

**Supplementary Table 1: Comparison of q values for significant ( $q < 0.05$ ) marker trait associations detected with models (1), (2), (3) and (4).**

| Trait | Locus    | DNA fragments | Chr. No. | Model (1): Origin | Model (2): Kinship | Model (3): Kinship and origin | Model (4): No origin, no kinship |
|-------|----------|---------------|----------|-------------------|--------------------|-------------------------------|----------------------------------|
| CQA   | STM0038  | STM0038-e     | II       | 0.136             | 0.039              | 0.160                         | 0.011                            |
| CQA   | G6pdh    | G6pdh-4b      | II       | 0.044             | 0.008              | 0.031                         | 0.017                            |
| CQA   |          | G6pdh-4d      | II       | 0.000             | 0.000              | 0.000                         | 0.000                            |
| CQA   | Stp23    | Stp23-7a      | III      | 0.005             | 0.046              | 0.004                         | 0.060                            |
| CQA   |          | Stp23-7b      | III      | 0.001             | 0.363              | 0.026                         | 0.134                            |
| CQA   |          | Stp23-8b      | III      | 0.002             | 0.332              | 0.029                         | 0.265                            |
| CQA   | Pain1    | Pain1-5b      | III      | 0.066             | 0.107              | 0.046                         | 0.203                            |
| CQA   |          | Pain1-5c      | III      | 0.000             | 0.030              | 0.000                         | 0.011                            |
| CQA   |          | Pain1-9a      | III      | 0.001             | 0.030              | 0.001                         | 0.023                            |
| CQA   |          | Pain1-8c      | III      | 0.001             | 0.079              | 0.001                         | 0.027                            |
| CQA   | Sssl     | Sssl-11a      | III      | 0.061             | 0.025              | 0.044                         | 0.041                            |
| CQA   |          | Sssl-11b      | III      | 0.077             | 0.039              | 0.072                         | 0.033                            |
| CQA   |          | Sssl-4b       | III      | 0.004             | 0.041              | 0.003                         | 0.039                            |
| CQA   |          | Sssl-7a       | III      | 0.004             | 0.070              | 0.004                         | 0.060                            |
| CQA   | StpL     | StpL-3b       | V        | 0.000             | 0.002              | 0.000                         | 0.002                            |
| CQA   |          | StpL-3d       | V        | 0.054             | 0.171              | 0.023                         | 0.520                            |
| CQA   |          | StpL-3e       | V        | 0.000             | 0.000              | 0.000                         | 0.000                            |
| CQA   | Sut2     | Sut2-11a      | V        | 0.037             | 0.224              | 0.031                         | 0.293                            |
