGAGAGCTCGAGGATATCCGGACCTACCTTGCTGACGGTCAAGATCTTTATGTCGATTGGCACTGCTGCTGACCTTGTTT	1283
	SLG4 (Sakanoto)	GGACGGAGAGCTCGAGGATATCCGGACCTACCTTGCTGACGGTCAAGATCTTTATGTCGATTGGCTGCTGCTGACCTTGTTT	1295
	SLG5 (Sakanoto)	GGACGGAGAGCTCGAGGATATCCGGACCTACCTTGCTGACGGTCAAGATCTTTATGTCGATTGGCTGCTGCTGACCTTGTTT	1286
	SLG7 (Sakanoto)	GGACGGAGAGCTCGAGGATATCCGGACCTACCTTGCTGACGGTCAAGATCTTTATGTCGATTGGCTGCTGCTGACCTTGTTT	1309
	SLG8 (Sakanoto)	GGACGGAGAGCTCGAGGATATCCGGACCTACCTTGCTGACGGTCAAGATCTTTATGTCGATTGGCTGCTGCTGACCTTGTTT	1289
	SLG18 (Haseyama)	GGACGGAGAGCTCGAGGATATCCGGACCTACCTTGCTGACGGTCAAGATCTTTATGTC-----762	
	SLG25 (Haseyama)	GGACGGAGAGCTCGAGGATATCCGGACCTACCTTGCTGACGGTCAAGATCTTTATGTCGAGTGGCTGCT-----759	
	SLG31 (Haseyama)	GGACGGAGAGCTCGAGGATATCCGGACCTACCTTGCTGACGGTCAAGATCTTTATGTC-----771	
b	SLG1 (Lim)	GGACGGAGAGCTCGAGGATATCCGGACCTACCTTGCTGACGGTCAAGATCTTTATGTCAGATTGG-----1220	
	SLG8 (Lim)	GGACGGAGAGCTCGAGGATATCCGGACCTACCTTGCTGACGGTCAAGATCTTTATGTCAGATTGG-----1221	
	SLG10 (Lim)	GGACGGAGAGCTCGAGGATATCCGGACCTACCTTGCTGACGG-----1202	
	SLG16 (Lim)	GGACGGAGAGCTCGAGGATATCCGGACCTACCTTGCTGACGGTCAAGATCTTT-----1168	
SLG18 (Lim)	GGACGGAGAGCTCGAGGATATCCGGACCTACCTTGCTGACGGTCAAGATCTTT-----1235		

Figure S4. Continued.

