Supplementary Material

Identification of QTNs, QTN-by-environment interactions, and their candidate genes for grain size traits in main crop and ratoon rice

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# Supplementary Figures and Tables

## 1.1 Supplementary Figures



**Supplementary Figure 1.** **Manhattan plots for the GWAS for grain width in main crop.** Known genes around QTNs were marked with magenta color, and candidate gene around QTN was marked with dark green color.

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**Supplementary Figure 2. Manhattan plots for grain length in main crop (A-C) and grain width in the joint analysis of main crop and ratoon rice (D-E).** Known genes around QTNs were marked with magenta color, candidate genes around QTN was marked with dark green, and candidate gene around QEI was marked with dark green and stat (\*).



**Supplementary Figure 3.** **Manhattan plots for grain length in ratoon rice.** Known genes around QTNs were marked with magenta color, known genes around QEIs were marked with magenta color and star (\*).



**Supplementary Figure 4.** **Manhattan plots for thousand grain weight in main crop (A-C) and grain width in the joint analysis of main crop and ratoon rice (D-E).** Known genes around QTNs were marked with magenta color, candidate gene around QTN was marked with dark green color, and candidate gene around QEI was marked with dark green color and star (\*).



**Supplementary Figure 5.** **Manhattan plots for the GWAS for thousand grain weight in ratoon rice.** Known genes around QTNs were marked with magenta color.

## 1.2 Supplementary Tables

**Table S1 Descriptive statistics and normal distribution test of grain size in 156 rice accessions in 2 environments**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Trait** | **Location** | **Ave** | **Max** | **Min** | **Std. dev** | **Kurtosis** | **Skewness** | **CV (%)** | ***h2B*(%)** | **W** | **P-value** |
| GW-MC | Env1 | 2.44 | 3.34 | 1.80 | 0.33 | -0.47 | 0.38 | 13.57 | 98.94 | 0.9785 | 0.01394 |
| Env2 | 2.47 | 3.34 | 1.82 | 0.34 | -0.52 | 0.41 | 13.70 | 0.97318 | 0.003452 |
| GL-MC | Env1 | 8.41 | 10.80 | 6.30 | 0.85 | -0.15 | 0.18 | 10.12 | 99.07 | 0.98091 | 0.02691 |
| Env2 | 8.42 | 10.93 | 6.83 | 0.84 | -0.35 | 0.19 | 9.91 | 0.98176 | 0.03398 |
| TGW-MC | Env1 | 23.92 | 33.23 | 16.27 | 3.01 | 0.17 | 0.04 | 12.58 | 96.39 | 0.99457 | 0.8235 |
| Env2 | 24.03 | 32.60 | 17.08 | 2.98 | -0.05 | 0.03 | 12.40 | 0.99345 | 0.6923 |
| GW-RR | Env1 | 2.38 | 3.26 | 1.69 | 0.29 | 0.05 | 0.31 | 12.17 | 97.66 | 0.98778 | 0.1803 |
| Env2 | 2.43 | 3.36 | 1.85 | 0.28 | 0.05 | 0.32 | 11.50 | 0.9879 | 0.1865 |
| GL-RR | Env1 | 8.00 | 10.26 | 6.35 | 0.79 | -0.36 | 0.20 | 9.91 | 98.37 | 0.98265 | 0.0435 |
| Env2 | 8.05 | 10.36 | 6.45 | 0.81 | -0.48 | 0.12 | 10.08 | 0.99109 | 0.4225 |
| TGW-RR | Env1 | 22.32 | 32.58 | 13.13 | 3.09 | 0.62 | 0.23 | 13.83 | 90.21 | 0.98576 | 0.1034 |
| Env2 | 21.74 | 29.57 | 10.17 | 2.84 | 1.26 | -0.20 | 13.04 | 0.9785 | 0.01394 |

GW: grain width; GL: grain length; TGW: thousand grain weight; Env1: environment1; Env2: environment 2

**Table S2 Analysis of variance for grain size traits of 159 rice accessions in two environments**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Traits** | **Source of variation** | **df** | **Main crop** | | |  | **Ratoon rice** | | |
| **MS** | **F** | **Pr(>F)** | **MS** | **F** | **Pr(>F)** |
| GW | Genotypes (G) | 158 | 0.668 | 488.96 | <2E-16 |  | 0.437 | 146.69 | <2E-16 |
|  | Environment (E) | 1 | 0.202 | 146.92 | <2E-16 |  | 0.491 | 164.94 | <2E-16 |
|  | G×E interactions | 158 | 0.007 | 5.16 | <2E-16 |  | 0.011 | 3.55 | <2E-16 |
| GL | Genotypes (G) | 158 | 4.223 | 442.71 | <2E-16 |  | 3.646 | 181.77 | <2E-16 |
|  | Environment (E) | 1 | 0.062 | 6.48 | 1.11E-2 |  | 0.531 | 26.47 | 3.67E-07 |
|  | G×E interactions | 158 | 0.039 | 4.14 | <2E-16 |  | 0.059 | 2.95 | <2E-16 |
| TGW | Genotypes (G) | 158 | 51.950 | 70.96 | <2E-16 |  | 45.100 | 19.35 | <2E-16 |
|  | Environment (E) | 1 | 2.560 | 3.50 | 6.18E-2 |  | 74.740 | 32.07 | 2.35E-08 |
|  | G×E interactions | 158 | 1.880 | 2.57 | <2E-16 |  | 4.490 | 1.93 | 2.03E-08 |

GW: grain width; GL: grain length; TGW: thousand grain weight

**Table S3 Main-effect QTN for grain width in main crop of 159 rice accessions in environment 1**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Marker** | **Chr** | **Position (bp)** | **LOD score** | **Additive** | **Variance** | **r2(%)** | **P-value** | **Significance** |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | | | | |
| 1 | 204944049 | 2 | 4944049 | 9.7150 | 0.0403 | 0.0016 | 1.4413 | 2.253E-11 | SIG |
| 2 | 302248120 | 3 | 2248120 | 12.5121 | -0.0471 | 0.0021 | 1.9516 | 3.1823E-14 | SIG |
| 3 | 316321816 | 3 | 16321816 | 9.1294 | 0.0397 | 0.0015 | 1.3923 | 8.9395E-11 | SIG |
| 4 | 328864309 | 3 | 28864309 | 16.0879 | -0.0553 | 0.0023 | 2.0914 | 8.1781E-17 | SIG |
| 5 | 331987897 | 3 | 31987897 | 8.9685 | -0.0393 | 0.0015 | 1.3932 | 1.0761E-09 | SIG |
| 6 | 505361276 | 5 | 5361276 | 28.8742 | -0.0813 | 0.0058 | 5.2635 | 9.1988E-31 | SIG |
| 7 | 506052088 | 5 | 6052088 | 7.5556 | -0.0349 | 0.0012 | 1.0923 | 3.6658E-09 | SIG |
| 8 | 508302651 | 5 | 8302651 | 10.2630 | -0.0415 | 0.0014 | 1.2897 | 6.2126E-12 | SIG |
| 9 | 707540563 | 7 | 7540563 | 15.6636 | -0.0545 | 0.0013 | 1.1757 | 2.014E-17 | SIG |
| 10 | 713191307 | 7 | 13191307 | 23.4228 | 0.0733 | 0.0012 | 1.0935 | 3.7853E-24 | SIG |
| 11 | 724208049 | 7 | 24208049 | 24.8446 | 0.0732 | 0.0020 | 1.7910 | 1.0601E-26 | SIG |
| 12 | 907639381 | 9 | 7639381 | 27.2761 | 0.0792 | 0.0024 | 2.1483 | 3.749E-29 | SIG |
| 13 | 1004780228 | 10 | 4780228 | 11.1093 | 0.0435 | 0.0015 | 1.3368 | 8.5215E-13 | SIG |
| 14 | 1117401993 | 11 | 17401993 | 29.6568 | -0.0832 | 0.0015 | 1.3662 | 1.4979E-31 | SIG |
| 15 | 1122278809 | 11 | 22278809 | 18.5012 | -0.0595 | 0.0015 | 1.3516 | 2.6992E-20 | SIG |
| 16 | 1126036677 | 11 | 26036677 | 19.5043 | -0.0619 | 0.0033 | 2.9915 | 2.6117E-21 | SIG |
| 17 | 1128029610 | 11 | 28029610 | 30.5384 | 0.0896 | 0.0009 | 0.8092 | 2.9022E-31 | SIG |
| 18 | 1211103678 | 12 | 11103678 | 14.0670 | 0.0502 | 0.0023 | 2.0812 | 8.3808E-16 | SIG |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | | | | |
| 1 | 1005603387 | 10 | 5603387 | 3.3402 | 0.0225 | 0.0004 | 0.3348 | 8.78323E-05 | SUG |
| 2 | 1005711159 | 10 | 5711159 | 3.3402 | 0.0225 | 0.0004 | 0.3348 | 8.78323E-05 | SUG |

**Table S4 Main-effect QTN for grain length in main crop of 159 rice accessions in environment 1**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Marker** | **Chr** | **Position (bp)** | **LOD score** | **Additive** | **Variance** | **r2(%)** | **P-value** | **Significance** |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | | | | |
| 1 | 119393842 | 1 | 19393842 | 11.3069 | -0.1109 | 0.0065 | 0.901 | 5.35991E-13 | SIG |
| 2 | 134736531 | 1 | 34736531 | 16.2889 | 0.0529 | 0.0127 | 1.7513 | 5.14851E-17 | SIG |
| 3 | 202085514 | 2 | 2085514 | 14.7434 | 0.1301 | 0.0084 | 1.1566 | 1.72565E-16 | SIG |
| 4 | 300616193 | 3 | 616193 | 37.0447 | 0.2480 | 0.0186 | 2.5656 | 5.49642E-39 | SIG |
| 5 | 316179400 | 3 | 16179400 | 18.3827 | 0.1494 | 0.0072 | 0.9907 | 3.55737E-20 | SIG |
| 6 | 316746142 | 3 | 16746142 | 40.2497 | 0.2648 | 0.0671 | 9.2713 | 3.29183E-42 | SIG |
| 7 | 401054013 | 4 | 1054013 | 24.4785 | -0.1845 | 0.0128 | 1.7622 | 2.4809E-26 | SIG |
| 8 | 605597086 | 6 | 5597086 | 14.9649 | -0.1317 | 0.0165 | 2.283 | 1.08559E-15 | SIG |
| 9 | 724964429 | 7 | 24964429 | 26.2230 | -0.1906 | 0.0110 | 1.5165 | 4.31965E-28 | SIG |
| 10 | 822125056 | 8 | 22125056 | 11.7954 | -0.1163 | 0.0121 | 1.6667 | 1.7053E-13 | SIG |
| 11 | 915356676 | 9 | 15356676 | 18.6014 | 0.1551 | 0.0132 | 1.8236 | 2.50761E-19 | SIG |
| 12 | 1101936516 | 11 | 1936516 | 17.8416 | 0.1519 | 0.0038 | 0.5279 | 1.44243E-18 | SIG |
| 13 | 1120929766 | 11 | 20929766 | 14.4766 | -0.1294 | 0.0044 | 0.6032 | 3.21804E-16 | SIG |
| 14 | 1126213773 | 11 | 26213773 | 25.7754 | -0.1890 | 0.0350 | 4.8415 | 1.68087E-26 | SIG |
| 15 | 1204438901 | 12 | 4438901 | 10.6687 | -0.1072 | 0.0099 | 1.3697 | 2.39604E-12 | SIG |
| 16 | 1222587924 | 12 | 22587924 | 16.8888 | 0.1423 | 0.0111 | 1.5373 | 1.29356E-17 | SIG |
| 17 | 1227081846 | 12 | 27081846 | 7.8580 | 0.0904 | 0.0069 | 0.9546 | 1.7934E-09 | SIG |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | | | | |
| 1 | 1200776662 | 12 | 776662 | 5.4371 | 0.0736 | 0.0052 | 0.7120 | 5.622E-07 | SUG |

**Table S5 Main-effect QTN for thousand grain weight in main crop of 159 rice accessions in environment 1**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Marker** | **Chr** | **Position (bp)** | **LOD score** | **Additive** | **Variance** | **r2(%)** | **P-value** | **Significance** |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | | | | |
| 1 | 221664294 | 2 | 21664294 | 14.7882 | -0.8023 | 0.3102 | 3.4237 | 1.5543E-16 | SIG |
| 2 | 231404034 | 2 | 31404034 | 12.6891 | 0.7266 | 0.3474 | 3.8333 | 2.1029E-14 | SIG |
| 3 | 431939665 | 4 | 31939665 | 26.4905 | -1.1749 | 0.4169 | 4.6008 | 2.3215E-28 | SIG |
| 4 | 501479400 | 5 | 1479400 | 10.4807 | 0.6493 | 0.3422 | 3.7766 | 3.7261E-12 | SIG |
| 5 | 513854833 | 5 | 13854833 | 9.2282 | 0.6035 | 0.3625 | 4.0004 | 7.0824E-11 | SIG |
| 6 | 603189214 | 6 | 3189214 | 9.6893 | -0.6285 | 0.1851 | 2.0426 | 2.3932E-11 | SIG |
| 7 | 701146652 | 7 | 1146652 | 14.0739 | -0.7784 | 0.4525 | 4.9932 | 8.2467E-16 | SIG |
| 8 | 702651150 | 7 | 2651150 | 31.3033 | -1.3373 | 0.4292 | 4.7361 | 3.292E-33 | SIG |
| 9 | 825154283 | 8 | 25154283 | 13.0226 | 0.7380 | 0.2887 | 3.1858 | 9.6371E-15 | SIG |
| 10 | 1001426946 | 10 | 1426946 | 21.0852 | -1.0067 | 0.3078 | 3.3972 | 6.6004E-23 | SIG |
| 11 | 1103505182 | 11 | 3505182 | 11.7410 | 0.6983 | 0.1584 | 1.7482 | 1.9376E-13 | SIG |
| 12 | 1122137790 | 11 | 22137790 | 11.7666 | -0.6970 | 0.1364 | 1.5049 | 1.8245E-13 | SIG |
| 13 | 1215799876 | 12 | 15799876 | 8.6810 | -0.5830 | 0.1801 | 1.9878 | 2.5708E-10 | SIG |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | | | | |
| 1 | 230953174 | 2 | 30953174 | 6.3746 | 0.4957 | 0.2279 | 2.5148 | 6.026E-08 | SUG |
| 2 | 601540336 | 6 | 1540336 | 4.8293 | 0.4225 | 0.1733 | 1.9127 | 2.4071E-06 | SUG |
| 3 | 1118164358 | 11 | 18164358 | 6.1153 | 0.2351 | 0.2281 | 2.5169 | 7.6716E-07 | SUG |