| CQA   |          | Sut2-9c       | V        | 0.047             | 0.246              | 0.038                         | 0.317                            |
| CQA   |          | Sut2-9b       | V        | 0.198             | 0.049              | 0.182                         | 0.044                            |
| CQA   |          | Sut2-5b       | V        | 0.017             | 0.030              | 0.012                         | 0.085                            |
| CQA   | Sps      | Sps3-a        | VII      | 0.029             | 0.003              | 0.023                         | 0.005                            |
| CQA   |          | Sps-3i        | VII      | 0.035             | 0.005              | 0.030                         | 0.006                            |
| CQA   |          | Sps-7c        | VII      | 0.022             | 0.005              | 0.019                         | 0.006                            |
| CQA   |          | Sps-15b       | VII      | 0.034             | 0.020              | 0.029                         | 0.047                            |
| CQA   | Sus3     | Sus3-1c       | VII      | 0.749             | 0.049              | 0.673                         | 0.060                            |
| CQA   | AGPaseB  | AGPsb-15a     | VII      | 0.123             | 0.006              | 0.095                         | 0.006                            |
| CQA   |          | AGPsb-6b      | VII      | 0.054             | 0.005              | 0.037                         | 0.005                            |
| CQA   | GP171    | GP171-a       | VIII     | 0.000             | 0.003              | 0.000                         | 0.004                            |
| CQA   | STM1052  | STM1052-b     | IX       | 0.478             | 0.005              | 0.438                         | 0.005                            |
| CQA   | Inv-ap-b | InvGF-4b      | IX       | 0.420             | 0.049              | 0.409                         | 0.038                            |
| CQA   |          | InvGF-4d      | IX       | 0.030             | 0.048              | 0.031                         | 0.039                            |
| CQA   |          | InvGE-6f      | IX       | 0.034             | 0.057              | 0.036                         | 0.049                            |
| CQA   | STM3012  | STM3012-a     | IX       | 0.045             | 0.402              | 0.036                         | 0.601                            |
| CQA   | StpH     | StpH-13a      | IX       | 0.045             | 0.006              | 0.031                         | 0.017                            |
| CQA   |          | StpH-3b       | IX       | 0.123             | 0.005              | 0.001                         | 0.134                            |
| CQA   |          | StpH-3c       | IX       | 0.079             | 0.001              | 0.001                         | 0.027                            |
| CQA   |          | StpH-13c      | IX       | 0.045             | 0.005              | 0.031                         | 0.017                            |
