

Figure S1. Analysis of relationship and leaves phenotypic in *Q. aliena* accessions. (a) JF_QA1, JF_QA2, JF_QA3, JF_QA4, and JF_QA5 belong to *Q. aliena*, and are planted in the Jiufeng National Forest Park, Beijing, China. DY_QD1, DY_QD2, DY_QD3, DY_QD4, and DY_QD5 belong to *Q. dentata*, and are planted in the Dayangshan National Forest Park, Beijing, China. YM_QM1, YM_QM2, YM_QM3, and YM_QM4 belong to *Q. mongolica*, and are planted in the Yunmengshan National Forest Park, Beijing, China. JF_QV1, JF_QV2, JF_QV3, JF_QV4, and JF_QV5 belong to *Q. variabilis*, and are planted in the Jiufeng National Forest Park, Beijing, China. (b)-(d) leaves phenotypic of the four trees at S3 stage, bars represent the standard deviation (SD, n = 15).

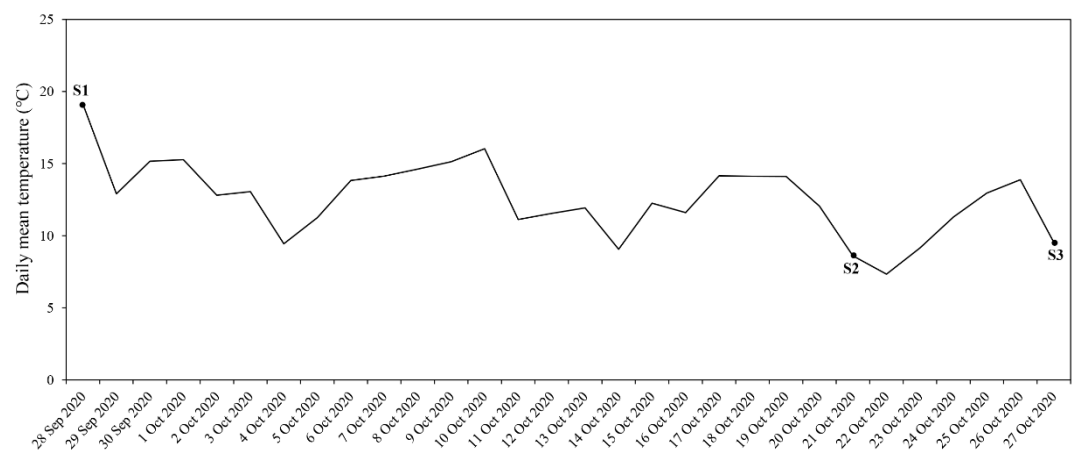


Figure S2. Daily mean temperatures in Beijing during the discoloration period (Sep-Oct 2020).