**Table S6 Main-effect QTN for grain width in ratoon rice of 159 rice accessions in environment 1**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Marker** | **Chr** | **Position (bp)** | **LOD score** | **Additive** | **Variance** | **r2(%)** | **P-value** | **Significance** |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | | | | |
| 1 | 204994560 | 2 | 4994560 | 8.5292 | -0.0340 | 0.0012 | 1.3679 | 3.6779E-10 | SIG |
| 2 | 205481928 | 2 | 5481928 | 16.4204 | -0.0500 | 0.0021 | 2.4642 | 3.8033E-17 | SIG |
| 3 | 229241853 | 2 | 29241853 | 10.8223 | 0.0398 | 0.0007 | 0.7846 | 1.6711E-12 | SIG |
| 4 | 313863861 | 3 | 13863861 | 14.5771 | -0.0465 | 0.0013 | 1.5694 | 2.5451E-16 | SIG |
| 5 | 327973483 | 3 | 27973483 | 22.7161 | -0.0634 | 0.0005 | 0.6190 | 1.9262E-23 | SIG |
| 6 | 335262383 | 3 | 35262383 | 12.4362 | 0.0429 | 0.0018 | 2.1607 | 3.802E-14 | SIG |
| 7 | 429978124 | 4 | 29978124 | 21.9022 | 0.0602 | 0.0007 | 0.8262 | 1.255E-22 | SIG |
| 8 | 505357438 | 5 | 5357438 | 32.9949 | -0.0816 | 0.0057 | 6.7909 | 6.5258E-35 | SIG |
| 9 | 906924345 | 9 | 6924345 | 10.9581 | 0.0392 | 0.0006 | 0.7318 | 1.215E-12 | SIG |
| 10 | 1003262163 | 10 | 3262163 | 30.8766 | 0.0785 | 0.0006 | 0.7324 | 1.332E-31 | SIG |
| 11 | 1107066369 | 11 | 7066369 | 13.5828 | -0.0445 | 0.0007 | 0.8037 | 2.5993E-15 | SIG |
| 12 | 1107818816 | 11 | 7818816 | 8.1079 | -0.0331 | 0.0009 | 1.0146 | 9.9384E-10 | SIG |
| 13 | 1116768397 | 11 | 16768397 | 34.4062 | -0.084 | 0.0019 | 2.2670 | 3.9359E-35 | SIG |
| 14 | 1118748365 | 11 | 18748365 | 12.9745 | -0.0433 | 0.0014 | 1.7036 | 1.0785E-14 | SIG |
| 15 | 1125125749 | 11 | 25125749 | 8.7264 | -0.0344 | 0.0007 | 0.8369 | 2.3103E-10 | SIG |
| 16 | 1212716690 | 12 | 12716690 | 19.1870 | 0.0556 | 0.0028 | 3.3706 | 5.4671E-21 | SIG |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | | | | |
| 1 | 3002278621 | 3 | 850101 | 4.4152 | -0.0240 | 0.0004 | 0.5229 | 6.5104E-06 | SUG |
| 2 | 505323603 | 5 | 5323603 | 7.4433 | 0.0322 | 0.0010 | 1.2248 | 3.606E-08 | SUG |
| 3 | 1004502295 | 10 | 4502295 | 6.7386 | 0.0303 | 0.0007 | 0.8832 | 2.5389E-08 | SUG |
| 4 | 1203761337 | 12 | 3761337 | 6.4363 | 0.0292 | 0.0007 | 0.8495 | 5.2039E-08 | SUG |

**Table S7 Main-effect QTN for grain length in ratoon rice of 159 rice accessions in environment 1**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Marker** | **Chr** | **Position (bp)** | **LOD score** | **Additive** | **Variance** | **r2(%)** | **P-value** | **Significance** |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | | | | |
| 1 | 125212877 | 1 | 25212877 | 15.0073 | -0.1469 | 0.0074 | 1.179 | 9.3192E-17 | SIG |
| 2 | 316708508 | 3 | 16708508 | 32.7223 | 0.2495 | 0.0599 | 9.5155 | 1.2274E-34 | SIG |
| 3 | 334087282 | 3 | 34087282 | 16.4269 | 0.1549 | 0.0046 | 0.7291 | 3.3938E-18 | SIG |
| 4 | 401015786 | 4 | 1015786 | 14.1433 | -0.1412 | 0.0091 | 1.4534 | 7.0114E-16 | SIG |
| 5 | 403785259 | 4 | 3785259 | 23.2110 | -0.1949 | 0.0107 | 1.6956 | 4.7141E-25 | SIG |
| 6 | 425746858 | 4 | 25746858 | 15.3770 | -0.1491 | 0.0222 | 3.5259 | 3.9313E-17 | SIG |
| 7 | 518384394 | 5 | 18384394 | 12.3576 | -0.1310 | 0.0158 | 2.5045 | 4.5694E-14 | SIG |
| 8 | 616645152 | 6 | 16645152 | 7.7001 | -0.0998 | 0.0088 | 1.4037 | 2.6047E-09 | SIG |
| 9 | 724800887 | 7 | 24800887 | 10.7332 | -0.1202 | 0.0056 | 0.8823 | 2.0594E-12 | SIG |
| 10 | 1018229059 | 10 | 18229059 | 10.4415 | -0.1179 | 0.0092 | 1.4545 | 4.0852E-12 | SIG |
| 11 | 1211562787 | 12 | 11562787 | 9.7869 | -0.1147 | 0.0054 | 0.8538 | 1.9024E-11 | SIG |
| 12 | 1214087199 | 12 | 14087199 | 14.2623 | 0.1510 | 0.0122 | 1.9349 | 5.4734E-15 | SIG |
| 13 | 1227144058 | 12 | 27144058 | 8.6598 | 0.1086 | 0.0106 | 1.6826 | 2.1904E-09 | SIG |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | | | | |
| 1 | 204612650 | 2 | 4612650 | 6.4293 | -0.0899 | 0.0078 | 1.244 | 3.7237E-07 | SUG |
| 2 | 321188351 | 3 | 21188351 | 6.3821 | -0.0894 | 0.008 | 1.2699 | 5.9189E-08 | SUG |
| 3 | 1200945154 | 12 | 945154 | 5.8410 | 0.0855 | 0.004 | 0.6386 | 2.1452E-07 | SUG |

**Table S8 Main-effect QTN for thousand grain weight in ratoon rice of 159 riceaccessions in environment 1**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Marker** | **Chr** | **Position (bp)** | **LOD score** | **Additive** | **Variance** | **r2(%)** | **P-value** | **Significance** |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | | | | |
| 1 | 132257504 | 1 | 32257504 | 18.2971 | 0.9231 | 0.2314 | 2.4276 | 5.0536E-19 | SIG |
| 2 | 224702111 | 2 | 24702111 | 10.6541 | 0.6407 | 0.1806 | 1.8943 | 2.48E-12 | SIG |
| 3 | 226049877 | 2 | 26049877 | 17.1879 | -0.8747 | 0.2003 | 2.1016 | 6.4969E-18 | SIG |
| 4 | 228749717 | 2 | 28749717 | 15.3904 | 0.8012 | 0.1663 | 1.7447 | 3.8098E-17 | SIG |
| 5 | 231234763 | 2 | 31234763 | 10.9198 | 0.6500 | 0.296 | 3.105 | 1.3293E-12 | SIG |
| 6 | 316766278 | 3 | 16766278 | 7.7666 | 0.5386 | 0.2663 | 2.7935 | 2.226E-09 | SIG |
| 7 | 404570606 | 4 | 4570606 | 24.2396 | -1.0752 | 0.4415 | 4.6318 | 4.3209E-26 | SIG |
| 8 | 431723084 | 4 | 31723084 | 29.7296 | -1.2454 | 0.3995 | 4.1909 | 1.2651E-31 | SIG |
| 9 | 613946862 | 6 | 13946862 | 9.0655 | -0.6048 | 0.2332 | 2.4468 | 8.6072E-10 | SIG |
| 10 | 819614457 | 8 | 19614457 | 8.0206 | -0.5562 | 0.2143 | 2.2482 | 9.5429E-09 | SIG |
| 11 | 1000463104 | 10 | 463104 | 16.0027 | -0.8516 | 0.2053 | 2.1535 | 9.9509E-17 | SIG |
| 12 | 1010606927 | 10 | 10606927 | 13.5255 | 0.7403 | 0.4212 | 4.4191 | 2.9722E-15 | SIG |
| 13 | 1103384367 | 11 | 3384367 | 9.1131 | 0.5875 | 0.1257 | 1.3183 | 9.2873E-11 | SIG |
| 14 | 1110422612 | 11 | 10422612 | 12.5886 | -0.7091 | 0.108 | 1.1333 | 2.6607E-14 | SIG |
| 15 | 1113977759 | 11 | 13977759 | 9.6315 | 0.5779 | 0.3646 | 3.8243 | 2.3383E-10 | SIG |
| 16 | 1117131649 | 11 | 17131649 | 13.3134 | 0.7316 | 0.1738 | 1.8235 | 4.8649E-14 | SIG |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | | | | |
| 1 | 505895833 | 5 | 5895833 | 6.3175 | 0.4775 | 0.2265 | 2.376 | 6.9026E-08 | SUG |
| 2 | 806110721 | 8 | 6110721 | 6.1099 | -0.4669 | 0.2149 | 2.2541 | 7.7686E-07 | SUG |

**Table S9 Main-effect QTN for grain width in main crop of 159 rice accessions in environment 2**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Marker** | **Chr** | **Position (bp)** | **LOD score** | **Additive** | **Variance** | **r2(%)** | **P-value** | **Significance** |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | | | | |
| 1 | 105991947 | 1 | 5991947 | 13.1902 | 0.0669 | 0.0027 | 2.3651 | 6.4611E-14 | SIG |
| 2 | 223208718 | 2 | 23208718 | 20.8751 | -0.0846 | 0.0017 | 1.4798 | 1.076E-22 | SIG |
| 3 | 324648339 | 3 | 24648339 | 9.1433 | -0.0520 | 0.0026 | 2.2792 | 8.6515E-11 | SIG |
| 4 | 505358771 | 5 | 5358771 | 44.2078 | -0.1497 | 0.0199 | 17.2873 | 6.2205E-45 | SIG |
| 5 | 703682234 | 7 | 3682234 | 11.3492 | -0.0582 | 0.0010 | 0.841 | 4.4789E-12 | SIG |
| 6 | 724771358 | 7 | 24771358 | 18.0897 | 0.0768 | 0.0023 | 1.9638 | 7.0391E-20 | SIG |
| 7 | 915748352 | 9 | 15748352 | 21.2544 | 0.0894 | 0.0014 | 1.2543 | 5.5766E-22 | SIG |
| 8 | 1118748365 | 11 | 18748365 | 15.0925 | -0.0686 | 0.0036 | 3.1333 | 7.6382E-17 | SIG |
| 9 | 1126036677 | 11 | 26036677 | 7.5017 | -0.0459 | 0.0018 | 1.5758 | 4.1643E-09 | SIG |
| 10 | 1211103678 | 12 | 11103678 | 11.9365 | 0.0597 | 0.0032 | 2.8166 | 1.2253E-13 | SIG |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | | | | |
| 1 | 140426419 | 1 | 40426419 | 6.1663 | -0.0409 | 0.0017 | 1.4472 | 6.8215E-07 | SUG |
| 2 | 335144023 | 3 | 35144023 | 6.9298 | 0.0446 | 0.0017 | 1.4528 | 1.1761E-07 | SUG |

**Table S10 Main-effect QTN for grain length in main crop of 159 rice accessions in environment 2**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Marker** | **Chr** | **Position (bp)** | **LOD score** | **Additive** | **Variance** | **r2(%)** | **P-value** | **Significance** |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | | | | |
| 1 | 109828171 | 1 | 9828171 | 25.5362 | -0.1864 | 0.0067 | 0.9579 | 2.13E-27 | SIG |
| 2 | 119393842 | 1 | 19393842 | 12.5261 | -0.1174 | 0.0073 | 1.0479 | 3.08E-14 | SIG |
| 3 | 130176332 | 1 | 30176332 | 15.6156 | -0.1351 | 0.0067 | 0.9585 | 2.25E-17 | SIG |
| 4 | 212917223 | 2 | 12917223 | 13.1978 | -0.0626 | 0.0138 | 1.9770 | 6.35E-14 | SIG |
| 5 | 224992114 | 2 | 24992114 | 13.5568 | -0.1235 | 0.0052 | 0.7519 | 2.76E-15 | SIG |
| 6 | 316708508 | 3 | 16708508 | 47.9439 | 0.3079 | 0.0912 | 13.0860 | 6.11E-50 | SIG |
| 7 | 400960933 | 4 | 960933 | 13.6822 | -0.1238 | 0.0055 | 0.7958 | 2.06E-15 | SIG |
| 8 | 505357676 | 5 | 5357676 | 10.4595 | 0.1059 | 0.0098 | 1.4074 | 3.92E-12 | SIG |
| 9 | 606503404 | 6 | 6503404 | 11.6161 | 0.1123 | 0.0105 | 1.5058 | 2.60E-13 | SIG |
| 10 | 724206745 | 7 | 24206745 | 10.2968 | -0.1050 | 0.0083 | 1.1954 | 5.74E-12 | SIG |
| 11 | 901068639 | 9 | 1068639 | 7.7969 | -0.0908 | 0.0048 | 0.6839 | 2.07E-09 | SIG |
| 12 | 915356676 | 9 | 15356676 | 13.5136 | 0.1245 | 0.0073 | 1.0410 | 3.07E-14 | SIG |
| 13 | 1117830860 | 11 | 17830860 | 9.6088 | 0.1006 | 0.0096 | 1.3802 | 2.89E-11 | SIG |
| 14 | 1204438901 | 12 | 4438901 | 10.2763 | -0.1045 | 0.0094 | 1.3513 | 6.02E-12 | SIG |
| 15 | 1214201832 | 12 | 14201832 | 10.5301 | -0.1077 | 0.0091 | 1.3005 | 3.32E-12 | SIG |
| 16 | 1218051198 | 12 | 18051198 | 27.4850 | -0.1958 | 0.0139 | 1.9912 | 2.31E-29 | SIG |
| 17 | 1224188617 | 12 | 24188617 | 7.4421 | -0.0871 | 0.0071 | 1.0150 | 4.79E-09 | SIG |
| 18 | 1227064916 | 12 | 27064916 | 8.6186 | 0.0948 | 0.0075 | 1.0782 | 2.98E-10 | SIG |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | | | | |
| 1 | 335504491 | 3 | 35504491 | 5.2844 | -0.0727 | 0.0048 | 0.6834 | 8.0969E-07 | SUG |
| 2 | 1223254141 | 12 | 23254141 | 5.9459 | 0.0770 | 0.0034 | 0.4930 | 1.6708E-07 | SUG |