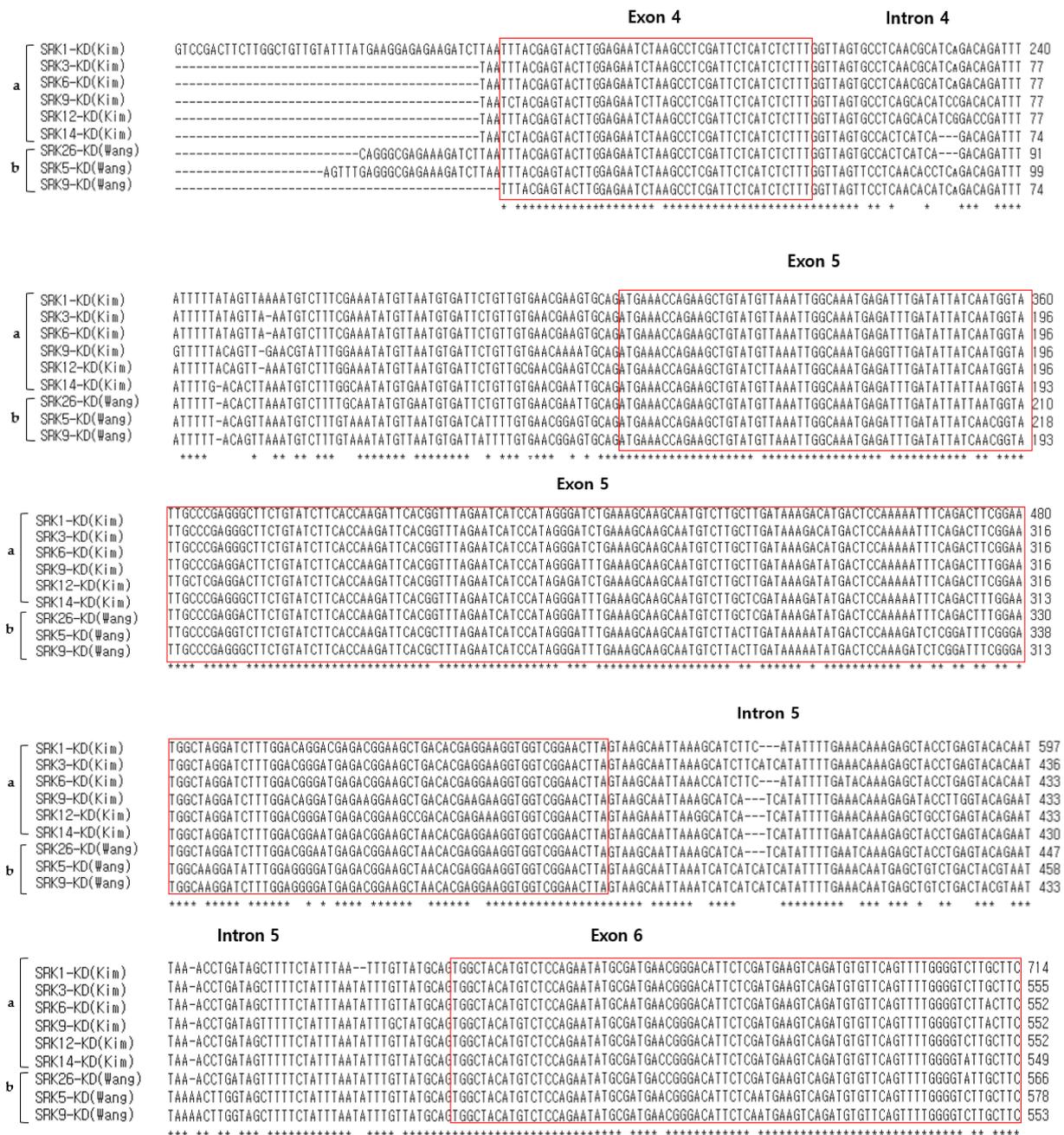


Figure S5. Multiple sequence alignment of the nucleotide sequences of the 9 class II S haplotype kinase domain of SRK alleles; a: S haplotype published by Kim (2016); b: S haplotype published by Haseyama (2018); c: S haplotype published by Lim (2002); Red box: 4th to 7th exons of the SRK; Asterisk: conserved nucleotide.