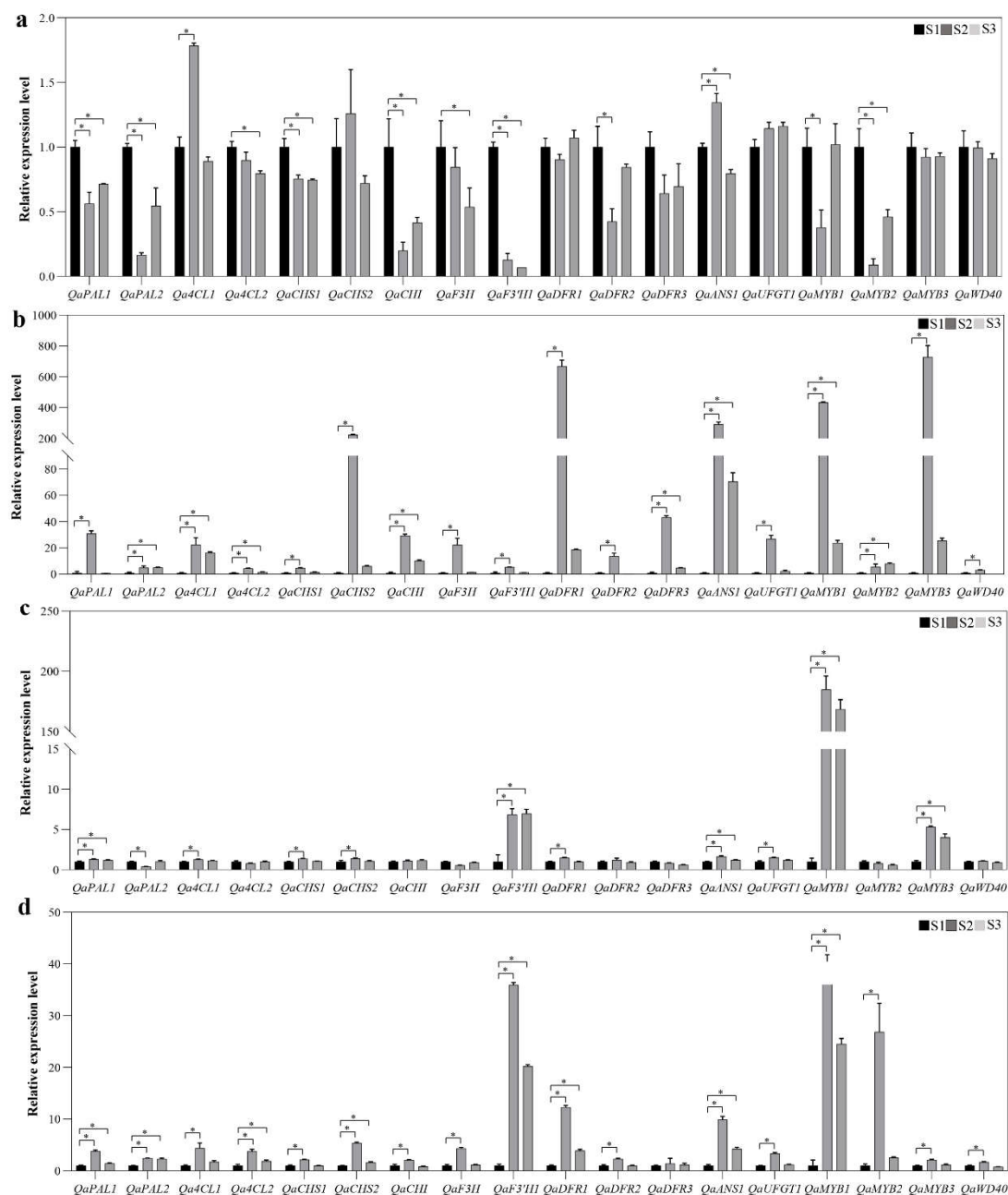


Figure S3. Gene expression during leaf senescence based on semi-quantitative PCR: (a) QAC, (b) QA1, (c) QA2, and (d) QA3. Bars represent standard deviation (SD). * $P < 0.05$.