**Table S11 Main-effect QTN for thousand grain weight in main crop of 159 rice accessions in environment 2**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Marker** | **Chr** | **Position (bp)** | **LOD score** | **Additive** | **Variance** | **r2(%)** | **P-value** | **Significance** |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | | | | |
| 1 | 113552450 | 1 | 13552450 | 6.8499 | 0.4231 | 0.1666 | 1.8761 | 1.95E-08 | SIG |
| 2 | 130072714 | 1 | 30072714 | 13.1581 | 0.6015 | 0.0853 | 0.9603 | 7.02E-15 | SIG |
| 3 | 139719661 | 1 | 39719661 | 13.5463 | -0.618 | 0.1707 | 1.9224 | 2.83E-15 | SIG |
| 4 | 208196020 | 2 | 8196020 | 13.1920 | 0.6082 | 0.1991 | 2.2418 | 6.48E-15 | SIG |
| 5 | 225079124 | 2 | 25079124 | 17.1510 | -0.7175 | 0.1126 | 1.2678 | 6.27E-19 | SIG |
| 6 | 410654189 | 4 | 10654189 | 14.4739 | 0.6434 | 0.1353 | 1.5229 | 3.24E-16 | SIG |
| 7 | 433256631 | 4 | 33256631 | 22.6513 | -0.8531 | 0.3621 | 4.0762 | 1.73E-24 | SIG |
| 8 | 522017452 | 5 | 22017452 | 10.2685 | -0.5114 | 0.1615 | 1.8179 | 5.39E-11 | SIG |
| 9 | 603189214 | 6 | 3189214 | 18.2820 | -0.7473 | 0.2617 | 2.9461 | 4.50E-20 | SIG |
| 10 | 707640833 | 7 | 7640833 | 16.5078 | -0.6915 | 0.2192 | 2.4683 | 2.81E-18 | SIG |
| 11 | 718517653 | 7 | 18517653 | 35.1149 | -1.1750 | 0.3255 | 3.6644 | 7.70E-36 | SIG |
| 12 | 817265592 | 8 | 17265592 | 19.6740 | 0.7798 | 0.6141 | 6.9137 | 2.12E-20 | SIG |
| 13 | 1009402611 | 10 | 9402611 | 17.7644 | 0.6798 | 0.5194 | 5.8478 | 1.72E-18 | SIG |
| 14 | 1110907638 | 11 | 10907638 | 15.3171 | 0.6749 | 0.4527 | 5.0967 | 4.52E-17 | SIG |
| 15 | 1200424245 | 12 | 424245 | 14.5405 | -0.6355 | 0.4078 | 4.5913 | 2.88E-15 | SIG |
| 16 | 1200591787 | 12 | 591787 | 14.1359 | -0.2648 | 0.2811 | 3.1642 | 7.32E-15 | SIG |
| 17 | 1210698465 | 12 | 10698465 | 17.6456 | -0.7353 | 0.3738 | 4.2085 | 1.98E-19 | SIG |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | | | | |
| 1 | 100800544 | 1 | 800544 | 5.9737 | -0.3838 | 0.0781 | 0.8791 | 1.5636E-07 | SUG |

**Table S12 Main-effect QTN for grain width in ratoon rice of 159 rice accessions in environment 2**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Marker** | **Chr** | **Position (bp)** | **LOD score** | **Additive** | **Variance** | **r2(%)** | **P-value** | **Significance** |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | | | | |
| 1 | 217616900 | 2 | 17616900 | 11.0079 | 0.0396 | 0.0005 | 0.6547 | 9.829E-12 | SIG |
| 2 | 225565194 | 2 | 25565194 | 22.5009 | -0.0603 | 0.0009 | 1.1252 | 2.455E-24 | SIG |
| 3 | 325165431 | 3 | 25165431 | 13.6068 | 0.0430 | 0.0017 | 2.2313 | 2.4576E-15 | SIG |
| 4 | 335144023 | 3 | 35144023 | 7.9619 | 0.0327 | 0.0009 | 1.202 | 1.0925E-08 | SIG |
| 5 | 404722231 | 4 | 4722231 | 24.4147 | -0.0627 | 0.0018 | 2.3024 | 2.877E-26 | SIG |
| 6 | 505358771 | 5 | 5358771 | 21.4303 | -0.0575 | 0.0029 | 3.754 | 3.7193E-22 | SIG |
| 7 | 506015422 | 5 | 6015422 | 7.5654 | -0.0312 | 0.0010 | 1.228 | 3.5817E-09 | SIG |
| 8 | 513900081 | 5 | 13900081 | 9.2967 | 0.0344 | 0.0012 | 1.499 | 6.0283E-11 | SIG |
| 9 | 521088250 | 5 | 21088250 | 9.3444 | -0.0346 | 0.0006 | 0.8102 | 4.5287E-10 | SIG |
| 10 | 710495471 | 7 | 10495471 | 24.0154 | -0.0624 | 0.0011 | 1.4033 | 7.2735E-26 | SIG |
| 11 | 725284287 | 7 | 25284287 | 29.0213 | 0.0720 | 0.0013 | 1.6967 | 9.544E-30 | SIG |
| 12 | 805984678 | 8 | 5984678 | 17.3524 | 0.0506 | 0.0018 | 2.2875 | 3.9233E-19 | SIG |
| 13 | 808915046 | 8 | 8915046 | 11.3178 | -0.0388 | 0.0014 | 1.7228 | 4.8157E-12 | SIG |
| 14 | 907342896 | 9 | 7342896 | 8.0760 | 0.0320 | 0.0005 | 0.5795 | 1.0717E-09 | SIG |
| 15 | 914471049 | 9 | 14471049 | 11.3938 | 0.0378 | 0.0008 | 1.0372 | 4.0423E-12 | SIG |
| 16 | 1117881763 | 11 | 17881763 | 50.6026 | -0.1134 | 0.0022 | 2.7878 | 2.5078E-51 | SIG |
| 17 | 1125735896 | 11 | 25735896 | 27.5050 | -0.0694 | 0.0026 | 3.3408 | 2.2045E-29 | SIG |
| 18 | 1126041008 | 11 | 26041008 | 13.2197 | 0.0425 | 0.0018 | 2.305 | 6.0763E-15 | SIG |
| 19 | 1203761318 | 12 | 3761318 | 9.2340 | 0.0347 | 0.0010 | 1.2982 | 6.9866E-11 | SIG |
| 20 | 1212532451 | 12 | 12532451 | 11.9395 | 0.0394 | 0.0010 | 1.3327 | 1.1507E-12 | SIG |

**Table S13 Main-effect QTN for grain length in ratoon rice of 159 rice accessions in environment 2**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Marker** | **Chr** | **Position (bp)** | **LOD score** | **Additive** | **Variance** | **r2(%)** | **P-value** | **Significance** |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | | | | |
| 1 | 119393842 | 1 | 19393842 | 7.9068 | -0.1023 | 0.0055 | 0.8410 | 1.60E-09 | SIG |
| 2 | 125276755 | 1 | 25276755 | 10.0922 | -0.1190 | 0.0108 | 1.6445 | 9.28E-12 | SIG |
| 3 | 204007974 | 2 | 4007974 | 7.7872 | 0.1014 | 0.0097 | 1.466 | 2.12E-09 | SIG |
| 4 | 301294521 | 3 | 1294521 | 25.3655 | 0.2100 | 0.0104 | 1.5767 | 3.16E-27 | SIG |
| 5 | 316708508 | 3 | 16708508 | 35.5423 | 0.2704 | 0.0704 | 10.6726 | 1.78E-37 | SIG |
| 6 | 401015786 | 4 | 1015786 | 14.4574 | -0.1454 | 0.0097 | 1.4701 | 3.37E-16 | SIG |
| 7 | 402223635 | 4 | 2223635 | 17.0373 | 0.1642 | 0.0147 | 2.2351 | 8.18E-19 | SIG |
| 8 | 413696726 | 4 | 13696726 | 10.2757 | -0.1214 | 0.0076 | 1.1484 | 6.03E-12 | SIG |
| 9 | 435129844 | 4 | 35129844 | 12.4884 | -0.1335 | 0.0072 | 1.0917 | 3.36E-14 | SIG |
| 10 | 724214245 | 7 | 24214245 | 9.0692 | -0.1161 | 0.0081 | 1.2245 | 8.53E-10 | SIG |
| 11 | 820719718 | 8 | 20719718 | 14.5311 | -0.1482 | 0.0151 | 2.2922 | 2.83E-16 | SIG |
| 12 | 916419362 | 9 | 16419362 | 16.7360 | 0.1597 | 0.0082 | 1.2501 | 1.65E-18 | SIG |
| 13 | 1108501237 | 11 | 8501237 | 11.7475 | -0.1225 | 0.0075 | 1.1316 | 1.79E-12 | SIG |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | | | | |
| 1 | 606540542 | 6 | 6540542 | 3.6951 | 0.0678 | 0.0046 | 0.6931 | 3.71E-05 | SUG |
| 2 | 1108314878 | 11 | 8314878 | 6.3163 | 0.0903 | 0.0074 | 1.1201 | 6.92E-08 | SUG |
| 3 | 1117830860 | 11 | 17830860 | 4.9318 | 0.0790 | 0.0059 | 0.9008 | 1.88E-06 | SUG |

**Table S14 Main-effect QTN for thousand grain weight in ratoon rice of 159 rice accessions in environment 2**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Marker** | **Chr** | **Position (bp)** | **LOD score** | **Additive** | **Variance** | **r2(%)** | **P-value** | **Significance** |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | | | | |
| 1 | 225079124 | 2 | 25079124 | 18.2466 | -0.9457 | 0.1956 | 2.4325 | 4.8844E-20 | SIG |
| 2 | 306596936 | 3 | 6596936 | 23.5944 | 1.1080 | 0.3426 | 4.2599 | 1.934E-25 | SIG |
| 3 | 330587749 | 3 | 30587749 | 6.7763 | 0.5210 | 0.1746 | 2.1704 | 2.3219E-08 | SIG |
| 4 | 431939665 | 4 | 31939665 | 12.4589 | -0.7399 | 0.1654 | 2.0559 | 3.6048E-14 | SIG |
| 5 | 501981355 | 5 | 1981355 | 24.5736 | 1.1433 | 0.3100 | 3.8540 | 1.9889E-26 | SIG |
| 6 | 506751886 | 5 | 6751886 | 8.5554 | -0.5990 | 0.2229 | 2.7717 | 3.4572E-10 | SIG |
| 7 | 511152752 | 5 | 11152752 | 12.6864 | -0.7406 | 0.1770 | 2.2001 | 2.0611E-13 | SIG |
| 8 | 611905299 | 6 | 11905299 | 22.5055 | -1.0805 | 0.3906 | 4.8568 | 3.1283E-23 | SIG |
| 9 | 628657023 | 6 | 28657023 | 9.8960 | 0.6441 | 0.4125 | 5.1286 | 1.2715E-10 | SIG |
| 10 | 807678664 | 8 | 7678664 | 16.2641 | -0.8679 | 0.2877 | 3.5773 | 4.9612E-18 | SIG |
| 11 | 1117131649 | 11 | 17131649 | 17.1211 | 0.9138 | 0.2607 | 3.2408 | 7.5781E-18 | SIG |
| 12 | 1118422045 | 11 | 18422045 | 8.6684 | -0.5996 | 0.3030 | 3.7672 | 2.1474E-09 | SIG |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | | | | |
| 1 | 140053361 | 1 | 40053361 | 4.6501 | 0.4262 | 0.1816 | 2.2584 | 3.7008E-06 | SUG |
| 2 | 316806894 | 3 | 16806894 | 4.9348 | 0.4386 | 0.1020 | 1.2677 | 1.8693E-06 | SUG |
| 3 | 422027451 | 4 | 22027451 | 6.7133 | 0.5249 | 0.2507 | 3.1171 | 1.9363E-07 | SUG |
| 4 | 1103476187 | 11 | 3476187 | 5.5165 | -0.4657 | 0.1328 | 1.6513 | 4.6506E-07 | SUG |

**Table S15 Main-effect QTNs interactions for grain width in main crop of 159 riceaccessions in two environments using multi-environment joint analysis**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Marker** | **Chr** | **Position (bp)** | **LOD score** | **Additive** | **Variance** | **r2(%)** | **P-value** | **Significance** |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | | | | |
| 1 | 138564970 | 1 | 38564970 | 40.8970 | 0.0531 | 0.0005 | 0.4667 | 1.272E-41 | SIG |
| 2 | 140502259 | 1 | 40502259 | 10.2573 | 0.0218 | 0.0005 | 0.4633 | 5.535E-11 | SIG |
| 3 | 201541597 | 2 | 1541597 | 26.9252 | -0.0394 | 0.0009 | 0.8008 | 8.4641E-29 | SIG |
| 4 | 313768754 | 3 | 13768754 | 34.2470 | -0.0457 | 0.0010 | 0.9194 | 3.5855E-36 | SIG |
| 5 | 316819050 | 3 | 16819050 | 11.3675 | -0.0246 | 0.0006 | 0.516 | 4.6505E-13 | SIG |
| 6 | 324648339 | 3 | 24648339 | 25.5588 | -0.0389 | 0.0015 | 1.3049 | 2.0188E-27 | SIG |
| 7 | 331660510 | 3 | 31660510 | 7.3262 | -0.0191 | 0.0004 | 0.3246 | 6.3089E-09 | SIG |
| 8 | 335144023 | 3 | 35144023 | 8.3243 | 0.0212 | 0.0004 | 0.3284 | 4.7421E-09 | SIG |
| 9 | 500636512 | 5 | 636512 | 14.6958 | 0.0277 | 0.0004 | 0.3979 | 2.017E-15 | SIG |
| 10 | 505361276 | 5 | 5361276 | 93.6886 | -0.0974 | 0.0083 | 7.4128 | 7.9129E-96 | SIG |
| 11 | 506213670 | 5 | 6213670 | 19.6598 | -0.0307 | 0.0010 | 0.9313 | 2.1926E-20 | SIG |
| 12 | 513788807 | 5 | 13788807 | 16.0072 | 0.0292 | 0.0008 | 0.7537 | 9.0326E-18 | SIG |
| 13 | 521087312 | 5 | 21087312 | 14.3008 | -0.0273 | 0.0002 | 0.1999 | 4.8529E-16 | SIG |
| 14 | 620319960 | 6 | 20319960 | 60.8151 | -0.0682 | 0.0011 | 0.9874 | 7.3095E-63 | SIG |
| 15 | 724401296 | 7 | 24401296 | 32.3148 | 0.0442 | 0.0005 | 0.4878 | 3.1563E-34 | SIG |
| 16 | 800487221 | 8 | 487221 | 30.8114 | -0.0429 | 0.0005 | 0.4653 | 1.548E-31 | SIG |
| 17 | 801495823 | 8 | 1495823 | 19.8533 | 0.0314 | 0.0007 | 0.6527 | 1.4042E-20 | SIG |
| 18 | 806060988 | 8 | 6060988 | 11.0279 | 0.0238 | 0.0006 | 0.4924 | 9.3858E-12 | SIG |
| 19 | 827378608 | 8 | 27378608 | 66.2065 | -0.0723 | 0.0011 | 0.9941 | 2.8472E-68 | SIG |
| 20 | 907514626 | 9 | 7514626 | 38.9908 | 0.0500 | 0.0010 | 0.9028 | 6.0692E-41 | SIG |
| 21 | 910216810 | 9 | 10216810 | 28.9976 | -0.0416 | 0.0003 | 0.2995 | 6.9094E-31 | SIG |
| 22 | 915748352 | 9 | 15748352 | 55.7970 | 0.0667 | 0.0007 | 0.6469 | 1.6035E-56 | SIG |
| 23 | 1022628897 | 10 | 22628897 | 18.6396 | 0.0317 | 0.0006 | 0.5763 | 2.2965E-19 | SIG |
| 24 | 1114234543 | 11 | 14234543 | 26.3805 | -0.0389 | 0.0004 | 0.3757 | 2.9971E-28 | SIG |
| 25 | 1118701082 | 11 | 18701082 | 35.4749 | -0.0467 | 0.0016 | 1.4135 | 2.0851E-37 | SIG |
| 26 | 1210350434 | 12 | 10350434 | 17.1268 | 0.0309 | 0.0008 | 0.7279 | 6.6376E-19 | SIG |
| 27 | 1215782282 | 12 | 15782282 | 8.2151 | -0.0203 | 0.0001 | 0.1267 | 6.0982E-09 | SIG |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | | | | |
| 1 | 219799308 | 2 | 19799308 | 6.6828 | 0.0185 | 0.0002 | 0.2068 | 2.077E-07 | SUG |
| 2 | 302278621 | 3 | 2278621 | 5.8835 | 0.0174 | 0.0003 | 0.2632 | 1.3084E-06 | SUG |
| 3 | 817656042 | 8 | 17656042 | 6.0548 | -0.0174 | 0.0003 | 0.2486 | 8.8182E-07 | SUG |
| 4 | 1212562266 | 12 | 12562266 | 6.3717 | 0.0177 | 0.0003 | 0.2553 | 6.0671E-08 | SUG |
| 5 | 1212651485 | 12 | 12651485 | 6.3717 | 0.0177 | 0.0003 | 0.2553 | 6.0671E-08 | SUG |