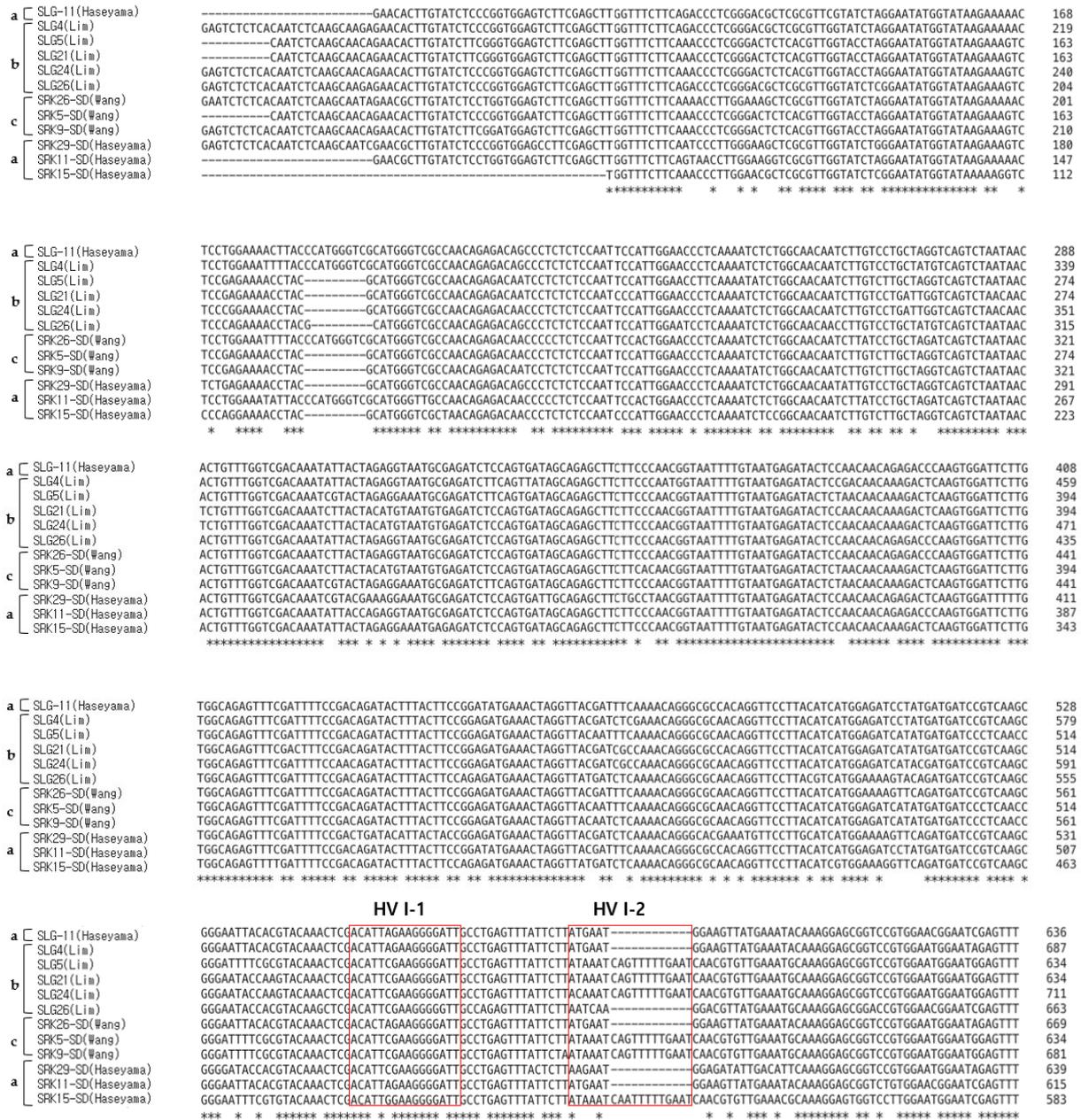


Figure S6. Multiple sequence alignment of the nucleotide sequences of the 12 class II S haplotype SLG and S domain of SRK alleles; a: S haplotype published by Haseyama (2018); b: S haplotype published by Lim (2002); c: S haplotype published by Wang (2018); Red box: hypervariable region I to III of SLG; Asterisk: conserved nucleotide.

