

Supplementary files:**Table S1:** List of primers used in this study

| Loc ID | Gene Name | Primer Sequence |
|---------------|------------------|--------------------------------------------------------------------------|
| LOC106764676 | VrHK2 | F: TCGGGCTTGCCTTGAATCCT R: CCTTGATGGACCCCGTGGAA |
| LOC106755439 | VrHK3 | F: TGTCTGCGTCTTGGTTGGT R: TGCCCAGAGATCTTCTCCCA |
| LOC106770782 | VrHK4.2 | F: GGTGCTTGACCGTGCCAAAA R: CCAACCTGGGGTCGGCTTAT |
| LOC106760765 | VrPHYE | F: GACGAGAGTGCATGCTGTTCTG R: TAGCTGCAAAGTGCTGCCTTCAT |
| LOC106754157 | VrEIN4.1 | F: CCTGATCTGGTCGCTGGTGA R: CCAGGTTCTCTTTCAGAATGTTGT |
| LOC106771501 | VrHP2 | F: TACCAGTGAGCAGCGAGTGG R: AACTGGCACTGCTTCCCTT |
| LOC106773913 | VrHP4.1 | F: GAAACCAATCCCGCAGGCAG R: GCGACATGCTGTTTCCTGGG |
| LOC106773969 | VrHP6.1 | F: CACTGCATTGGCAGCGTAGG R: GCCGATCATCCTTCGGTTTGG |
| LOC106760963 | VrRR3 | F: GGGGTTGGACGAGCAGAGAG R: GAGAAGCGAGAACGGTGGGT |
| LOC106767155 | VrRR5.2 | F: TCCTTCTGGTTCGCCAGAGC R: TGAGCAAGACCAAATGACAAACAAA |
| LOC106752532 | VrRR9 | F: GGAGTTTCTGGGGTTGCGTG R: GTCTCAGGTGAAAGCCCCTGT |
| LOC106763713 | VrRR10 | F: TGGCCAGCCACCTTCAGAAA R: GTCTGTGTTTCCTTGAAATGGCAC |

Table S2: Conserved domain and cellular localization of *VrTCS* proteins

| | Accession no | Gene name | domain analysis | Cellular localization |
|-----------|----------------|-----------------|---------------------------|---------------------------------|
| HK family | XP_014493084.1 | <i>VrHK3</i> | TM,CHASE,HisK,HATPase,REC | Plasma Membrane |
| | XP_014504489.1 | <i>VrHK2</i> | TM,CHASE,HisK,HATPase,REC | Plasma Membrane |
| | XP_014521127.1 | <i>VrHK4.1</i> | TM,CHASE,HisK,HATPase,REC | Cytoplasmic |
| | XP_014512070.1 | <i>VrHK4.2</i> | TM,CHASE,HisK,HATPase,REC | Cytoplasmic |
| | XP_014511763.1 | <i>VrCK11</i> | TM,HisK,HATPase,REC | Plasma Membrane |
| | XP_014520983.1 | <i>VrHK1.1</i> | TM,HisK,HATPase,REC | Plasma Membrane |
| | XP_014509790.1 | <i>VrHK1.2</i> | TM,HisK,HATPase,REC | Plasma Membrane |
| | XP_022636630.1 | <i>VrCK12</i> | CCR,HisK,HATPase,REC | Nuclear |
| | XP_014502712.1 | <i>VrHK5</i> | CCR,HisK,HATPase,REC | Nuclear |
| | XP_014493880.1 | <i>VrETR1</i> | TM,GAF,HisK,HATPase,REC | Plasma Membrane |
| | XP_022634661.1 | <i>VrERS1</i> | TM,GAF,HisK,HATPase | Plasma Membrane |
| | XP_014491627.1 | <i>VrEIN4.1</i> | TM,GAF,HisK,REC | Plasma Membrane |
| | XP_014491630.1 | <i>VrEIN4.2</i> | TM,GAF,HisK,REC | Plasma Membrane |
| | XP_014513852.1 | <i>VrERS2</i> | TM,GAF,HisK,HATPase,REC | Plasma Membrane |
| | XP_014514415.1 | <i>VrETR2</i> | TM,GAF,HisK,REC | Plasma Membrane |
| | XP_014513562.1 | <i>VrPHYA</i> | GAF,PAS,PAC,HisK,HATPase | Cytoplasmic |
| | XP_014499672.1 | <i>VrPHYE</i> | GAF,PAS,PAS,HisK,HATPase | Cytoplasmic, Plasma Membrane |
| | XP_014491560.1 | <i>VrPHYB</i> | GAF,PAS,PAC,HisK,HATPase | Cytoplasmic |
| HP family | XP_014517590.1 | <i>VrHPI.1</i> | HPT | Cytoplasmic, Extracellular |
| | XP_014507545.1 | <i>VrHPI.2</i> | HPT | Cytoplasmic, Nuclear |
| | XP_014512934.1 | <i>VrHPI.3</i> | HPT | Nuclear |
| | XP_014512980.1 | <i>VrHP2</i> | HPT | Nuclear |
| | XP_014516166.1 | <i>VrHP4.1</i> | HPT | Nuclear |