**Table S16 Main-effect QTNs and QTN-by-environment interactions for grain length in main crop of 159 rice accessions in two environments using multi-environment joint analysis**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Main effect QTNs for grain length in main crop | | | | | |  | QTN-by-environment interactions for grain length in main crop | | | | | | |
| No. | Chr | Position (bp) | LOD (Q) | add | r2(%) |  | No. | Chr | Position (bp) | LOD (QE) | add\*env1 | add\*env2 | r2(%) |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | |  | ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | |
|
| 1 | 1 | 19393842 | 26.7024 | -0.0834 | 0.5202 |  | 1 | 3 | 30340995 | 6.3927 | -0.0378 | 0.0378 | 0.2016 |
| 2 | 1 | 36273012 | 12.0679 | 0.0523 | 0.1401 |  |  |  |  |  |  |  |  |
| 3 | 1 | 41721637 | 55.1168 | -0.1354 | 0.8621 |  |  |  |  |  |  |  |  |
| 4 | 2 | 4611151 | 15.4240 | -0.0526 | 0.4937 |  |  |  |  |  |  |  |  |
| 5 | 2 | 12917223 | 21.6944 | -0.0170 | 0.7721 |  |  |  |  |  |  |  |  |
| 6 | 2 | 24585913 | 48.8115 | -0.1230 | 0.4083 |  |  |  |  |  |  |  |  |
| 7 | 2 | 29971324 | 19.1238 | -0.0674 | 0.1273 |  |  |  |  |  |  |  |  |
| 8 | 3 | 616193 | 22.4779 | 0.0755 | 0.2431 |  |  |  |  |  |  |  |  |
| 9 | 3 | 16038474 | 51.1129 | 0.1271 | 0.7320 |  |  |  |  |  |  |  |  |
| 10 | 3 | 16708508 | 124.9527 | 0.2742 | 10.2135 |  |  |  |  |  |  |  |  |
| 11 | 3 | 23238238 | 44.2780 | -0.1160 | 0.2769 |  |  |  |  |  |  |  |  |
| 12 | 3 | 24589241 | 10.2696 | 0.0487 | 0.1221 |  |  |  |  |  |  |  |  |
| 13 | 4 | 607359 | 21.0166 | -0.0724 | 0.3920 |  |  |  |  |  |  |  |  |
| 14 | 4 | 4591488 | 49.9063 | 0.1249 | 0.9692 |  |  |  |  |  |  |  |  |
| 15 | 4 | 35129844 | 62.0264 | -0.1468 | 1.2292 |  |  |  |  |  |  |  |  |
| 16 | 5 | 5456085 | 33.3734 | 0.0957 | 0.7284 |  |  |  |  |  |  |  |  |
| 17 | 6 | 6534568 | 36.8136 | 0.1041 | 0.9205 |  |  |  |  |  |  |  |  |
| 18 | 7 | 14471382 | 16.6963 | -0.0671 | 0.1874 |  |  |  |  |  |  |  |  |
| 19 | 7 | 23874203 | 8.1755 | 0.0430 | 0.2567 |  |  |  |  |  |  |  |  |
| 20 | 7 | 24533051 | 12.6751 | -0.0548 | 0.1466 |  |  |  |  |  |  |  |  |
| 21 | 8 | 489575 | 18.5360 | 0.0675 | 0.2474 |  |  |  |  |  |  |  |  |
| 22 | 8 | 22125056 | 33.4626 | -0.098 | 1.2091 |  |  |  |  |  |  |  |  |
| 23 | 9 | 6053137 | 13.7134 | -0.0569 | 0.3262 |  |  |  |  |  |  |  |  |
| 24 | 9 | 7955689 | 22.0845 | -0.0724 | 0.7747 |  |  |  |  |  |  |  |  |
| 25 | 9 | 12884227 | 13.1748 | 0.0556 | 0.2004 |  |  |  |  |  |  |  |  |
| 26 | 11 | 17788225 | 28.2961 | 0.0859 | 1.0136 |  |  |  |  |  |  |  |  |
| 27 | 11 | 26213773 | 27.4812 | -0.0793 | 1.0188 |  |  |  |  |  |  |  |  |
| 28 | 12 | 4438901 | 12.6055 | -0.0543 | 0.3590 |  |  |  |  |  |  |  |  |
| 29 | 12 | 18076706 | 32.3876 | -0.0942 | 0.6669 |  |  |  |  |  |  |  |  |
| 30 | 12 | 22587924 | 54.807 | 0.1335 | 1.4548 |  |  |  |  |  |  |  |  |
| 31 | 12 | 24218710 | 17.5835 | -0.0653 | 0.5587 |  |  |  |  |  |  |  |  |
| 32 | 12 | 27092306 | 40.3835 | 0.1099 | 1.4291 |  |  |  |  |  |  |  |  |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | |  |  |  |  |  |  |  |  |
| 1 | 2 | 5436687 | 7.2903 | -0.0203 | 0.1802 |  |  |  |  |  |  |  |  |

**Table S17 Main-effect QTNs and QTN-by-environment interactions for thousand grain weight in main crop of 159 riceaccessions in two environments using multi-environment joint analysis**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Main effect QTNs for thousand grain weight in main crop | | | | | |  | QTN-by-environment interactions for thousand grain weight in main crop | | | | | | |
| No. | Chr | Position (bp) | LOD (Q) | add | r2(%) |  | No. | Chr | Position (bp) | LOD (QE) | add\*env1 | add\*env2 | r2(%) |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | |  | ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | |
|
| 1 | 1 | 580218 | 17.6454 | -0.3817 | 0.6538 |  | 1 | 8 | 27495394 | 16.6544 | 0.3694 | -0.3694 | 1.5253 |
| 2 | 1 | 39719661 | 18.5866 | -0.3969 | 0.7871 |  | 2 | 9 | 12289928 | 22.7877 | -0.4437 | 0.4437 | 2.2002 |
| 3 | 2 | 4346020 | 22.4278 | 0.4395 | 0.6522 |  |  |  |  |  |  |  |  |
| 4 | 2 | 20481915 | 39.5567 | 0.6259 | 0.8745 |  |  |  |  |  |  |  |  |
| 5 | 2 | 25079124 | 44.8750 | -0.6854 | 1.1487 |  |  |  |  |  |  |  |  |
| 6 | 2 | 35005427 | 10.9096 | 0.2954 | 0.7791 |  |  |  |  |  |  |  |  |
| 7 | 3 | 35145112 | 11.0291 | 0.2844 | 0.9100 |  |  |  |  |  |  |  |  |
| 8 | 3 | 35437797 | 11.1080 | -0.2955 | 0.4293 |  |  |  |  |  |  |  |  |
| 9 | 4 | 31490102 | 46.0059 | -0.6883 | 1.2483 |  |  |  |  |  |  |  |  |
| 10 | 4 | 33294138 | 24.7448 | -0.4658 | 1.2066 |  |  |  |  |  |  |  |  |
| 11 | 5 | 248172 | 14.5578 | 0.3411 | 0.7463 |  |  |  |  |  |  |  |  |
| 12 | 5 | 630924 | 11.0921 | 0.2961 | 0.6193 |  |  |  |  |  |  |  |  |
| 13 | 5 | 5356835 | 31.7745 | -0.5307 | 3.1917 |  |  |  |  |  |  |  |  |
| 14 | 6 | 3189214 | 64.3369 | -0.8887 | 4.1357 |  |  |  |  |  |  |  |  |
| 15 | 6 | 5384404 | 11.0899 | -0.2962 | 0.9578 |  |  |  |  |  |  |  |  |
| 16 | 6 | 8254727 | 18.2192 | -0.3824 | 0.4816 |  |  |  |  |  |  |  |  |
| 17 | 6 | 8508510 | 11.9027 | 0.2504 | 1.0449 |  |  |  |  |  |  |  |  |
| 18 | 6 | 24706996 | 56.4054 | 0.8097 | 2.1902 |  |  |  |  |  |  |  |  |
| 19 | 7 | 8364433 | 50.7121 | -0.7412 | 1.1877 |  |  |  |  |  |  |  |  |
| 20 | 7 | 18236933 | 10.6413 | -0.0890 | 0.9255 |  |  |  |  |  |  |  |  |
| 21 | 8 | 17687290 | 25.5001 | -0.4803 | 2.5604 |  |  |  |  |  |  |  |  |
| 22 | 10 | 9402611 | 17.1034 | 0.2964 | 1.5402 |  |  |  |  |  |  |  |  |
| 23 | 11 | 2678930 | 26.9119 | -0.4883 | 1.1722 |  |  |  |  |  |  |  |  |
| 24 | 11 | 3505182 | 54.131 | 0.7765 | 2.1896 |  |  | | | | | |  |
| 25 | 11 | 14219838 | 20.5876 | 0.4083 | 1.9419 |  |  |  |  |  |  |  |  |
| 26 | 12 | 424245 | 16.6283 | -0.3623 | 1.5308 |  |  |  |  |  |  |  |  |
| 27 | 12 | 10698465 | 24.6932 | -0.4728 | 1.7272 |  |  |  |  |  |  |  |  |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | |  |  |  |  |  |  |  |  |
|
| 1 | 2 | 33674994 | 5.1423 | 0.1973 | 0.3179 |  |  |  |  |  |  |  |  |
| 2 | 5 | 22190487 | 7.2697 | -0.2315 | 0.5057 |  |  |  |  |  |  |  |  |
| 3 | 7 | 1146652 | 5.6663 | -0.2082 | 0.3617 |  |  |  |  |  |  |  |  |

**Table S18 Main-effect QTNs and QTN-by-environment interactions for grain width in ratoon rice of 159 rice accessions in two environments using multi-environment joint analysis**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Main effect QTNs for grain width in ratoon rice | | | | | |  | QTN-by-environment interactions for grain width in ratoon rice | | | | | | |
| ID | Chr | Position (bp) | LOD (Q) | add | r2(%) |  | ID | Chr | Position (bp) | LOD (QE) | add\*env1 | add\*env2 | r2(%) |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | |  | ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | |
|
| 1 | 2 | 4438556 | 12.7337 | 0.0250 | 0.6968 |  | 1 | 2 | 7733574 | 12.9165 | -0.0246 | 0.0246 | 0.7436 |
| 2 | 2 | 25565194 | 34.7859 | -0.0437 | 0.5675 |  | 2 | 10 | 710130 | 7.6514 | -0.0186 | 0.0186 | 0.4236 |
| 3 | 2 | 29413021 | 11.492 | 0.0226 | 0.4634 |  |  |  |  |  |  |  |  |
| 4 | 3 | 3390977 | 9.5865 | 0.0205 | 0.1967 |  |  |  |  |  |  |  |  |
| 5 | 3 | 14636351 | 11.6905 | 0.0203 | 0.4402 |  |  |  |  |  |  |  |  |
| 6 | 3 | 16504015 | 14.2389 | -0.0259 | 0.7082 |  |  |  |  |  |  |  |  |
| 7 | 3 | 22162176 | 11.9409 | -0.0232 | 0.3209 |  |  |  |  |  |  |  |  |
| 8 | 3 | 27973483 | 31.607 | -0.0419 | 0.3608 |  |  |  |  |  |  |  |  |
| 9 | 4 | 4722231 | 18.5414 | -0.0295 | 0.4880 |  |  |  |  |  |  |  |  |
| 10 | 4 | 13491272 | 15.2251 | 0.0264 | 0.7100 |  |  |  |  |  |  |  |  |
| 11 | 5 | 5358236 | 55.8300 | -0.0593 | 3.7483 |  |  |  |  |  |  |  |  |
| 12 | 5 | 13900081 | 12.3287 | 0.0235 | 0.6710 |  |  |  |  |  |  |  |  |
| 13 | 5 | 21159341 | 25.3342 | -0.0358 | 0.6647 |  |  |  |  |  |  |  |  |
| 14 | 6 | 14040627 | 20.1295 | 0.0318 | 0.4307 |  |  |  |  |  |  |  |  |
| 15 | 6 | 23191777 | 58.1151 | 0.0639 | 0.9187 |  |  |  |  |  |  |  |  |
| 16 | 7 | 25284287 | 62.4030 | 0.0657 | 1.3675 |  |  |  |  |  |  |  |  |
| 17 | 8 | 487221 | 43.3514 | -0.0498 | 0.8752 |  |  |  |  |  |  |  |  |
| 18 | 8 | 6166430 | 23.4842 | 0.0339 | 1.0234 |  |  |  |  |  |  |  |  |
| 19 | 8 | 8915046 | 11.5364 | -0.0228 | 0.5720 |  |  |  |  |  |  |  |  |
| 20 | 8 | 12442028 | 33.9802 | 0.0438 | 0.5111 |  |  |  |  |  |  |  |  |
| 21 | 9 | 7342896 | 39.5741 | 0.0470 | 1.2041 |  |  |  |  |  |  |  |  |
| 22 | 10 | 4958252 | 17.7834 | -0.0294 | 0.8852 |  |  |  |  |  |  |  |  |
| 23 | 10 | 11172977 | 9.2935 | 0.0202 | 0.3986 |  |  |  |  |  |  |  |  |
| 24 | 11 | 7048922 | 8.2464 | -0.0189 | 0.1498 |  |  | | | | | |  |
| 25 | 11 | 7848256 | 9.1518 | -0.0191 | 0.4086 |  |  |  |  |  |  |  |  |
| 26 | 11 | 16768397 | 53.5398 | -0.0575 | 1.1317 |  |  |  |  |  |  |  |  |
| 27 | 11 | 25125749 | 47.4877 | -0.0528 | 2.0390 |  |  |  |  |  |  |  |  |
| 28 | 12 | 4584004 | 13.0056 | 0.0184 | 0.7209 |  |  |  |  |  |  |  |  |
| 29 | 12 | 10711089 | 22.6157 | 0.0335 | 1.1879 |  |  |  |  |  |  |  |  |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | |  |  |  |  |  |  |  |  |
|
| 1 | 3 | 31973046 | 5.7008 | -0.0150 | 0.3026 |  |  |  |  |  |  |  |  |
| 2 | 3 | 35262383 | 5.1097 | 0.0150 | 0.2710 |  |  |  |  |  |  |  |  |
| 3 | 11 | 26058071 | 4.0679 | 0.0132 | 0.2124 |  |  |  |  |  |  |  |  |