| CQA   | STM3023b | STM3023b-e    | IX       | 0.034             | 0.440              | 0.029                         | 0.460                            |
| CQA   | Rca      | Rca-3b        | X        | 0.071             | 0.010              | 0.064                         | 0.011                            |
| CQA   |          | Rca-1a        | X        | 0.000             | 0.000              | 0.000                         | 0.000                            |
| CQA   | Inv-ap-a | pCD141-3c     | X        | 0.008             | 0.021              | 0.007                         | 0.017                            |
| CQA   |          | pCD141-3b     | X        | 0.035             | 0.050              | 0.030                         | 0.049                            |
| CQA   | CT120    | CT120/RsaI-b  | XI       | 0.261             | 0.072              | 0.267                         | 0.037                            |
| CQA   |          | CT120/TaqI-a  | XI       | 0.078             | 0.032              | 0.073                         | 0.031                            |
| CQA   | GP250    | GP250/Vspl-a  | XI       | 0.045             | 0.125              | 0.036                         | 0.118                            |

|     |                 |                |      |       |       |       |       |
|-----|-----------------|----------------|------|-------|-------|-------|-------|
| CQA | <i>St1.1</i>    | St1.1_Hinfl-a  | XI   | 0.036 | 0.125 | 0.031 | 0.085 |
| CQA |                 | St1.1_HaeIII-b | XI   | 0.045 | 0.125 | 0.036 | 0.095 |
| CQA | <i>Sut1</i>     | Sut1-7a        | XI   | 0.402 | 0.039 | 0.401 | 0.021 |
| CQA | <i>STM0037</i>  | STM0037-a      | XI   | 0.036 | 0.238 | 0.031 | 0.261 |
| CQA |                 | STM0037-c      | XI   | 0.030 | 0.007 | 0.026 | 0.005 |
| CQA | <i>Dbe</i>      | Dbe-5c         | XI   | 0.186 | 0.022 | 0.140 | 0.055 |
| CQA |                 | Dbe-8a         | XI   | 0.211 | 0.039 | 0.135 | 0.134 |
| CQA |                 | Dbe-5f         | XI   | 0.066 | 0.010 | 0.036 | 0.039 |
| CQA |                 | Dbe-5g         | XI   | 0.045 | 0.003 | 0.036 | 0.002 |
| CQA |                 | Sus4-2a        | XII  | 0.483 | 0.070 | 0.432 | 0.017 |
| CQS | <i>STM0038</i>  | STM0038-e      | II   | 0.057 | 0.025 | 0.055 | 0.017 |
| CQS | <i>G6pdh</i>    | G6pdh-4d       | II   | 0.000 | 0.000 | 0.000 | 0.000 |
| CQS | <i>Stp23</i>    | Stp23-7a       | III  | 0.000 | 0.000 | 0.000 | 0.000 |
| CQS |                 | Stp23-7b       | III  | 0.000 | 0.000 | 0.000 | 0.000 |
| CQS |                 | Stp23-8b       | III  | 0.000 | 0.000 | 0.000 | 0.000 |
| CQS |                 | Stp23-8a       | III  | 0.003 | 0.002 | 0.002 | 0.002 |
| CQS | <i>Pain1</i>    | Pain1-5b       | III  | 0.048 | 0.035 | 0.030 | 0.058 |
| CQS |                 | Pain1-5c       | III  | 0.000 | 0.000 | 0.000 | 0.000 |
| CQS |                 | Pain1-9a       | III  | 0.000 | 0.000 | 0.000 | 0.000 |
| CQS |                 | Pain1-8c       | III  | 0.000 | 0.000 | 0.000 | 0.000 |
| CQS | <i>Sssl</i>     | Sssl-4b        | III  | 0.000 | 0.001 | 0.000 | 0.001 |
| CQS |                 | Sssl-7a        | III  | 0.000 | 0.001 | 0.000 | 0.001 |