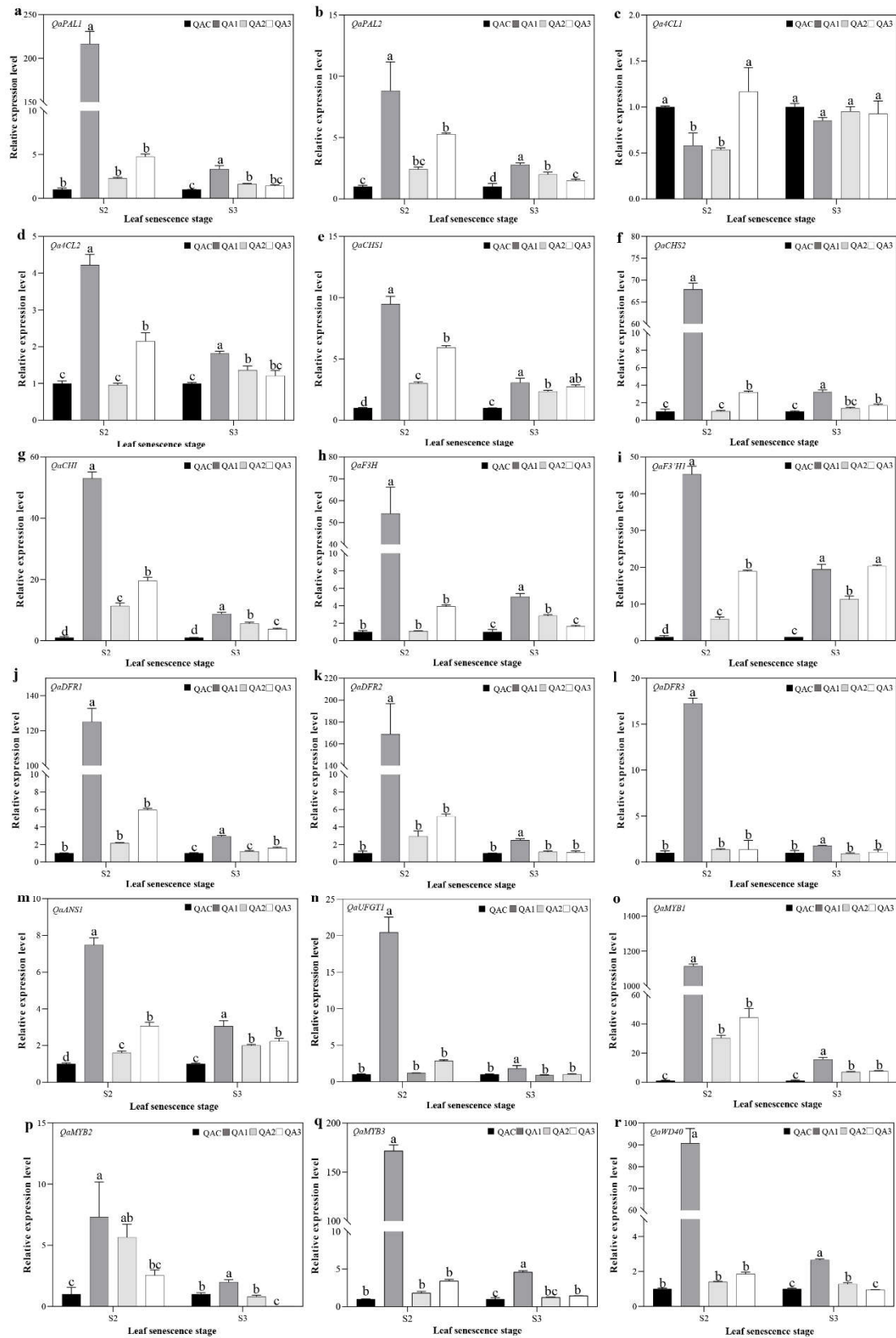


Figure S4. Differential gene expression during leaf senescence in *Q. aliena* accessions based on semi-quantitative PCR. Bars represent standard deviation (SD). * $P < 0.05$, and lowercase letters represent significant differences at $P < 0.05$.