**Table S19 Main-effect QTNs and QTN-by-environment interactions for grain length in ratoon rice of 159 rice accessions in two environments using multi-environment joint analysis**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Main effect QTNs for grain length in ratoon rice | | | | | |  | QTN-by-environment interactions for grain length in ratoon rice | | | | | | |
| No. | Chr | Position (bp) | LOD (Q) | add | r2(%) |  | No. | Chr | Position (bp) | LOD (QE) | add\*env1 | add\*env2 | r2(%) |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | |  | ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | |
|
| 1 | 1 | 25212877 | 15.9230 | -0.0692 | 0.2557 |  | 1 | 4 | 20228091 | 15.7721 | -0.0688 | 0.0688 | 0.7362 |
| 2 | 2 | 5151266 | 11.0671 | 0.0564 | 0.4954 |  | 2 | 6 | 26752211 | 21.2258 | 0.0806 | -0.0806 | 1.0259 |
| 3 | 2 | 17474355 | 9.6785 | 0.0527 | 0.2148 |  |  |  |  |  |  |  |  |
| 4 | 2 | 20073320 | 11.8733 | -0.0614 | 0.4711 |  |  |  |  |  |  |  |  |
| 5 | 3 | 16708508 | 57.6390 | 0.1546 | 3.5766 |  |  |  |  |  |  |  |  |
| 6 | 3 | 16845802 | 36.5658 | 0.1146 | 2.0171 |  |  |  |  |  |  |  |  |
| 7 | 3 | 34087282 | 39.4380 | 0.1188 | 0.4197 |  |  |  |  |  |  |  |  |
| 8 | 4 | 3855798 | 74.6811 | -0.1890 | 1.3100 |  |  |  |  |  |  |  |  |
| 9 | 4 | 4591488 | 18.7990 | 0.0757 | 0.3924 |  |  |  |  |  |  |  |  |
| 10 | 4 | 9493312 | 27.9829 | -0.0964 | 0.4843 |  |  |  |  |  |  |  |  |
| 11 | 4 | 35129844 | 23.6844 | -0.0869 | 0.4740 |  |  |  |  |  |  |  |  |
| 12 | 5 | 5914985 | 45.9299 | 0.1320 | 0.9316 |  |  |  |  |  |  |  |  |
| 13 | 5 | 14607988 | 12.1241 | -0.0597 | 0.1565 |  |  |  |  |  |  |  |  |
| 14 | 5 | 20889199 | 26.9320 | 0.0959 | 0.3029 |  |  |  |  |  |  |  |  |
| 15 | 6 | 6533624 | 21.3076 | 0.0827 | 0.6676 |  |  |  |  |  |  |  |  |
| 16 | 7 | 24964429 | 67.6761 | -0.1752 | 1.4424 |  |  |  |  |  |  |  |  |
| 17 | 7 | 28370748 | 24.2758 | -0.0879 | 0.3858 |  |  |  |  |  |  |  |  |
| 18 | 8 | 3954657 | 11.8470 | -0.0588 | 0.4127 |  |  |  |  |  |  |  |  |
| 19 | 8 | 20516196 | 19.3989 | -0.0803 | 0.8544 |  |  |  |  |  |  |  |  |
| 20 | 9 | 16419362 | 39.1286 | 0.1186 | 0.7065 |  |  |  |  |  |  |  |  |
| 21 | 10 | 14508748 | 9.5444 | -0.0521 | 0.3824 |  |  |  |  |  |  |  |  |
| 22 | 11 | 8501237 | 16.7441 | -0.0761 | 0.4312 |  |  |  |  |  |  |  |  |
| 23 | 11 | 17830860 | 25.8279 | 0.0912 | 1.2305 |  |  |  |  |  |  |  |  |
| 24 | 11 | 18450177 | 25.6913 | -0.0912 | 1.1420 |  |  | | | | | |  |
| 25 | 11 | 22928269 | 27.9500 | 0.0956 | 1.0533 |  |  |  |  |  |  |  |  |
| 26 | 12 | 43637 | 14.5081 | 0.0661 | 0.2501 |  |  |  |  |  |  |  |  |
| 27 | 12 | 4438901 | 12.6198 | -0.0606 | 0.4930 |  |  |  |  |  |  |  |  |
| 28 | 12 | 13963973 | 8.8320 | -0.050 | 0.3390 |  |  |  |  |  |  |  |  |
| 29 | 12 | 22702465 | 10.6073 | -0.0571 | 0.4154 |  |  |  |  |  |  |  |  |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | |  |  |  |  |  |  |  |  |
|
| 1 | 6 | 6777283 | 4.2638 | 0.0342 | 0.1614 |  |  |  |  |  |  |  |  |
| 2 | 6 | 20496138 | 6.9149 | -0.0437 | 0.2632 |  |  |  |  |  |  |  |  |

**Table S20 Main-effect QTNs and QTN-by-environment interactions for thousand grain weight in ratoon rice of 159 riceaccessions in two environments using multi-environment joint analysis**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Main effect QTNs for thousand grain weight in ratoon rice | | | | | |  | QTN-by-environment interactions for thousand grain weight in ratoon rice | | | | | | |
| ID | Chr | Position (bp) | LOD (Q) | add | r2(%) |  | ID | Chr | Position (bp) | LOD (QE) | add\*env1 | add\*env2 | r2(%) |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | |  | ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | |
|
| 1 | 1 | 4921429 | 8.6017 | 0.1184 | 1.9646 |  | 1 | 7 | 15307889 | 4.5104 | -0.3033 | 0.3033 | 1.0407 |
| 2 | 3 | 22986087 | 19.7952 | -0.6664 | 2.0165 |  |  |  |  |  |  |  |  |
| 3 | 4 | 4570606 | 16.6756 | -0.6044 | 1.5781 |  |  |  |  |  |  |  |  |
| 4 | 4 | 24390487 | 21.4844 | 0.6987 | 1.6579 |  |  |  |  |  |  |  |  |
| 5 | 4 | 27688228 | 9.0793 | -0.4360 | 2.1372 |  |  |  |  |  |  |  |  |
| 6 | 4 | 31939665 | 53.4528 | -1.2542 | 5.3728 |  |  |  |  |  |  |  |  |
| 7 | 5 | 14238870 | 15.5683 | 0.5738 | 1.4108 |  |  |  |  |  |  |  |  |
| 8 | 5 | 14579088 | 32.3958 | -0.9063 | 3.0528 |  |  |  |  |  |  |  |  |
| 9 | 5 | 19116277 | 7.9108 | 0.2922 | 1.4597 |  |  |  |  |  |  |  |  |
| 10 | 6 | 12843781 | 11.0815 | 0.4841 | 0.7439 |  |  |  |  |  |  |  |  |
| 11 | 6 | 13123202 | 8.3084 | -0.4162 | 0.5950 |  |  |  |  |  |  |  |  |
| 12 | 6 | 14099638 | 9.5350 | -0.4613 | 1.3231 |  |  |  |  |  |  |  |  |
| 13 | 8 | 8333745 | 10.6489 | -0.4765 | 1.5629 |  |  |  |  |  |  |  |  |
| 14 | 8 | 16572646 | 19.1127 | -0.6743 | 1.2154 |  |  |  |  |  |  |  |  |
| 15 | 9 | 5251526 | 7.3255 | 0.3944 | 1.5320 |  |  |  |  |  |  |  |  |
| 16 | 11 | 3518389 | 8.8094 | -0.4266 | 1.2922 |  |  |  |  |  |  |  |  |
| 17 | 11 | 14219838 | 13.6805 | 0.5068 | 3.3536 |  |  |  |  |  |  |  |  |
| 18 | 11 | 17131649 | 33.0474 | 0.9235 | 3.0028 |  |  |  |  |  |  |  |  |
| 19 | 11 | 18828665 | 10.1167 | -0.4594 | 1.4236 |  |  |  |  |  |  |  |  |
| 20 | 12 | 10561772 | 8.4207 | -0.4178 | 1.3049 |  |  |  |  |  |  |  |  |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | |  |  |  |  |  |  |  |  |
|
| 1 | 8 | 17696038 | 4.3115 | 0.3002 | 1.0194 |  |  |  |  |  |  |  |  |
| 2 | 12 | 2900755 | 4.0200 | 0.2841 | 0.9072 |  |  |  |  |  |  |  |  |

**Table S21 Candidate genes around main-effect QTNs of rice grain size in main crop**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Trait** | **No.** | **Locus** | |  | **LOD scores** | | | **r2 (%)** |  | **Gene differential expression analysis** | | |  | | **GO annotation** | | | | |
| **Chr** | **Posi (bp)** |  | **I** | **II** | **III** |  | **Gene\_ID** | **log2(Fold Change)** | **P-value** | |  | **GO\_ID** | **GO\_name** | **E-value** | | **Reference** |
| Grain width | 1 | 2 | 1541597 |  |  |  | 26.93 | 0.80 |  | Os02g0126400 | 1.03 | 2.43E-02 | |  | GO:0046777 | protein autophosphorylation | | 0 | Qiu et al., 2016 |
|  | 2 | 2 | 4944049 |  | 9.72 |  |  | 1.44 |  | Os02g0187800 | -1.02 | 9.04E-03 | |  | GO:0009809 | lignin biosynthetic process | | 0 | Zhang et al., 2021 |
|  | 3 | 2 | 19799308 |  |  |  | 6.68 | 0.21 |  | Os02g0538000 | 1.23 | 6.74E-03 | |  | GO:0009793 | embryo development ending in seed dormancy | | 0 | Figueiredo et al., 2014 |
|  | 4 | 3 | 16819050 |  |  |  | 11.37 | 0.52 |  | Os03g0411500 | -1.22 | 4.09E-03 | |  | GO:0015979 | photosynthesis | | 2.50E-107 | Chen et al., 2021 |
|  | 5 | 3 | 24648339 |  |  | 9.14 | 25.56 | 1.30~2.28 |  | Os03g0640100 | 1.06 | 1.31E-02 | |  | GO:0045787 | positive regulation of cell cycle | | 0 | Guo et al., 2022 |
|  | 6 | 3 | 28864309 |  | 16.09 |  |  | 2.09 |  | Os03g0717700 | 1.12 | 3.00E-03 | |  | GO:0006468 | protein phosphorylation | | 0 | Qiu et al., 2016 |
|  | 7 | 7 | 3682234 |  |  | 11.35 |  | 0.84 |  | Os07g0166800 | 1.51 | 1.95E-02 | |  | GO:0006511 | ubiquitin-dependent protein catabolic process | | 1.88E-109 | Li et al., 2018 |
|  | 8 | 8 | 6060988 |  |  |  | 11.03 | 0.49 |  | Os08g0205900 | -1.02 | 2.43E-02 | |  | GO:0005985 | sucrose metabolic process | | 0 | Nakamura et al., 1992 |
|  | 9 | 10 | 22628897 |  |  |  | 18.64 | 0.58 |  | Os10g0567400 | 1.75 | 4.09E-04 | |  | GO:0015995 | chlorophyll biosynthetic process | | 0 | Chen et al., 2021 |
|  | 10 | 12 | 10350434 |  |  |  | 17.13 | 0.73 |  | Os12g0277500 | -1.19 | 3.71E-03 | |  | GO:0009793 | embryo development ending in seed dormancy | | 0 | Figueiredo et al., 2014 |
| Grain length | 1 | 1 | 9828171 |  |  | 25.54 |  | 0.96 |  | Os01g0280500 | -1.01 | 2.37E-02 | |  | GO:0009793 | embryo development ending in seed dormancy | | 8.15E-143 | Figueiredo et al., 2014 |
|  | 2 | 2 | 5436687 |  |  |  | 7.29 | 0.18 |  | Os02g0197600 | -1.33 | 3.03E-02 | |  | GO:0009735 | response to cytokinin | | 4.31E-147 | Jameson et al., 2016 |
|  | 3 | 2 | 24585913 |  |  |  | 48.81 | 0.41 |  | Os02g0621300 | -1.17 | 1.05E-02 | |  | GO:0009737 | response to abscisic acid | | 0 | Qin et al., 2021 |
|  | 4 | 2 | 24992114 |  |  | 13.56 |  | 0.75 |  | Os02g0626100 | -1.27 | 9.33E-03 | |  | GO:0009739 | response to gibberellin | | 0 | Shi et al., 2020 |
|  | 5 | 3 | 616193 |  | 37.04 |  | 22.48 | 0.24~2.57 |  | Os03g0108600 | 1.24 | 1.41E-02 | |  | GO:0071369 | cellular response to ethylene stimulus | | 0 | Ma et al., 2018 |
|  | 6 | 4 | 4591488 |  |  |  | 49.91 | 0.97 |  | Os04g0169100 | -1.20 | 2.76E-03 | |  | GO:2000904 | regulation of starch metabolic process | | 0 | Zhang et al., 2016 |
|  | 7 | 12 | 776662 |  | 5.44 |  |  | 0.71 |  | Os12g0112500 | -1.15 | 2.37E-02 | |  | GO:0005983 | starch catabolic process | | 8.5E-132 | Zhang et al., 2016 |
| Thousand grain weight | 1 | 5 | 22017452 |  |  | 10.27 |  | 1.82 |  | Os05g0445900 | 1.19 | 1.48E-02 | |  | GO:0080111 | DNA demethylation | | 0 | Zhu et al., 2018 |