| | | | | |
|------------|----------------|-----------------|-------------|-----------------------------------|
| | XP_014500111.1 | <i>VrHP4.2</i> | HPT | Nuclear |
| | XP_022636012.1 | <i>VrHP5</i> | HPT | Nuclear, Cytoplasmic |
| | XP_014516228.1 | <i>VrHP6.1</i> | HPT | Extracellular |
| | XP_014500874.2 | <i>VrHP6.2</i> | HPT | Extracellular, Plasma Membrane |
| Type-A RRs | XP_014499904.1 | <i>VrRR3</i> | REC | Nuclear |
| | XP_014507166.1 | <i>VrRR5.1</i> | REC | Nuclear |
| | XP_014496480.1 | <i>VrRR6</i> | REC | Nuclear, Chloroplast |
| | XP_014507478.1 | <i>VrRR5.2</i> | REC | Nuclear, Cytoplasmic |
| | XP_014489713.1 | <i>VrRR9</i> | REC | Nuclear |
| | XP_014522822.1 | <i>VrRR8.1</i> | REC | Nuclear |
| | XP_014499886.1 | <i>VrRR8.2</i> | TM,REC | Nuclear, Plasma Membrane |
| | XP_014498631.1 | <i>VrRR17</i> | REC | Nuclear, Extracellular |
| Type-B RRs | XP_014508686.1 | <i>VrRR1</i> | REC,HTM_MYB | Nuclear |
| | XP_014499068.1 | <i>VrRR2</i> | REC,HTM_MYB | Nuclear |
| | XP_022643111.1 | <i>VrRR14</i> | REC,HTM_MYB | Nuclear |
| | XP_014501987.1 | <i>VrRR18</i> | REC,HTM_MYB | Nuclear |
| | XP_014496227.1 | <i>VrRR12</i> | REC,HTM_MYB | Nuclear |
| | XP_022638188.1 | <i>VrRR10</i> | REC,HTM_MYB | Nuclear |
| | XP_014520235.1 | <i>VrRR11.1</i> | REC | Nuclear |
| | XP_014506928.1 | <i>VrRR11.2</i> | REC | Nuclear |
| Type-C RRs | XP_014491455.1 | <i>VrRR22</i> | REC | Cytoplasmic |
| | XP_022634687.1 | <i>VrRR36</i> | REC | Chloroplast, Mitochondrial |
| | XP_014494988.1 | <i>VrRR24</i> | REC | Nuclear, Mitochondrial |
| PRRs | XP_014509970.1 | <i>VrPRR1.2</i> | REC,CCT | Nuclear |
| | XP_014494669.1 | <i>VrPRR1.1</i> | REC,CCT | Nuclear |
| | XP_014520921.1 | <i>VrPRR2.1</i> | REC,MYB | Nuclear |
| | XP_014510108.1 | <i>VrPRR2.2</i> | REC,MYB | Nuclear |

| | | | | |
|--|----------------|-----------------|---------|---------|
| | XP_014491914.1 | <i>VrPRR7.1</i> | REC,CCT | Nuclear |
| | XP_014499070.1 | <i>VrPRR5</i> | REC,CCT | Nuclear |
| | XP_014524112.1 | <i>VrPRR9</i> | REC,CCT | Nuclear |
| | XP_014491911.1 | <i>VrPRR7.2</i> | REC,CCT | Nuclear |