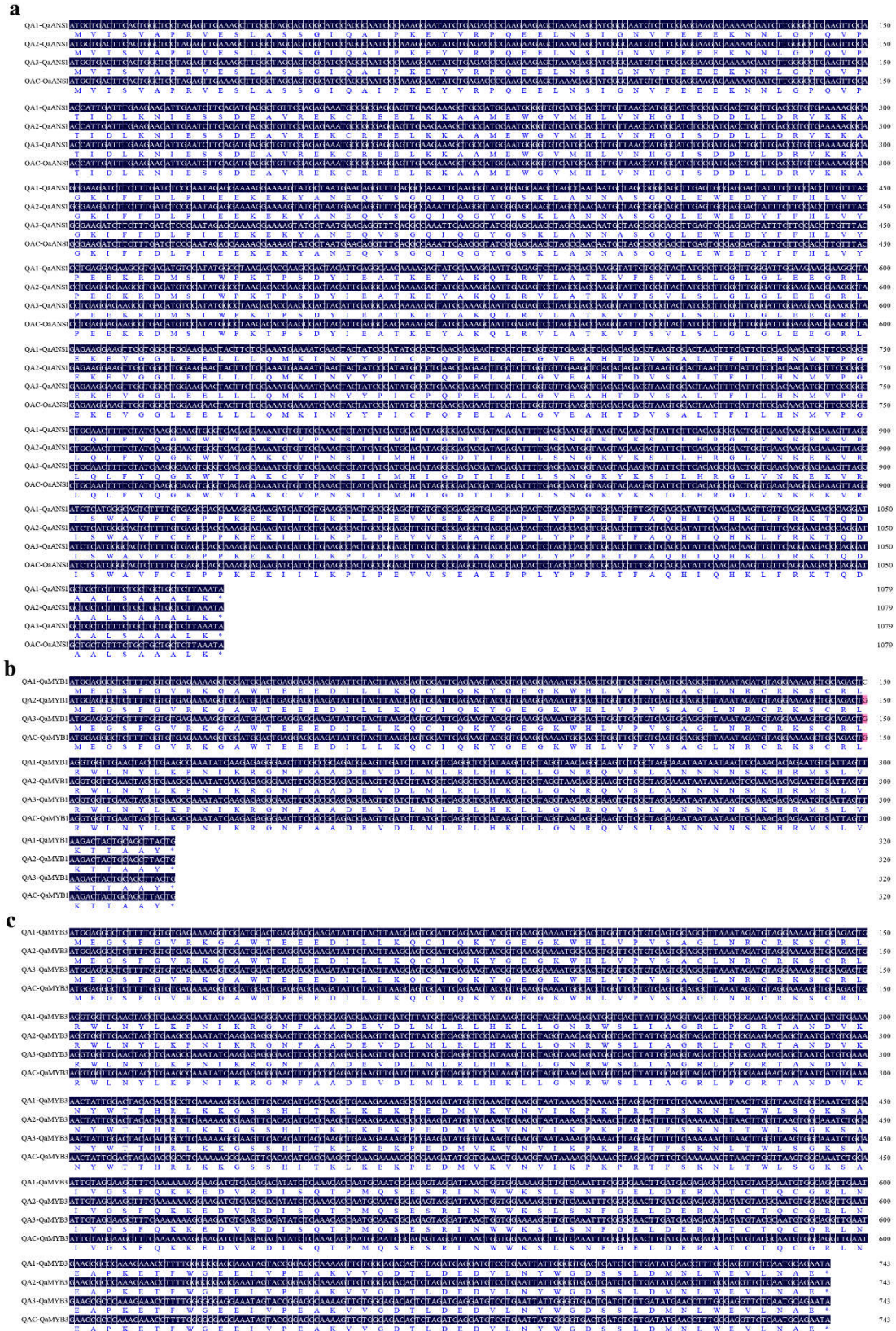


Figure S5 Homology analysis of *QaANS1* (a), *QaMYB1* (b), and *QaMYB3* (c) in the three variants and QAC.

Table S1. Anthocyanin synthesis-related genes in *Quercus aliena* and other species

Gene	Homologue in <i>Q. robur</i> L.	Homologues in other species (gene ID)
<i>QaPAL1</i>	Qrob_P0101950.2	<i>AtPAL1</i> (AT2G37040), <i>AtPAL2</i> (AT3G53260)
<i>QaPAL2</i>	Qrob_P0328050.2	<i>AtPAL3</i> (AT5G04230), <i>AtPAL4</i> (AT3G10340)
<i>Qa4CL1</i>	Qrob_P0278330.2	<i>At4CL1</i> (AT1G51680), <i>At4CL2</i> (AT3G21240)
<i>Qa4CL2</i>	Qrob_P0058290.2	<i>At4CL3</i> (AT1G65060)
<i>Qa4CL3</i>	Qrob_P0766030.2	
<i>QaCHS1</i>	Qrob_P0522690.2	
<i>QaCHS2</i>	Qrob_P0004890.2	<i>AtCHS</i> (AT5G13930)
<i>QaCHS3</i>	Qrob_P0063990.2	
<i>QaCHS4</i>	Qrob_P0276680.2	
<i>QaCHI</i>	Qrob_P0211560.2	<i>AtCHI</i> (AT3G55120)
<i>QaF3H</i>	Qrob_P0200790.2	<i>AtF3H</i> (AT3G51240)
<i>QaF3'H1</i>	Qrob_P0098800.2	<i>VvF3'H</i> (NC_012023.3)
<i>QaF3'H2</i>	Qrob_P0276000.2	
<i>QaDFR1</i>	Qrob_P0599010.2	
<i>QaDFR2</i>	Qrob_P0497760.2	<i>AtDFR</i> (AT5G42800)
<i>QaDFR3</i>	Qrob_P0119180.2	
<i>QaANS1</i>	Qrob_P0502480.2	<i>AtANS</i> (AT4G22880)
<i>QaANS2</i>	Qrob_P0514540.2	
<i>QaUFGT1</i>	Qrob_P0392850.2	
<i>QaUFGT2</i>	Qrob_P0624920.2	<i>VvUFGT</i> (NC_012022.3)
<i>QaUFGT3</i>	Qrob_P0624910.2	
<i>QaMYB1</i>	Qrob_P0355830.2	<i>VvMYBA1</i> (BAD18977.1), <i>VvMYBA2</i> (BAD18978.1)
<i>QaMYB2</i>	Qrob_P0437590.2	<i>MdMYB10</i> (DQ267896), <i>FaTTG1</i> (JQ989287)
<i>QaMYB3</i>	Qrob_P0398080.2	<i>DcTT8</i> (PKU66073.1)
<i>QaWD40</i>	Qrob_P0231390.2	