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**Table S22 Candidate genes around main-effect QTNs of rice grain size in ratoon rice**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Trait** | **Locus** | |  | **LOD scores** | | | | | | **r2 (%)** |  | **Gene differential expression analysis** | | |  | **GO annotation** | | | |
| **Chr** | **Posi (bp)** |  | **I** | | | **II** | | **III** |  | **Gene\_ID** | **log2(Fold Change)** | **P-value** |  | **GO\_ID** | **GO\_name** | **E-value** | **Reference** |
| Grain width | 2 | 4438556 |  |  | |  | | 12.73 | | 0.70 |  | Os02g0178800 | 1.36 | 1.76E-03 |  | GO:0009737 | response to abscisic acid | 0 | Qin et al., 2021 |
|  | 2 | 4994560 |  | 8.53 |  | | |  | | 1.37 |  | Os02g0187800 | -1.02 | 9.04E-03 |  | GO:0009809 | lignin biosynthetic process | 0 | Zhang et al., 2021 |
|  | 2 | 5481928 |  | 16.42 |  | | |  | | 2.46 |  | Os02g0197600 | -1.33 | 3.03E-02 |  | GO:0009735 | response to cytokinin | 4.31E-147 | Jameson et al., 2016 |
|  | 3 | 22162176 |  |  |  | | | 11.94 | | 0.32 |  | Os03g0592500 | -1.59 | 8.37E-04 |  | GO:0071215 | cellular response to abscisic acid stimulus | 1.10E-150 | Qin et al., 2021 |
|  | 3 | 27973483 |  | 22.72 |  | | | 31.61 | | 0.36~0.62 |  | Os03g0695700 | 1.13 | 5.82E-03 |  | GO:0009826 | unidimensional cell growth | 0 | Huang et al., 2017 |
|  | 4 | 4722231 |  |  | 24.41 | | | 18.54 | | 0.49~2.30 |  | Os04g0169100 | -1.20 | 2.76E-03 |  | GO:2000904 | regulation of starch metabolic process | 0 | Zhang et al., 2016 |
|  | 8 | 5984678~6166430 |  |  | 17.35 | | | 23.48 | | 1.02~2.29 |  | Os08g0205900 | -1.02 | 2.43E-02 |  | GO:0005985 | sucrose metabolic process | 0 | Nakamura et al., 1992 |
|  | 11 | 7818816~7848256 |  | 8.11 |  | | | 9.15 | | 0.41~1.01 |  | Os11g0242800 | -1.29 | 4.95E-03 |  | GO:0015979 | photosynthesis | 1.17E-147 | Chen et al., 2021 |
| Grain length | 2 | 20073320 |  |  |  | | | 11.87 | | 0.47 |  | Os02g0538000 | 1.23 | 6.74E-03 |  | GO:0009793 | embryo development ending in seed dormancy | 0 | Figueiredo et al., 2014 |
|  | 4 | 4591488 |  |  |  | | | 18.80 | | 0.39 |  | Os04g0169100 | -1.20 | 2.76E-03 |  | GO:2000904 | regulation of starch metabolic process | 0 | Zhang et al., 2016 |
|  | 4 | 25746858 |  | 15.38 |  | | |  | | 3.53 |  | Os04g0514800 | -1.02 | 5.96E-03 |  | GO:0009850 | auxin metabolic process | 0 | Liu et al., 2015 |
|  | 10 | 14508748 |  |  |  | | | 9.54 | | 0.38 |  | Os10g0418000 | -1.34 | 4.79E-02 |  | GO:0044030 | regulation of DNA methylation | 6.13E-78 | Xing et al., 2015 |
| Thousand grain weight | 2 | 24702111 |  | 10.65 |  | | |  | | 1.89 |  | Os02g0621300 | -1.17 | 1.05E-02 |  | GO:0009737 | response to abscisic acid | 0 | Qin et al., 2021 |
|  | 3 | 16806894 |  |  | 4.93 | | |  | | 1.27 |  | Os03g0411500 | -1.22 | 4.09E-03 |  | GO:0015979 | photosynthesis | 2.50E-107 | Chen et al., 2021 |
|  | 3 | 22986087 |  |  |  | | | 19.80 | | 2.02 |  | Os03g0607400 | -1.33 | 1.51E-02 |  | GO:0051512 | positive regulation of unidimensional cell growth | 1.02E-81 | Si et al., 2016 |

