Supplementary table 1. Primers used in this study.

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| **Accession no.** | **Sequence (5’-3’)** | **usage of primers** |
| MdFRK2P | F: CTGTTTAGTCATCAATTAAGATC | Vector construction for tobacco plant transformation |
| R: TTCACTAATGGATTATTTATGTC |
| qMdSDH1 | F: CTGTACCAGAGGCACCTCCGAGT | Quantitative expression of  MdSDH1 |
| R: TTGCATGCTCTGCTCTCTCGTTG |
| qMdSDH2 | F: ACA CCATCA AGA TCCTACCTT TC | Quantitative expression of  MdSDH2 |
| R: CATTTCATGGTC TTGAGGTAGTG |
| qMdCWINV1 | F: TAA CAA ATA TGT GGT GCT CCT CTG | Quantitative expression of  qMdCWINV1 |
| R:ACC CTA GCT GTT ATG CAC GCC T |
| qMdCWINV2 | F: TTC AAA GCT AAA GGC AGA CAC G | Quantitative expression of  qMdCWINV2 |
| R:GTA AAT CTA CAT CTA CAA AGC CAG C |
| qMdNINV1 | F: CTGTACCAGAGGCACCTCCGAGT | Quantitative expression of  MdNINV1 |
| R: TTGCATGCTCTGCTCTCTCGTTG |
| qMdSUSY1 | F: CTC AAG CGT GTT AAG CAA CAG | Quantitative expression of  qMdSUSY1 |
| R:CTG AAT GGA ACA CGA AGA ATA TC |
| qMdSUSY4 | F: CTGTACCAGAGGCACCTCCGAGT | Quantitative expression of  MdSUSY4 |
| R: TTGCATGCTCTGCTCTCTCGTTG |
| qMdFRK1 | F: CTGTACCAGAGGCACCTCCGAGT | Quantitative expression of  MdFRK1 |
| R: TTGCATGCTCTGCTCTCTCGTTG |
| qMdFRK2 | F: CTGTACCAGAGGCACCTCCGAGT | Quantitative expression of  MdFRK2 |
| R: TTGCATGCTCTGCTCTCTCGTTG |
| qMdFRK3 | F:AGA GTCAAGGGTATGAAGGTAGAT G | Quantitative expression of  MdFRK3 |
| R:CTC GTCCTGAAGCAA AGA AAGAT |
| qMdFRK4 | F:TCAGGATGAGGAGGGGCTACGAG | Quantitative expression of  MdFRK4 |
| R:CTGCTTTAAGCACTGGAGCACAGC |
| qMdHXK1 | F: CTG AAA GTG GTC GGG AGC AAA C | Quantitative expression of  qMdHXK1 |
| R:TGC ACG AGT GGC AAC TAT GTC G |
| qMdHXK2 | F:TGGTGGATTATACGAGCATTACA | Quantitative expression of  MdHXK2 |
| R:TCCAGGGTATTGTGAGTGAGA G |
| qMdHXK3 | F: AGA TTG TGG CGG ATG TAT GTG AC | Quantitative expression of  qMdHXK3 |
| R:CAA CAG TCC TCT TGC CAA AAA TG |
| qMdActin | F:GGACAGCGAGGACATTCAGC | Real-time PCR of actin as a reference gene in apple plants |
| R:CTGACCCATTCCAACCATAACA |