| CQS | <i>StpL</i>     | StpL-3b        | V    | 0.000 | 0.000 | 0.000 | 0.000 |
| CQS |                 | StpL-3d        | V    | 0.021 | 0.043 | 0.030 | 0.047 |
| CQS |                 | StpL-3e        | V    | 0.000 | 0.000 | 0.000 | 0.000 |
| CQS |                 | StpL-3c        | V    | 0.048 | 0.171 | 0.142 | 0.083 |
| CQS | <i>Sut2</i>     | Sut2-11a       | V    | 0.047 | 0.044 | 0.033 | 0.073 |
| CQS |                 | Sut2-6c        | V    | 0.048 | 0.039 | 0.030 | 0.075 |
| CQS |                 | Sut2-5b        | V    | 0.026 | 0.024 | 0.019 | 0.033 |
| CQS | <i>Sps</i>      | Sps-3f         | VII  | 0.065 | 0.050 | 0.055 | 0.047 |
| CQS | <i>Sus3</i>     | Sus3-1a        | VII  | 0.020 | 0.031 | 0.017 | 0.036 |
| CQS |                 | Sus3/STM1043-a | VII  | 0.024 | 0.014 | 0.015 | 0.047 |
| CQS |                 | Sus3/STM1097-a | VII  | 0.020 | 0.014 | 0.015 | 0.047 |
| CQS | <i>Pha2</i>     | Pha2-3a        | VII  | 0.001 | 0.002 | 0.001 | 0.001 |
| CQS | <i>AGPaseB</i>  | AGPsb-15a      | VII  | 0.094 | 0.033 | 0.056 | 0.047 |
| CQS |                 | AGPss-6b       | VII  | 0.040 | 0.009 | 0.020 | 0.013 |
| CQS | <i>GP171</i>    | GP171-a        | VIII | 0.000 | 0.000 | 0.000 | 0.000 |
| CQS | <i>Inv-ap-b</i> | InvGF-4d       | IX   | 0.041 | 0.298 | 0.187 | 0.047 |
| CQS |                 | InvGE-6f       | IX   | 0.040 | 0.298 | 0.187 | 0.047 |
| CQS | <i>STM3012</i>  | STM3012-c      | IX   | 0.011 | 0.024 | 0.010 | 0.026 |
| CQS |                 | STM3012-a      | IX   | 0.041 | 0.061 | 0.030 | 0.106 |
| CQS | <i>StpH</i>     | StpH-3a        | IX   | 0.078 | 0.045 | 0.017 | 0.092 |
| CQS |                 | StpH-13b       | IX   | 0.078 | 0.055 | 0.046 | 0.097 |
| CQS |                 | StpH-13a       | IX   | 0.040 | 0.007 | 0.017 | 0.019 |
| CQS |                 | StpH-3b        | IX   | 0.281 | 0.043 | 0.034 | 0.303 |
| CQS |                 | StpH-3c        | IX   | 0.281 | 0.043 | 0.034 | 0.225 |
| CQS | <i>STM3023b</i> | STM3023b-e     | IX   | 0.048 | 0.142 | 0.051 | 0.129 |
| CQS | <i>Rca</i>      | Rca-3b         | X    | 0.098 | 0.043 | 0.082 | 0.047 |
| CQS |                 | Rca-1a         | X    | 0.016 | 0.001 | 0.012 | 0.001 |
| CQS | <i>Inv-ap-a</i> | pCD141-3c      | X    | 0.028 | 0.031 | 0.024 | 0.029 |
| CQS | <i>STM0037</i>  | STM0037-a      | XI   | 0.043 | 0.045 | 0.030 | 0.074 |
| CQS |                 | STM0037-c      | XI   | 0.078 | 0.043 | 0.051 | 0.058 |

|     |                 |                |      |       |       |       |       |
|-----|-----------------|----------------|------|-------|-------|-------|-------|
| CQS | <i>Dbe</i>      | Dbe-5f         | XI   | 0.028 | 0.006 | 0.017 | 0.013 |
| TSC | <i>G6pdh</i>    | G6pdh-4d       | II   | 0.000 | 0.000 | 0.000 | 0.000 |
| TSC | <i>Stp23</i>    | Stp23-7a       | III  | 0.000 | 0.000 | 0.000 | 0.000 |
| TSC |                 | Stp23-7b       | III  | 0.000 | 0.004 | 0.000 | 0.003 |
| TSC |                 | Stp23-8b       | III  | 0.000 | 0.000 | 0.000 | 0.000 |
| TSC |                 | Stp23-8a       | III  | 0.000 | 0.000 | 0.000 | 0.000 |
| TSC |                 | Stp23-7c       | III  | 0.029 | 0.115 | 0.108 | 0.040 |
| TSC | <i>Pain1</i>    | Pain1-5b       | III  | 0.002 | 0.002 | 0.001 | 0.004 |