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**Table S23 Main-effect QTN for grain width, grain length, and thousand grain weight in main crop and ratoon rice of 159 rice accessions in single environment and multi-environment joint analysis using evolutionary population**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Trait** | **MC or RR** | **Environment** | **Marker** | **Chromosome** | **Position (bp)** | **LOD** | **add** | **variance** | **r2(%)** | **P-value** | **significance** |
| 1 | GW | MC | 1 | 140490468 | 1 | 40490468 | 4.3648 | 0.0331 | 0.0011 | 1.2262 | 4.3183E-05 | SUG |
| 2 | GW | MC | 1 | 201050680 | 2 | 1050680 | 14.0231 | 0.0658 | 0.0015 | 1.7669 | 9.28686E-16 | SIG |
| 3 | GW | MC | 1 | 326622478 | 3 | 26622478 | 18.7354 | -0.0818 | 0.0052 | 5.9084 | 1.56446E-20 | SIG |
| 4 | GW | MC | 1 | 421031164 | 4 | 21031164 | 14.4951 | -0.0673 | 0.0017 | 1.9938 | 3.08196E-16 | SIG |
| 5 | GW | MC | 1 | 431159467 | 4 | 31159467 | 20.8742 | 0.087 | 0.0033 | 3.8071 | 1.07827E-22 | SIG |
| 6 | GW | MC | 1 | 505361276 | 5 | 5361276 | 20.2645 | -0.0859 | 0.0051 | 5.7792 | 4.45336E-22 | SIG |
| 7 | GW | MC | 1 | 513788807 | 5 | 13788807 | 3.9669 | 0.0313 | 0.001 | 1.1192 | 1.91947E-05 | SUG |
| 8 | GW | MC | 1 | 810329229 | 8 | 10329229 | 14.5155 | 0.0696 | 0.0037 | 4.2501 | 2.93915E-16 | SIG |
| 9 | GW | MC | 1 | 816385094 | 8 | 16385094 | 16.6274 | -0.0752 | 0.0023 | 2.5796 | 2.36178E-17 | SIG |
| 10 | GW | MC | 1 | 826714889 | 8 | 26714889 | 12.7967 | -0.062 | 0.0009 | 1.0379 | 1.63464E-14 | SIG |
| 11 | GW | MC | 1 | 1101582356 | 11 | 1582356 | 11.199 | -0.0575 | 0.0022 | 2.5204 | 6.32976E-12 | SIG |
| 12 | GW | MC | 1 | 1126376406 | 11 | 26376406 | 10.8635 | 0.0559 | 0.0031 | 3.5555 | 1.51697E-12 | SIG |
| 13 | GW | MC | 2 | 134815173 | 1 | 34815173 | 10.7976 | -0.0387 | 0.0005 | 0.4983 | 1.77058E-12 | SIG |
| 14 | GW | MC | 2 | 140476043 | 1 | 40476043 | 4.4284 | 0.0207 | 0.0005 | 0.5853 | 3.73079E-05 | SUG |
| 15 | GW | MC | 2 | 204878888 | 2 | 4878888 | 19.3927 | -0.057 | 0.0016 | 1.7731 | 3.38666E-21 | SIG |
| 16 | GW | MC | 2 | 220138937 | 2 | 20138937 | 11.3542 | 0.0398 | 0.0016 | 1.738 | 4.79745E-13 | SIG |
| 17 | GW | MC | 2 | 314483625 | 3 | 14483625 | 13.4957 | 0.0444 | 0.0018 | 1.9653 | 3.18671E-15 | SIG |
| 18 | GW | MC | 2 | 321778824 | 3 | 21778824 | 19.4634 | -0.058 | 0.0011 | 1.1759 | 3.44637E-20 | SIG |
| 19 | GW | MC | 2 | 326795140 | 3 | 26795140 | 7.7983 | -0.0323 | 0.001 | 1.0556 | 2.06527E-09 | SIG |
| 20 | GW | MC | 2 | 335144023 | 3 | 35144023 | 10.6693 | 0.0406 | 0.0013 | 1.4206 | 2.14312E-11 | SIG |
| 21 | GW | MC | 2 | 413960907 | 4 | 13960907 | 14.8756 | -0.0478 | 0.0013 | 1.4552 | 1.26738E-16 | SIG |
| 22 | GW | MC | 2 | 504631781 | 5 | 4631781 | 30.3826 | -0.0819 | 0.0044 | 4.9051 | 2.78273E-32 | SIG |
| 23 | GW | MC | 2 | 504775669 | 5 | 4775669 | 15.9931 | -0.0476 | 0.0023 | 2.5094 | 1.01736E-16 | SIG |
| 24 | GW | MC | 2 | 505358771 | 5 | 5358771 | 16.6238 | -0.0513 | 0.0018 | 2.0292 | 2.38143E-17 | SIG |
| 25 | GW | MC | 2 | 906961682 | 9 | 6961682 | 13.3654 | 0.0442 | 0.0008 | 0.8912 | 4.32197E-15 | SIG |
| 26 | GW | MC | 2 | 910486075 | 9 | 10486075 | 8.7021 | 0.0341 | 0.0011 | 1.1834 | 2.44601E-10 | SIG |
| 27 | GW | MC | 2 | 915748352 | 9 | 15748352 | 18.6728 | 0.0595 | 0.0007 | 0.7739 | 2.1278E-19 | SIG |
| 28 | GW | MC | 2 | 1125818848 | 11 | 25818848 | 17.0568 | 0.052 | 0.0027 | 2.9866 | 7.81373E-19 | SIG |
| 29 | GW | MC | 2 | 1211133135 | 12 | 11133135 | 15.0736 | 0.0478 | 0.0018 | 1.9932 | 7.98318E-17 | SIG |
| 30 | GW | MC | MEJA | 201236423 | 2 | 1236423 | 29.019 | 0.0557 | 0.0011 | 1.2459 | 6.57469E-31 | SIG |
| 31 | GW | MC | MEJA | 220136939 | 2 | 20136939 | 12.877 | 0.0339 | 0.0011 | 1.2886 | 1.35474E-14 | SIG |
| 32 | GW | MC | MEJA | 223163721 | 2 | 23163721 | 40.9266 | -0.0715 | 0.0007 | 0.8136 | 6.86951E-43 | SIG |
| 33 | GW | MC | MEJA | 321778824 | 3 | 21778824 | 11.7973 | -0.0272 | 0.0007 | 0.7588 | 1.59646E-12 | SIG |
| 34 | GW | MC | MEJA | 504631781 | 5 | 4631781 | 26.3888 | -0.0525 | 0.0018 | 2.0554 | 2.93991E-28 | SIG |
| 35 | GW | MC | MEJA | 505358771 | 5 | 5358771 | 41.1839 | -0.0712 | 0.0035 | 3.982 | 6.57058E-42 | SIG |
| 36 | GW | MC | MEJA | 506052088 | 5 | 6052088 | 9.3278 | -0.0283 | 0.0008 | 0.8856 | 5.60237E-11 | SIG |
| 37 | GW | MC | MEJA | 514169729 | 5 | 14169729 | 6.1061 | -0.0226 | 0.0005 | 0.5436 | 1.14108E-07 | SUG |
| 38 | GW | MC | MEJA | 806080284 | 8 | 6080284 | 30.8827 | 0.0625 | 0.0008 | 0.8883 | 1.3136E-31 | SIG |
| 39 | GW | MC | MEJA | 810329229 | 8 | 10329229 | 20.5218 | 0.0461 | 0.0016 | 1.84 | 2.44738E-22 | SIG |
| 40 | GW | MC | MEJA | 816963433 | 8 | 16963433 | 25.2891 | -0.0511 | 0.0025 | 2.8006 | 5.1502E-26 | SIG |
| 41 | GW | MC | MEJA | 826714889 | 8 | 26714889 | 42.6112 | -0.073 | 0.0013 | 1.4184 | 1.3924E-44 | SIG |
| 42 | GW | MC | MEJA | 910486075 | 9 | 10486075 | 18.0811 | 0.0417 | 0.0016 | 1.7998 | 7.18211E-20 | SIG |
| 43 | GW | MC | MEJA | 920103851 | 9 | 20103851 | 22.266 | 0.0459 | 0.0008 | 0.9043 | 5.43044E-23 | SIG |
| 44 | GW | MC | MEJA | 1107833619 | 11 | 7833619 | 15.4743 | -0.038 | 0.0011 | 1.2935 | 3.35944E-16 | SIG |
| 45 | GW | MC | MEJA | 1117149260 | 11 | 17149260 | 29.1651 | -0.0589 | 0.0029 | 3.214 | 6.854E-30 | SIG |
| 46 | GW | MC | MEJA | 1125624085 | 11 | 25624085 | 18.3448 | 0.0417 | 0.0017 | 1.9565 | 3.8854E-20 | SIG |
| 47 | GW | MC | MEJA | 1211178871 | 12 | 11178871 | 15.7811 | 0.0394 | 0.0011 | 1.2022 | 1.65756E-16 | SIG |
| 48 | GL | MC | 1 | 301294521 | 3 | 1294521 | 24.4767 | 0.2973 | 0.0236 | 3.3069 | 2.49118E-26 | SIG |
| 49 | GL | MC | 1 | 316708508 | 3 | 16708508 | 33.5357 | 0.3893 | 0.1267 | 17.7195 | 1.86351E-35 | SIG |
| 50 | GL | MC | 1 | 433360398 | 4 | 33360398 | 14.8636 | -0.2078 | 0.0192 | 2.6842 | 1.30355E-16 | SIG |
| 51 | GL | MC | 1 | 525364698 | 5 | 25364698 | 22.0966 | -0.2754 | 0.018 | 2.5176 | 8.0213E-23 | SIG |
| 52 | GL | MC | 1 | 602130119 | 6 | 2130119 | 15.7795 | 0.2164 | 0.0371 | 5.1965 | 1.53683E-17 | SIG |
| 53 | GL | MC | 1 | 604725106 | 6 | 4725106 | 15.7988 | 0.2186 | 0.033 | 4.6198 | 1.46905E-17 | SIG |
| 54 | GL | MC | 1 | 607737965 | 6 | 7737965 | 15.6934 | -0.2146 | 0.0203 | 2.8404 | 1.87849E-17 | SIG |
| 55 | GL | MC | 1 | 714471382 | 7 | 14471382 | 17.2692 | -0.2476 | 0.0114 | 1.601 | 5.38866E-18 | SIG |
| 56 | GL | MC | 1 | 724533051 | 7 | 24533051 | 19.2738 | -0.2502 | 0.0227 | 3.178 | 4.46644E-21 | SIG |
| 57 | GL | MC | 1 | 1117785691 | 11 | 17785691 | 8.2797 | 0.1445 | 0.0194 | 2.7149 | 5.25565E-09 | SIG |
| 58 | GL | MC | 2 | 105419896 | 1 | 5419896 | 5.0602 | -0.0924 | 0.0085 | 1.2475 | 1.38435E-06 | SUG |
| 59 | GL | MC | 2 | 231132137 | 2 | 31132137 | 5.295 | 0.0948 | 0.0081 | 1.1824 | 7.8942E-07 | SUG |
| 60 | GL | MC | 2 | 316708508 | 3 | 16708508 | 35.1278 | 0.347 | 0.1006 | 14.7134 | 4.65926E-37 | SIG |
| 61 | GL | MC | 2 | 431203233 | 4 | 31203233 | 7.8303 | 0.119 | 0.0131 | 1.916 | 1.91467E-09 | SIG |
| 62 | GL | MC | 2 | 525364698 | 5 | 25364698 | 26.9845 | -0.2716 | 0.0181 | 2.6423 | 1.03877E-27 | SIG |
| 63 | GL | MC | 2 | 607759617 | 6 | 7759617 | 5.312 | 0.0954 | 0.0075 | 1.0971 | 7.58033E-07 | SUG |
| 64 | GL | MC | 2 | 702290160 | 7 | 2290160 | 8.5657 | -0.1266 | 0.0143 | 2.0833 | 3.37454E-10 | SIG |
| 65 | GL | MC | 2 | 712384603 | 7 | 12384603 | 17.5341 | -0.1994 | 0.0082 | 1.1971 | 2.92807E-18 | SIG |
| 66 | GL | MC | 2 | 716562571 | 7 | 16562571 | 8.5411 | -0.1128 | 0.0121 | 1.7758 | 2.87904E-09 | SIG |
| 67 | GL | MC | 2 | 818394489 | 8 | 18394489 | 47.0358 | 0.4698 | 0.0232 | 3.3945 | 4.98937E-49 | SIG |
| 68 | GL | MC | 2 | 1204443515 | 12 | 4443515 | 10.4138 | -0.1406 | 0.0184 | 2.6909 | 4.36042E-12 | SIG |
| 69 | GL | MC | 2 | 1222906272 | 12 | 22906272 | 8.9312 | -0.1286 | 0.0158 | 2.3036 | 1.42558E-10 | SIG |
| 70 | GL | MC | 2 | 1224137319 | 12 | 24137319 | 8.9989 | -0.1298 | 0.0162 | 2.3716 | 1.21551E-10 | SIG |
| 71 | GL | MC | MEJA | 100316750 | 1 | 316750 | 20.9872 | 0.1125 | 0.003 | 0.4293 | 8.29056E-23 | SIG |
| 72 | GL | MC | MEJA | 127124415 | 1 | 27124415 | 41.8529 | 0.179 | 0.0096 | 1.3721 | 8.05232E-44 | SIG |
| 73 | GL | MC | MEJA | 217656418 | 2 | 17656418 | 51.4311 | -0.2231 | 0.0206 | 2.9635 | 3.72257E-52 | SIG |
| 74 | GL | MC | MEJA | 224475326 | 2 | 24475326 | 21.0072 | -0.1125 | 0.0038 | 0.542 | 7.91254E-23 | SIG |
| 75 | GL | MC | MEJA | 316708508 | 3 | 16708508 | 88.325 | 0.3488 | 0.1017 | 14.6019 | 1.88142E-90 | SIG |
| 76 | GL | MC | MEJA | 325129163 | 3 | 25129163 | 22.5203 | 0.1155 | 0.013 | 1.8712 | 3.02349E-23 | SIG |
| 77 | GL | MC | MEJA | 334087282 | 3 | 34087282 | 27.2554 | 0.1328 | 0.0036 | 0.5177 | 3.93422E-29 | SIG |
| 78 | GL | MC | MEJA | 401015786 | 4 | 1015786 | 3.9756 | -0.0446 | 0.0009 | 0.1262 | 1.87966E-05 | SUG |
| 79 | GL | MC | MEJA | 520889199 | 5 | 20889199 | 5.9223 | 0.0496 | 0.002 | 0.2807 | 1.19665E-06 | SUG |
| 80 | GL | MC | MEJA | 525364698 | 5 | 25364698 | 44.0519 | -0.187 | 0.0085 | 1.222 | 8.90745E-45 | SIG |
| 81 | GL | MC | MEJA | 602130119 | 6 | 2130119 | 12.6344 | 0.0837 | 0.0056 | 0.7988 | 2.39038E-14 | SIG |
| 82 | GL | MC | MEJA | 617543510 | 6 | 17543510 | 32.878 | -0.1527 | 0.0112 | 1.6037 | 1.32816E-33 | SIG |
| 83 | GL | MC | MEJA | 702288888 | 7 | 2288888 | 15.0264 | -0.0958 | 0.0074 | 1.0676 | 9.42249E-16 | SIG |
| 84 | GL | MC | MEJA | 714471382 | 7 | 14471382 | 35.2393 | -0.1708 | 0.0057 | 0.8196 | 5.78165E-36 | SIG |
| 85 | GL | MC | MEJA | 800471029 | 8 | 471029 | 26.5609 | -0.1305 | 0.0088 | 1.2696 | 1.97169E-28 | SIG |
| 86 | GL | MC | MEJA | 818394489 | 8 | 18394489 | 104.6895 | 0.4245 | 0.019 | 2.7225 | 7.4798E-107 | SIG |
| 87 | GL | MC | MEJA | 1016532434 | 10 | 16532434 | 40.4964 | 0.1747 | 0.0062 | 0.8966 | 1.85939E-42 | SIG |
| 88 | GL | MC | MEJA | 1117785691 | 11 | 17785691 | 3.2574 | 0.0397 | 0.0015 | 0.216 | 0.000553056 | SUG |
| 89 | GL | MC | MEJA | 1211214543 | 12 | 11214543 | 22.9159 | 0.1221 | 0.0119 | 1.7131 | 9.35691E-25 | SIG |
| 90 | GL | MC | MEJA | 1215176154 | 12 | 15176154 | 37.9166 | -0.1665 | 0.0074 | 1.0652 | 7.29864E-40 | SIG |
| 91 | TGW | MC | 1 | 221664294 | 2 | 21664294 | 8.5298 | -0.6283 | 0.2177 | 2.336 | 3.67212E-10 | SIG |
| 92 | TGW | MC | 1 | 231234763 | 2 | 31234763 | 22.3567 | 1.1811 | 1.0526 | 11.2961 | 3.43246E-24 | SIG |
| 93 | TGW | MC | 1 | 334733054 | 3 | 34733054 | 16.5033 | 0.9474 | 0.3712 | 3.9837 | 2.83988E-18 | SIG |
| 94 | TGW | MC | 1 | 335437797 | 3 | 35437797 | 15.9056 | -0.9237 | 0.421 | 4.5181 | 1.14489E-17 | SIG |
| 95 | TGW | MC | 1 | 420926659 | 4 | 20926659 | 6.3254 | -0.5282 | 0.2784 | 2.9874 | 6.77388E-08 | SUG |
| 96 | TGW | MC | 1 | 506624426 | 5 | 6624426 | 7.5295 | -0.5838 | 0.2043 | 2.1922 | 3.89909E-09 | SIG |
| 97 | TGW | MC | 1 | 628503941 | 6 | 28503941 | 22.2022 | 1.1911 | 0.344 | 3.6914 | 4.91549E-24 | SIG |
| 98 | TGW | MC | 1 | 701027206 | 7 | 1027206 | 7.3701 | -0.5363 | 0.2982 | 3.2 | 4.267E-08 | SUG |
| 99 | TGW | MC | 1 | 702255614 | 7 | 2255614 | 7.4953 | -0.585 | 0.3417 | 3.6675 | 4.22791E-09 | SIG |
| 100 | TGW | MC | 1 | 808787015 | 8 | 8787015 | 6.1021 | -0.5248 | 0.1686 | 1.8097 | 1.15188E-07 | SUG |
| 101 | TGW | MC | 1 | 1001426946 | 10 | 1426946 | 23.4889 | -1.2272 | 0.4029 | 4.3238 | 2.47158E-25 | SIG |
| 102 | TGW | MC | 1 | 1017036118 | 10 | 17036118 | 11.2993 | -0.7422 | 0.2879 | 3.09 | 5.45709E-13 | SIG |
| 103 | TGW | MC | 1 | 1211816442 | 12 | 11816442 | 9.2555 | 0.646 | 0.2793 | 2.9973 | 5.55737E-10 | SIG |
| 104 | TGW | MC | 2 | 231332457 | 2 | 31332457 | 11.3805 | 0.7628 | 0.4723 | 5.0398 | 4.16817E-12 | SIG |
| 105 | TGW | MC | 2 | 335461301 | 3 | 35461301 | 8.5083 | -0.6452 | 0.2054 | 2.1919 | 3.86311E-10 | SIG |
| 106 | TGW | MC | 2 | 505651540 | 5 | 5651540 | 5.815 | 0.5251 | 0.2723 | 2.9061 | 2.28199E-07 | SUG |