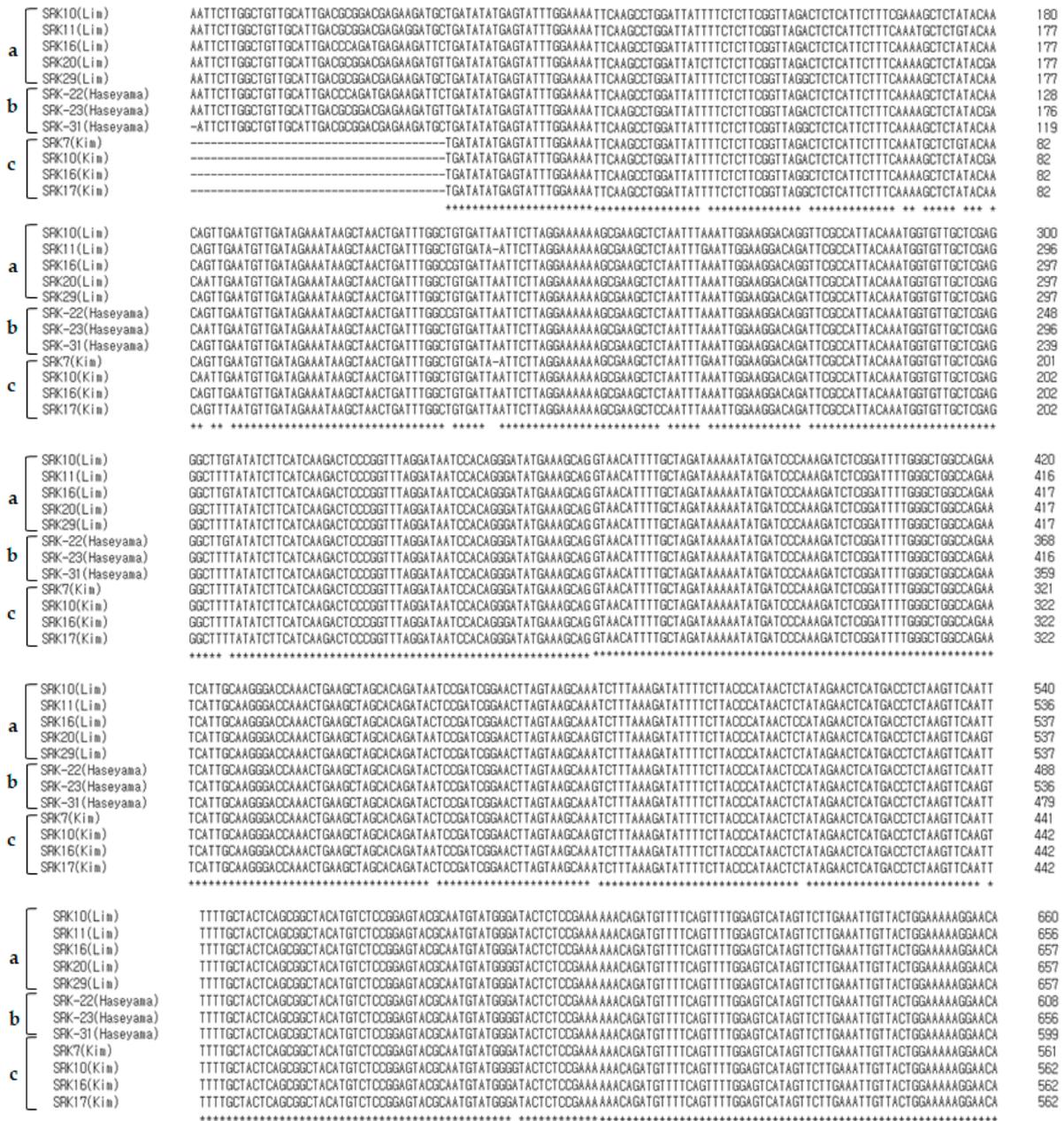


Figure S7. Multiple sequence alignment of SRK10 (Lim, AY052579), SRK16 (Lim, AY052579) and other 10 S haplotypes; Asterisk: conserved nucleotide; a: S haplotype published by Lim (2002); b: S haplotype published by Haseyama (2018); c: S haplotype published by Kim (2016).