Table S2. Primers used in the study

Gene	Forward primer	Reverse primer
Primers used for PCR amplification		
<i>QaPAL1</i>	ATGGAATATTGCAATGGAA	TTAATTTATAGGAAGAGGAGCAC
<i>QaPAL2</i>	ATGGGAACCAATATTAATAAAAG	TCACCTAATCAACTCGGTC
<i>Qa4CL1</i>	ATGGAGTCCCAAAAAGACCT	TTAATTTGCTAGACCTGCTGC
<i>Qa4CL2</i>	ATGGCTCTCCAAACAAAGGA	TCAAAGGTGAAAGGGACCC
<i>Qa4CL3</i>	ATGGGAACCTATTTCATAATTT	TTATTTTCAACATTGGATTCTG
<i>QaCHS1</i>	ATGGCTTCGTCTTTGGATG	TCAGTGACTGGTTTCCACG
<i>QaCHS2</i>	ATGGTGACTGTTGATGAAGTACG	TTAAGCAGAGACGCTGTGGA
<i>QaCHS3</i>	ATGTCAAGAACTAATGGCAATG	TTACAGGCTACGGACGAGTAT
<i>QaCHS4</i>	ATGGCGTTAGTTGGAATCTC	TCACCCATGCTTTATAGGAGAA
<i>QaCHI1</i>	ATGGTCCTAGTAGCGTCTCTTC	TCAGTGACCTTCACATTCACA
<i>QaF3H</i>	ATGGCTCCTACTACTCTCACAGC	CTAAGCAAAGATATCCTCAACGG
<i>QaF3'H1</i>	ATGGAGTCTTCCTCTTCTTGG	CTAATAAAGATGAAGCGGGAG
<i>QaF3'H2</i>	ATGGACTTTTGATCTTTGTAAT	TTAGAAAGTAATAGGAATAGCTT
<i>QaDFR1</i>	ATGGGGTCAGAGGGTGAG	TCAATCTTTTTTCGTGCCAG
<i>QaDFR2</i>	ATGGAAGGAGATAAGGGTACAGT	CTAGAGAAACCCCTTTTCTTTG
<i>QaDFR3</i>	ATGGCCACCCAAAACCTT	TTATATCTGCAGCAGGCCCT
<i>QaANS1</i>	ATGGTGACTTCAGTGGCTC	TTATTTAAGAGCAGCAGCAGA
<i>QaANS2</i>	ATGGAACCAGAAATAACGACG	TTAAGTGCCTTTCTGGATCCTC
<i>QaUFGT1</i>	ATGTCCTCTTCCTCGACCAAT	TCATTCCTTTGCTGCATTTC
<i>QaUFGT2</i>	ATGTCGATGACCAAAAGCTC	TTAAGGCACAGATATTAGCTCCA
<i>QaUFGT3</i>	ATGTCAGTGACCAAAAGCTCTC	TTAAGGCACAGATGTTAGCTCG
<i>QaMYB1</i>	ATGGAGGGCTCTTTCGGT	TCAGTAAGCTGCAGTAGTCTTAA
<i>QaMYB2</i>	ATGGGAAGGGCTCCTTGT	TCAGATCAATAGTGATTACAGAA
<i>QaMYB3</i>	ATGGAGGGCTCTTTGGT	CTATTCTGCATTGAGAACCTCC
<i>QaWD40</i>	ATGGGTGCGAGTAGCGAT	TCATACCCTAAGTATCTGAAGCT
Primers used for semi-quantitative or quantitative real-time PCR		
<i>YGQaPAL1</i>	CTTGCCCCACAAATTGAAGT	TGAAGCAATGGCTAGACGTG
<i>YGQaPAL2</i>	GTGAAGCTCGGAGGTGAGAC	GAAGTTGCACCAAACCCAGT
<i>YGQa4CL1</i>	GCCAAACTTGGACAGGGTTA	CCAGTTTCTGGGTCAACGAT
<i>YGQa4CL2</i>	GGCATTGGACAAGGAGATGT	TGCGTGATAATGAGCTTTGC
<i>YGQaCHS1</i>	AGTTGGGAAAAGAAGCAGCA	CAGCAAAGCAACCTTGTGA
<i>YGQaCHS2</i>	CCCAATTCTGAGGTTGAGA	TTTGAAATGAGGCCAGGAAC
<i>YGQaCHI</i>	GAAAGAGTGCGGAGGAGTTG	TTTTCAACGGCTTTGGTTTC
<i>YGQaF3H</i>	GGGAGAAGACCCTTCAGTCC	AACACCCCAGTCCTCACAAG
<i>YGQaF3'H1</i>	CAGGGCGGAGATTGATAAAA	GTATTGCCTCTGCCAATGGT
<i>YGQaDFR1</i>	GAGGGTGAGACCGTTTGTGT	CTTCGTTCAAGTCAGCCTTC
<i>YGQaDFR2</i>	GGCCATAACACTCCAAAGGA	TTGAATGGCTCCATCAAACA
<i>YGQaDFR3</i>	CACATGTGGAGGATGTTTGC	GGGAAATCCCCAAAATCAGT
<i>YGQaANS1</i>	TGGGTCACAGCAAAATGTGT	TGGTGGCTCACAAAAGACTG
<i>YGQaUFGT1</i>	CAAACATGGTGGTGAAGTGC	ACTCACCTCCTTCCCCAACT
<i>YGQaMYB1</i>	TTCTGTCTAGTGCAGGCTTA	GCTAGCGAGACTGCCTGTT