| TSC |                 | Pain1-5c       | III  | 0.000 | 0.000 | 0.000 | 0.000 |
| TSC |                 | Pain1-9a       | III  | 0.000 | 0.000 | 0.000 | 0.000 |
| TSC |                 | Pain1-8c       | III  | 0.000 | 0.000 | 0.000 | 0.000 |
| TSC |                 | Pain1-5d       | III  | 0.045 | 0.023 | 0.033 | 0.027 |
| TSC | <i>Sssl</i>     | Sssl-4b        | III  | 0.000 | 0.001 | 0.000 | 0.000 |
| TSC |                 | Sssl-7a        | III  | 0.000 | 0.002 | 0.001 | 0.002 |
| TSC | <i>StKI</i>     | inhib-d        | III  | 0.063 | 0.077 | 0.090 | 0.043 |
| TSC | <i>StpL</i>     | Stpl-3b        | V    | 0.000 | 0.000 | 0.000 | 0.000 |
| TSC |                 | Stpl-3e        | V    | 0.000 | 0.000 | 0.000 | 0.000 |
| TSC |                 | Stpl-3c        | V    | 0.000 | 0.000 | 0.000 | 0.002 |
| TSC |                 | Stpl-3i        | V    | 0.019 | 0.236 | 0.114 | 0.076 |
| TSC | <i>Sut2</i>     | Sut2-11b       | V    | 0.024 | 0.032 | 0.029 | 0.022 |
| TSC |                 | Sut2-7c        | V    | 0.019 | 0.063 | 0.052 | 0.027 |
| TSC |                 | Sut2-3b        | V    | 0.020 | 0.034 | 0.025 | 0.027 |
| TSC |                 | Sut2-9a        | V    | 0.019 | 0.031 | 0.023 | 0.027 |
| TSC |                 | Sut2-7b        | V    | 0.014 | 0.048 | 0.037 | 0.020 |
| TSC |                 | Sut2-5b        | V    | 0.025 | 0.032 | 0.025 | 0.040 |
| TSC | <i>Sps</i>      | Sps-3f         | VII  | 0.019 | 0.016 | 0.016 | 0.014 |
| TSC |                 | Sps-3h         | VII  | 0.017 | 0.011 | 0.011 | 0.011 |
| TSC | <i>Sus3</i>     | Sus3-1a        | VII  | 0.051 | 0.077 | 0.045 | 0.089 |
| TSC |                 | Sus3-1c        | VII  | 0.053 | 0.016 | 0.037 | 0.020 |
| TSC | <i>Pha2</i>     | Pha2-3a        | VII  | 0.004 | 0.009 | 0.003 | 0.009 |
| TSC |                 | Pha2-3c        | VII  | 0.029 | 0.077 | 0.033 | 0.076 |
| TSC | <i>Gp171</i>    | GP171-a        | VIII | 0.003 | 0.001 | 0.001 | 0.004 |
| TSC | <i>AGPaseB</i>  | AGPsb-15a      | VII  | 0.067 | 0.031 | 0.056 | 0.040 |
| TSC |                 | AGPsb-2a       | VII  | 0.036 | 0.023 | 0.033 | 0.026 |
| TSC | <i>STM3012</i>  | STM3012-b      | IX   | 0.044 | 0.046 | 0.026 | 0.106 |
| TSC | <i>StpH</i>     | StpH-3a        | IX   | 0.063 | 0.011 | 0.002 | 0.072 |
| TSC |                 | StpH-13b       | IX   | 0.064 | 0.037 | 0.025 | 0.076 |
| TSC |                 | StpH-13a       | IX   | 0.065 | 0.016 | 0.026 | 0.046 |
| TSC | <i>STM3023b</i> | STM3023b-e     | IX   | 0.033 | 0.115 | 0.037 | 0.106 |
| TSC | <i>Rca</i>      | Rca-1a         | X    | 0.101 | 0.047 | 0.185 | 0.031 |
| TSC | <i>Inv-ap-a</i> | pCD141-3c      | X    | 0.007 | 0.009 | 0.005 | 0.009 |
| TSC |                 | pCD141-3a      | X    | 0.033 | 0.032 | 0.026 | 0.033 |
| TSC | <i>St1.1</i>    | St1.1_Hinfl-a  | XI   | 0.054 | 0.087 | 0.085 | 0.045 |
| TSC |                 | St1.1_HaeIII-b | XI   | 0.033 | 0.061 | 0.054 | 0.027 |
| TSC | <i>STM0037</i>  | STM0037-a      | XI   | 0.002 | 0.002 | 0.001 | 0.004 |
| TSC |                 | STM0037-g      | XI   | 0.003 | 0.007 | 0.003 | 0.009 |
| TSC | <i>Dbe</i>      | Dbe-5f         | XI   | 0.052 | 0.016 | 0.033 | 0.027 |