a	SRK10(Lin)	GAGGATTCACAGTCAACCCGGAAAGACAATCTTGTATGCTATGTAAGTTTAAAGACCAATAATATCTACTCTCGAGATTGCCAAAACACTTTAAATGCCTTTATATTTATAAA	780
	SRK11(Lin)	GAGGATTCACAGTCAACCCGGAAAGACAATCTTGTATGCTATGTAAGTTTAAAGACCAATAATATCTACTCTCGAGATTGCCAAAACACTTTAAATGCCTTTATATTTATAAA	776
	SRK16(Lin)	GAGGATTCACAGTCAACCCGGAAAGACAATCTTGTATGCTATGTAAGTTTAAAGACCAATAATATCTACTCTCGAGATTGCCAAAACACTTTAAATGCCTTTATATTTATAAA	777
	SRK20(Lin)	GAGGATTCACAGTCAACCCGGAAAGACAATCTTGTATGCTATGTAAGTTTAAAGACCAATAATATCTACTCTCGAGATTGCCAAAACACTTTAAATGCCTTTATATTTATAAA	777
	SRK29(Lin)	GAGGATTCACAGTCAACCCGGAAAGACAATCTTGTATGCTATGTAAGTTTAAAGACCAATAATATCTACTCTCGAGATTGCCAAAACACTTTAAATGCCTTTATATTTATAAA	777
	SRK-22(Haseyama)	GAGGATTCACAGTCAACCCGGAAAGACAATCTTGTATGCTATGTAAGTTTAAAGACCAATAATATCTACTCTCGAGATTGCCAAAACACTTTAAATGCCTTTATATTTATAAA	728
	SRK-23(Haseyama)	GAGGATTCACAGTCAACCCGGAAAGACAATCTTGTATGCTATGTAAGTTTAAAGACCAATAATATCTACTCTCGAGATTGCCAAAACACTTTAAATGCCTTTATATTTATAAA	776
	SRK-31(Haseyama)	GAGGATTCACAGTCAACCCGGAAAGACAATCTTGTATGCTATGTAAGTTTAAAGACCAATAATATCTACTCTCGAGATTGCCAAAACACTTTAAATGCCTTTATATTTATAAA	719
	SRK7(Kim)	GAGGATTCACAGTCAACCCGGAAAGACAATCTTGTATGCTATGTAAGTTTAAAGACCAATAATATCTACTCTCGAGATTGCCAAAACACTTTAAATGCCTTTATATTTATAAA	681
	SRK10(Kim)	GAGGATTCACAGTCAACCCGGAAAGACAATCTTGTATGCTATGTAAGTTTAAAGACCAATAATATCTACTCTCGAGATTGCCAAAACACTTTAAATGCCTTTATATTTATAAA	682
b	SRK16(Kim)	GAGGATTCACAGTCAACCCGGAAAGACAATCTTGTATGCTATGTAAGTTTAAAGACCAATAATATCTACTCTCGAGATTGCCAAAACACTTTAAATGCCTTTATATTTATAAA	682
	SRK17(Kim)	GAGGATTCACAGTCAACCCGGAAAGACAATCTTGTATGCTATGTAAGTTTAAAGACCAATAATATCTACTCTCGAGATTGCCAAAACACTTTAAATGCCTTTATATTTATAAA	682