YGQaMYB2	GGCTGCTTAGGTGTGGAAG	TTATCAGTTCGACCGGAAG
YGQaMYB3	TCCGGGAAGAACAGCTAATG	GCAGGTTTCCCACTTAACCA
YGQaWD40	GAGACACCAAGCGTCTGTCA	CTGAGACGACGACCACTGAA
Primers used for analysis of simple sequence repeats		
<i>ssrQrZAG96</i>	CCCAGTCACATCCACTACTGTCC	GGTTGGGAAAAGGAGATCAGA
<i>ssrQrZAG102</i>	GCCTACACTCTTCAATCTACATGA	GACTTGTAACACCTTAAGCATTATCT
<i>ssrQrZAG112</i>	TTCTTGCTTTGGTGCGCG	GTGGTCAGAGACTCGGTAAGTATTC
<i>ssrQrZAG7</i>	CAACTGGTGTTCGGATCAA	GTGCATTCTTTTATAGCATTAC
<i>Qden03011</i>	AACCCAACCTTCCCTTCATC	GCAGTGGTGCCTAATGTAGAC
<i>Qden03021</i>	ACAGCAAACCAGACTCCAC	CCCCAAAGTTTCGGCTAATAC
<i>Qden03032</i>	AGTTGTGGTCCTGCTCGC	GAAAAGTGCGATGACGGTTG
<i>Qden05011</i>	CCCACTCCCTGTCCATTGT	CACTGTGTGCTGCGACTTG
<i>Qden05031</i>	CCCGATTGCGCATCATTTGT	GTAACGCCGTTTTCTCCACC