| TY  | <i>STM0038</i>  | STM0038-e      | II   | 0.354 | 0.032 | 0.413 | 0.018 |
| TY  | <i>G6pdh</i>    | G6pdh-4d       | II   | 0.291 | 0.052 | 0.280 | 0.045 |
| TY  | <i>StpL</i>     | StpL-3e        | V    | 0.000 | 0.015 | 0.000 | 0.004 |
| TY  | <i>Sut2</i>     | Sut2-11a       | V    | 0.095 | 0.044 | 0.145 | 0.026 |
| TY  |                 | Sut2-8a        | V    | 0.095 | 0.125 | 0.413 | 0.026 |

|     |                 |                |      |       |       |       |       |
|-----|-----------------|----------------|------|-------|-------|-------|-------|
| TY  |                 | Sut2-7a        | V    | 0.095 | 0.132 | 0.418 | 0.026 |
| TY  |                 | Sut2-12a       | V    | 0.095 | 0.032 | 0.167 | 0.018 |
| TY  |                 | Sut2-6c        | V    | 0.095 | 0.033 | 0.121 | 0.026 |
| TY  |                 | Sut2-9c        | V    | 0.095 | 0.044 | 0.107 | 0.026 |
| TY  | <i>Sps</i>      | Sps-3f         | VII  | 0.161 | 0.066 | 0.233 | 0.042 |
| TY  | <i>Sus3</i>     | Sus3/STM1097-f | VII  | 0.435 | 0.044 | 0.274 | 0.045 |
| TY  | <i>AGPaseB</i>  | AGPsb-6c       | VII  | 0.253 | 0.032 | 0.274 | 0.026 |
| TY  | <i>Inv-ap-b</i> | InvGE-6i       | IX   | 0.229 | 0.015 | 0.274 | 0.012 |
| TY  | <i>Rca</i>      | Rca-1a         | X    | 0.354 | 0.065 | 0.413 | 0.026 |
| TY  | <i>Sus4</i>     | Sus4-2b        | XII  | 0.594 | 0.061 | 0.922 | 0.018 |
| TSY | <i>STM0038</i>  | STM0038-d      | II   | 0.054 | 0.258 | 0.049 | 0.264 |
| TSY | <i>Stp23</i>    | Stp23-7a       | III  | 0.002 | 0.079 | 0.001 | 0.092 |
| TSY |                 | Stp23-7b       | III  | 0.026 | 0.065 | 0.008 | 0.132 |
| TSY |                 | Stp23-8b       | III  | 0.002 | 0.009 | 0.001 | 0.021 |
| TSY |                 | Stp23-8a       | III  | 0.002 | 0.017 | 0.002 | 0.021 |
| TSY | <i>Pain1</i>    | Pain1-5b       | III  | 0.072 | 0.089 | 0.045 | 0.152 |
| TSY |                 | Pain1-5c       | III  | 0.053 | 0.039 | 0.004 | 0.120 |
| TSY |                 | Pain1-9a       | III  | 0.003 | 0.065 | 0.002 | 0.092 |
| TSY |                 | Pain1-8c       | III  | 0.002 | 0.049 | 0.001 | 0.057 |
| TSY | <i>Sssl</i>     | Sssl-4a        | III  | 0.089 | 0.049 | 0.087 | 0.067 |
| TSY |                 | Sssl-4b        | III  | 0.012 | 0.065 | 0.008 | 0.067 |
| TSY |                 | Sssl-7a        | III  | 0.012 | 0.065 | 0.008 | 0.067 |
| TSY | <i>StKI</i>     | inhia-d        | III  | 0.158 | 0.049 | 0.175 | 0.057 |
| TSY | <i>StpL</i>     | StpL-3b        | V    | 0.033 | 0.012 | 0.018 | 0.021 |
| TSY |                 | StpL-3c        | V    | 0.074 | 0.120 | 0.045 | 0.153 |
| TSY | <i>Pha2</i>     | Pha2-3c        | VII  | 0.026 | 0.058 | 0.025 | 0.067 |
| TSY | <i>GP171</i>    | GP171-a        | VIII | 0.074 | 0.079 | 0.045 | 0.144 |
| TSY | <i>StpH</i>     | StpH-3a        | IX   | 0.292 | 0.012 | 0.018 | 0.212 |
| TSY | <i>St1.1</i>    | St1.1_HaeIII-b | XI   | 0.048 | 0.375 | 0.067 | 0.268 |
| TSY | <i>STM0037</i>  | STM0037-g      | XI   | 0.025 | 0.065 | 0.014 | 0.092 |
| TSY | <i>Dbc</i>      | Dbc-5c         | XI   | 0.026 | 0.089 | 0.033 | 0.092 |
| TSY | <i>Sus4</i>     | Sus4-2b        | XII  | 0.198 | 0.056 | 0.386 | 0.026 |