a	SRK10(Lin)	CAGGCATGGACTCATTGGGCGCAGGGAAGAGCGCTAGAAAATCGTAGATCCDGTCACTCGTAGATTTCATGTGCATCAACATTTCAACCAAAGAAAGTCTAAAATGCATACAAAATGGTCTC	900
	SRK11(Lin)	CAGGCATGGACTCATTGGGCGCAGGGAAGAGCGCTAGAAAATCGTAGATCCDGTCACTCGTAGATTTCATGTGCATCAACATTTCAACCAAAGAAAGTCTAAAATGCATACAAAATGGTCTC	896
	SRK16(Lin)	CAGGCATGGACTCATTGGGCGCAGGGAAGAGCGCTAGAAAATCGTAGATCCDGTCACTCGTAGATTTCATGTGCATCAACATTTCAACCAAAGAAAGTCTAAAATGCATACAAAATGGTCTC	897
	SRK20(Lin)	CAGGCATGGACTCATTGGGCGCAGGGAAGAGCGCTAGAAAATCGTAGATCCDGTCACTCGTAGATTTCATGTGCATCAACATTTCAACCAAAGAAAGTCTAAAATGCATACAAAATGGTCTC	897
	SRK29(Lin)	CAGGCATGGACTCATTGGGCGCAGGGAAGAGCGCTAGAAAATCGTAGATCCDGTCACTCGTAGATTTCATGTGCATCAACATTTCAACCAAAGAAAGTCTAAAATGCATACAAAATGGTCTC	897
	SRK-22(Haseyama)	CAGGCATGGACTCATTGGGCGCAGGGAAGAGCGCTAGAAAATCGTAGATCCDGTCACTCGTAGATTTCATGTGCATCAACATTTCAACCAAAGAAAGTCTAAAATGCATACAAAATGGTCTC	848
	SRK-23(Haseyama)	CAGGCATGGACTCATTGGGCGCAGGGAAGAGCGCTAGAAAATCGTAGATCCDGTCACTCGTAGATTTCATGTGCATCAACATTTCAACCAAAGAAAGTCTAAAATGCATACAAAATGGTCTC	896
	SRK-31(Haseyama)	CAGGCATGGACTCATTGGGCGCAGGGAAGAGCGCTAGAAAATCGTAGATCCDGTCACTCGTAGATTTCATGTGCATCAACATTTCAACCAAAGAAAGTCTAAAATGCATACAAAATGGTCTC	839
	SRK7(Kim)	CAGGCATGGACTCATTGGGCGCAGGGAAGAGCGCTAGAAAATCGTAGATCCDGTCACTCGTAGATTTCATGTGCATCAACATTTCAACCAAAGAAAGTCTAAAATGCATACAAAATGGTCTC	801
	SRK10(Kim)	CAGGCATGGACTCATTGGGCGCAGGGAAGAGCGCTAGAAAATCGTAGATCCDGTCACTCGTAGATTTCATGTGCATCAACATTTCAACCAAAGAAAGTCTAAAATGCATACAAAATGGTCTC	802
b	SRK16(Kim)	CAGGCATGGACTCATTGGGCGCAGGGAAGAGCGCTAGAAAATCGTAGATCCDGTCACTCGTAGATTTCATGTGCATCAACATTTCAACCAAAGAAAGTCTAAAATGCATACAAAATGGTCTC	802
	SRK17(Kim)	CAGGCATGGACTCATTGGGCGCAGGGAAGAGCGCTAGAAAATCGTAGATCCDGTCACTCGTAGATTTCATGTGCATCAACATTTCAACCAAAGAAAGTCTAAAATGCATACAAAATGGTCTC	802

a	SRK10(Lin)	TTGTGTATTCAGAAAGTGCAGGACCAACGATGTCGTGCGTGGTTGGATGCTT	960
	SRK11(Lin)	TTATGTATTCAGAAAGTGCAGGACCAACGATGTCGTGCGTGGTTGGATGCTT	956
	SRK16(Lin)	TTGTGTATTCAGAAAGTGCAGGACCAACGATGTCGTGCGTGGTTGGATGCTT	957
	SRK20(Lin)	TTGTGTATTCAGAAAGTGCAGGACCAACGATGTCGTGCGTGGTTGGATGCTT	957
	SRK29(Lin)	TTGTGTATTCAGAAAGTGCAGGACCAACGATGTCGTGCGTGGTTGGATGCTT	957
	SRK-22(Haseyama)	TTGTGTATTCAGAAAGTGCAGGACCAACGATGTCGTGCGTGGTTGGATGCTT	908
	SRK-23(Haseyama)	TTGTGTATTCAGAAAGTGCAGGACCAACGATGTCGTGCGTGGTTGGATGCTT	956
	SRK-31(Haseyama)	TTGTGTATTCAGAAAGTGCAGGACCAACGATGTCGTGCGTGGTTGGATGCTT	899
	SRK7(Kim)	TTGTGTATTCAGAAAGTGCAGGACCAACGATGTCGTGCGTGGTTGGATGCTT	823
	SRK10(Kim)	TTGTGTATTCAGAAAGTGCAGGACCAACGATGTCGTGCGTGGTTGGATGCTT	824
b	SRK16(Kim)	TTGTGTATTCAGAAAGTGCAGGACCAACGATGTCGTGCGTGGTTGGATGCTT	824
	SRK17(Kim)	TTGTGTATTCAGAAAGTGCAGGACCAACGATGTCGTGCGTGGTTGGATGCTT	824

Figure S7. Continued.