| 107 | TGW | MC | 2 | 616653419 | 6 | 16653419 | 12.0078 | -0.8067 | 0.66 | 7.0428 | 9.83241E-13 | SIG |
| 108 | TGW | MC | 2 | 628503941 | 6 | 28503941 | 11.7799 | 0.7981 | 0.1544 | 1.6479 | 1.76838E-13 | SIG |
| 109 | TGW | MC | 2 | 701080125 | 7 | 1080125 | 9.1572 | -0.6877 | 0.4026 | 4.2965 | 6.96874E-10 | SIG |
| 110 | TGW | MC | 2 | 801493649 | 8 | 1493649 | 9.5598 | 0.3283 | 0.4734 | 5.0512 | 2.7577E-10 | SIG |
| 111 | TGW | MC | 2 | 808787015 | 8 | 8787015 | 15.4991 | -0.9638 | 0.5688 | 6.0701 | 2.95661E-17 | SIG |
| 112 | TGW | MC | 2 | 808811557 | 8 | 8811557 | 9.7231 | -0.7119 | 0.2837 | 3.0273 | 2.21017E-11 | SIG |
| 113 | TGW | MC | 2 | 906852848 | 9 | 6852848 | 8.6252 | -0.6534 | 0.178 | 1.899 | 2.93244E-10 | SIG |
| 114 | TGW | MC | 2 | 1116334757 | 11 | 16334757 | 12.5064 | 0.8144 | 0.6591 | 7.0335 | 3.11898E-13 | SIG |
| 115 | TGW | MC | 2 | 1223643046 | 12 | 23643046 | 9.6271 | 0.6948 | 0.2382 | 2.542 | 2.77058E-11 | SIG |
| 116 | TGW | MC | MEJA | 104407547 | 1 | 4407547 | 13.7283 | 0.4186 | 0.0421 | 0.4527 | 1.8498E-15 | SIG |
| 117 | TGW | MC | MEJA | 139046778 | 1 | 39046778 | 21.4332 | -0.5408 | 0.1044 | 1.1223 | 2.93821E-23 | SIG |
| 118 | TGW | MC | MEJA | 204346020 | 2 | 4346020 | 11.6238 | 0.3791 | 0.0249 | 0.2681 | 2.5497E-13 | SIG |
| 119 | TGW | MC | MEJA | 204706818 | 2 | 4706818 | 7.7962 | -0.3092 | 0.0905 | 0.9728 | 1.59974E-08 | SIG |
| 120 | TGW | MC | MEJA | 224553100 | 2 | 24553100 | 43.6124 | -0.8766 | 0.229 | 2.4612 | 1.37287E-45 | SIG |
| 121 | TGW | MC | MEJA | 231234763 | 2 | 31234763 | 10.5087 | 0.3567 | 0.096 | 1.0316 | 3.48902E-12 | SIG |
| 122 | TGW | MC | MEJA | 231262967 | 2 | 31262967 | 10.5087 | 0.3567 | 0.096 | 1.0316 | 3.48902E-12 | SIG |
| 123 | TGW | MC | MEJA | 235005427 | 2 | 35005427 | 8.0469 | 0.3123 | 0.0798 | 0.8579 | 1.14774E-09 | SIG |
| 124 | TGW | MC | MEJA | 308081540 | 3 | 8081540 | 25.5102 | 0.606 | 0.1847 | 1.9854 | 3.09571E-26 | SIG |
| 125 | TGW | MC | MEJA | 335486847 | 3 | 35486847 | 12.3697 | -0.3927 | 0.0806 | 0.866 | 4.44176E-14 | SIG |
| 126 | TGW | MC | MEJA | 431318603 | 4 | 31318603 | 59.0925 | -1.1367 | 0.4012 | 4.3112 | 8.12264E-60 | SIG |
| 127 | TGW | MC | MEJA | 510518812 | 5 | 10518812 | 10.7691 | 0.3683 | 0.046 | 0.494 | 1.89306E-12 | SIG |
| 128 | TGW | MC | MEJA | 600023671 | 6 | 23671 | 15.603 | -0.4599 | 0.2071 | 2.2255 | 2.498E-16 | SIG |
| 129 | TGW | MC | MEJA | 628503941 | 6 | 28503941 | 41.0574 | 0.8493 | 0.1749 | 1.8794 | 5.07504E-43 | SIG |
| 130 | TGW | MC | MEJA | 701080125 | 7 | 1080125 | 17.8836 | -0.491 | 0.2072 | 2.2272 | 1.30941E-18 | SIG |
| 131 | TGW | MC | MEJA | 710299436 | 7 | 10299436 | 20.5664 | -0.5272 | 0.0478 | 0.5139 | 2.20617E-22 | SIG |
| 132 | TGW | MC | MEJA | 903772207 | 9 | 3772207 | 13.8503 | -0.4076 | 0.1047 | 1.1252 | 1.41315E-14 | SIG |
| 133 | TGW | MC | MEJA | 904639851 | 9 | 4639851 | 14.5337 | 0.2601 | 0.1778 | 1.9107 | 2.92956E-15 | SIG |
| 134 | TGW | MC | MEJA | 904826405 | 9 | 4826405 | 18.9444 | 0.506 | 0.0697 | 0.7486 | 9.61653E-21 | SIG |
| 135 | TGW | MC | MEJA | 1001426946 | 10 | 1426946 | 7.5405 | -0.2974 | 0.0237 | 0.2543 | 3.79906E-09 | SIG |
| 136 | TGW | MC | MEJA | 1013915559 | 10 | 13915559 | 33.6255 | -0.7147 | 0.3675 | 3.949 | 2.37551E-34 | SIG |
| 137 | TGW | MC | MEJA | 1016131068 | 10 | 16131068 | 19.0549 | -0.5055 | 0.0689 | 0.7407 | 7.43576E-21 | SIG |
| 138 | TGW | MC | MEJA | 1020319057 | 10 | 20319057 | 16.3725 | 0.4726 | 0.0556 | 0.5973 | 3.85328E-18 | SIG |
| 139 | TGW | MC | MEJA | 1116334757 | 11 | 16334757 | 24.0824 | 0.5843 | 0.3344 | 3.5933 | 8.28821E-25 | SIG |
| 140 | TGW | MC | MEJA | 1117803774 | 11 | 17803774 | 7.6668 | 0.3 | 0.0704 | 0.7562 | 2.15539E-08 | SIG |
| 141 | GW | RR | 1 | 225565194 | 2 | 25565194 | 11.3265 | -0.0554 | 0.0007 | 0.886 | 5.1195E-13 | SIG |
| 142 | GW | RR | 1 | 316415833 | 3 | 16415833 | 6.2872 | -0.0386 | 0.0014 | 1.6544 | 5.16458E-07 | SUG |
| 143 | GW | RR | 1 | 505357438 | 5 | 5357438 | 28.69 | -0.1003 | 0.0086 | 10.2534 | 1.41023E-30 | SIG |
| 144 | GW | RR | 1 | 513900081 | 5 | 13900081 | 4.7854 | 0.0337 | 0.0011 | 1.3438 | 2.67503E-06 | SUG |
| 145 | GW | RR | 1 | 725284287 | 7 | 25284287 | 10.7505 | 0.0546 | 0.0008 | 0.9663 | 1.77772E-11 | SIG |
| 146 | GW | RR | 1 | 805969839 | 8 | 5969839 | 6.4855 | 0.0401 | 0.0013 | 1.5469 | 3.27178E-07 | SUG |
| 147 | GW | RR | 1 | 906837440 | 9 | 6837440 | 18.7435 | 0.0747 | 0.0022 | 2.5865 | 1.80818E-19 | SIG |
| 148 | GW | RR | 1 | 1003262163 | 10 | 3262163 | 27.3216 | 0.0994 | 0.0011 | 1.2962 | 4.77936E-28 | SIG |
| 149 | GW | RR | 1 | 1004502295 | 10 | 4502295 | 3.6691 | 0.0299 | 0.0007 | 0.857 | 3.94823E-05 | SUG |
| 150 | GW | RR | 1 | 1107818816 | 11 | 7818816 | 9.4607 | -0.0493 | 0.0019 | 2.2536 | 4.09751E-11 | SIG |
| 151 | GW | RR | 1 | 1116768397 | 11 | 16768397 | 22.6673 | -0.0848 | 0.0018 | 2.1254 | 2.15521E-23 | SIG |
| 152 | GW | RR | 1 | 1118701082 | 11 | 18701082 | 10.1386 | -0.0511 | 0.0019 | 2.2596 | 8.32305E-12 | SIG |
| 153 | GW | RR | 1 | 1122223115 | 11 | 22223115 | 18.3276 | -0.0737 | 0.0012 | 1.3951 | 4.04472E-20 | SIG |
| 154 | GW | RR | 1 | 1125125749 | 11 | 25125749 | 8.4956 | -0.0462 | 0.0013 | 1.5143 | 3.98124E-10 | SIG |
| 155 | GW | RR | 1 | 1210386656 | 12 | 10386656 | 8.2023 | 0.0455 | 0.0019 | 2.2098 | 7.95352E-10 | SIG |
| 156 | GW | RR | 2 | 140476070 | 1 | 40476070 | 11.7326 | -0.0442 | 0.002 | 2.5295 | 1.853E-12 | SIG |
| 157 | GW | RR | 2 | 217616900 | 2 | 17616900 | 30.5225 | 0.0876 | 0.0027 | 3.4194 | 3.01063E-31 | SIG |
| 158 | GW | RR | 2 | 223888162 | 2 | 23888162 | 12.5484 | -0.0467 | 0.0008 | 1.0061 | 2.92333E-14 | SIG |
| 159 | GW | RR | 2 | 336328500 | 3 | 36328500 | 12.297 | 0.0469 | 0.0017 | 2.1888 | 5.26624E-14 | SIG |
| 160 | GW | RR | 2 | 422072891 | 4 | 22072891 | 7.7731 | 0.0364 | 0.001 | 1.3253 | 1.6871E-08 | SIG |
| 161 | GW | RR | 2 | 505358771 | 5 | 5358771 | 17.4274 | -0.0573 | 0.0029 | 3.7074 | 3.74352E-18 | SIG |
| 162 | GW | RR | 2 | 506015422 | 5 | 6015422 | 11.791 | -0.0458 | 0.0021 | 2.6493 | 1.72332E-13 | SIG |
| 163 | GW | RR | 2 | 521088250 | 5 | 21088250 | 19.2727 | -0.0597 | 0.0022 | 2.7465 | 5.34618E-20 | SIG |
| 164 | GW | RR | 2 | 725127139 | 7 | 25127139 | 26.8931 | 0.0773 | 0.0014 | 1.8287 | 9.11966E-29 | SIG |
| 165 | GW | RR | 2 | 907639381 | 9 | 7639381 | 16.5776 | 0.0566 | 0.0012 | 1.5401 | 2.38841E-18 | SIG |
| 166 | GW | RR | 2 | 1022038949 | 10 | 22038949 | 15.3988 | -0.0535 | 0.0025 | 3.2285 | 3.7359E-17 | SIG |
| 167 | GW | RR | 2 | 1113995468 | 11 | 13995468 | 51.4814 | -0.1328 | 0.0026 | 3.3567 | 3.31519E-52 | SIG |
| 168 | GW | RR | 2 | 1118701082 | 11 | 18701082 | 14.9619 | -0.0519 | 0.002 | 2.5022 | 1.03611E-16 | SIG |
| 169 | GW | RR | 2 | 1125735896 | 11 | 25735896 | 11.162 | -0.0443 | 0.0011 | 1.3592 | 7.52936E-13 | SIG |
| 170 | GW | RR | 2 | 1210711089 | 12 | 10711089 | 15.7479 | 0.0543 | 0.0025 | 3.2509 | 1.65438E-17 | SIG |
| 171 | GW | RR | 2 | 1227465140 | 12 | 27465140 | 19.4722 | 0.0625 | 0.0014 | 1.8133 | 3.37701E-20 | SIG |
| 172 | GW | RR | MEJA | 105421087 | 1 | 5421087 | 9.1685 | 0.0043 | 0.0005 | 0.5665 | 6.78879E-10 | SIG |
| 173 | GW | RR | MEJA | 204994560 | 2 | 4994560 | 15.2559 | -0.0282 | 0.0008 | 0.9701 | 5.21548E-17 | SIG |
| 174 | GW | RR | MEJA | 225565194 | 2 | 25565194 | 33.4266 | -0.0454 | 0.0005 | 0.6123 | 2.39939E-35 | SIG |
| 175 | GW | RR | MEJA | 229241853 | 2 | 29241853 | 17.1014 | 0.0307 | 0.0004 | 0.4814 | 7.04125E-19 | SIG |
| 176 | GW | RR | MEJA | 303390977 | 3 | 3390977 | 26.1316 | 0.0384 | 0.0006 | 0.689 | 5.34064E-28 | SIG |
| 177 | GW | RR | MEJA | 316504015 | 3 | 16504015 | 15.0212 | -0.0286 | 0.0007 | 0.8555 | 9.53546E-16 | SIG |
| 178 | GW | RR | MEJA | 331660510 | 3 | 31660510 | 5.5412 | -0.0164 | 0.0003 | 0.3284 | 4.38451E-07 | SUG |
| 179 | GW | RR | MEJA | 404722231 | 4 | 4722231 | 11.0907 | -0.0236 | 0.0003 | 0.3133 | 8.90158E-13 | SIG |
| 180 | GW | RR | MEJA | 413817255 | 4 | 13817255 | 12.7843 | -0.0256 | 0.0005 | 0.5537 | 1.68284E-14 | SIG |
| 181 | GW | RR | MEJA | 505323603 | 5 | 5323603 | 7.3103 | 0.019 | 0.0004 | 0.4578 | 4.89698E-08 | SUG |
| 182 | GW | RR | MEJA | 505358236 | 5 | 5358236 | 52.7153 | -0.0606 | 0.0032 | 3.9152 | 9.8672E-55 | SIG |
| 183 | GW | RR | MEJA | 513900081 | 5 | 13900081 | 5.1303 | 0.0157 | 0.0002 | 0.3004 | 1.17065E-06 | SUG |
| 184 | GW | RR | MEJA | 521088250 | 5 | 21088250 | 22.6226 | -0.0331 | 0.0008 | 0.987 | 2.38893E-23 | SIG |
| 185 | GW | RR | MEJA | 725284287 | 7 | 25284287 | 28.1824 | 0.0405 | 0.0004 | 0.5154 | 6.58566E-29 | SIG |
| 186 | GW | RR | MEJA | 800487221 | 8 | 487221 | 29.7484 | -0.0418 | 0.0005 | 0.5848 | 1.78941E-30 | SIG |
| 187 | GW | RR | MEJA | 806166430 | 8 | 6166430 | 11.4811 | 0.0241 | 0.0004 | 0.5207 | 3.30643E-12 | SIG |
| 188 | GW | RR | MEJA | 808915046 | 8 | 8915046 | 10.4167 | -0.023 | 0.0005 | 0.5798 | 3.83392E-11 | SIG |
| 189 | GW | RR | MEJA | 812442028 | 8 | 12442028 | 17.428 | 0.0299 | 0.0004 | 0.5018 | 3.7379E-18 | SIG |
| 190 | GW | RR | MEJA | 817510908 | 8 | 17510908 | 29.4902 | -0.0418 | 0.0016 | 2.0096 | 3.24273E-30 | SIG |
| 191 | GW | RR | MEJA | 819654130 | 8 | 19654130 | 7.4181 | 0.0197 | 0.0002 | 0.3051 | 3.82056E-08 | SUG |
| 192 | GW | RR | MEJA | 907342896 | 9 | 7342896 | 23.5331 | 0.0363 | 0.0006 | 0.7171 | 2.23039E-25 | SIG |
| 193 | GW | RR | MEJA | 1011991995 | 10 | 11991995 | 9.7444 | 0.022 | 0.0005 | 0.5772 | 2.1023E-11 | SIG |
| 194 | GW | RR | MEJA | 1021983205 | 10 | 21983205 | 22.8753 | -0.0354 | 0.0011 | 1.392 | 1.33508E-23 | SIG |
| 195 | GW | RR | MEJA | 1106648699 | 11 | 6648699 | 16.1171 | -0.029 | 0.0003 | 0.3096 | 6.99048E-18 | SIG |
| 196 | GW | RR | MEJA | 1116528947 | 11 | 16528947 | 17.418 | -0.0283 | 0.0005 | 0.6476 | 3.8247E-18 | SIG |
| 197 | GW | RR | MEJA | 1116768397 | 11 | 16768397 | 54.8819 | -0.0616 | 0.0012 | 1.4738 | 1.31854E-55 | SIG |
| 198 | GW | RR | MEJA | 1118761608 | 11 | 18761608 | 61.9895 | -0.0665 | 0.0009 | 1.1315 | 1.02982E-62 | SIG |
| 199 | GW | RR | MEJA | 1125735896 | 11 | 25735896 | 43.8426 | -0.0541 | 0.0016 | 1.9532 | 8.058E-46 | SIG |
| 200 | GW | RR | MEJA | 1126349247 | 11 | 26349247 | 19.5934 | 0.0324 | 0.001 | 1.2752 | 2.12291E-21 | SIG |
| 201 | GW | RR | MEJA | 1209492644 | 12 | 9492644 | 10.7003 | 0.0232 | 0.0005 | 0.6191 | 2.22497E-12 | SIG |
| 202 | GL | RR | 1 | 125212877 | 1 | 25212877 | 13.7046 | -0.1312 | 0.0059 | 0.9399 | 1.95511E-15 | SIG |
| 203 | GL | RR | 1 | 206168637 | 2 | 6168637 | 5.558 | 0.0795 | 0.0062 | 0.9813 | 4.21262E-07 | SUG |
| 204 | GL | RR | 1 | 207093706 | 2 | 7093706 | 16.1357 | 0.1446 | 0.0103 | 1.6444 | 6.69336E-18 | SIG |
| 205 | GL | RR | 1 | 217474355 | 2 | 17474355 | 14.3413 | 0.1348 | 0.009 | 1.4378 | 4.41492E-16 | SIG |
| 206 | GL | RR | 1 | 231629057 | 2 | 31629057 | 11.6607 | 0.1187 | 0.0086 | 1.372 | 2.33835E-13 | SIG |
| 207 | GL | RR | 1 | 316746142 | 3 | 16746142 | 26.1652 | 0.1994 | 0.0381 | 6.0501 | 4.93987E-28 | SIG |
| 208 | GL | RR | 1 | 321140760 | 3 | 21140760 | 17.0132 | 0.1495 | 0.0188 | 2.994 | 8.64956E-19 | SIG |
| 209 | GL | RR | 1 | 334113758 | 3 | 34113758 | 19.7123 | 0.1649 | 0.0052 | 0.8308 | 1.60971E-21 | SIG |
| 210 | GL | RR | 1 | 401015786 | 4 | 1015786 | 16.1207 | -0.1445 | 0.0096 | 1.5217 | 6.93276E-18 | SIG |
| 211 | GL | RR | 1 | 406883844 | 4 | 6883844 | 17.339 | -0.1536 | 0.007 | 1.1088 | 4.58853E-18 | SIG |
| 212 | GL | RR | 1 | 431723084 | 4 | 31723084 | 10.6102 | -0.1124 | 0.0033 | 0.5168 | 2.74877E-12 | SIG |
| 213 | GL | RR | 1 | 724964429 | 7 | 24964429 | 20.7783 | -0.1707 | 0.0088 | 1.3992 | 1.34775E-22 | SIG |
| 214 | GL | RR | 1 | 820722975 | 8 | 20722975 | 20.4004 | -0.1681 | 0.0198 | 3.1475 | 3.24617E-22 | SIG |
| 215 | GL | RR | 1 | 906961517 | 9 | 6961517 | 11.9567 | 0.1205 | 0.0061 | 0.9714 | 1.16883E-13 | SIG |
| 216 | GL | RR | 1 | 1013888948 | 10 | 13888948 | 8.2083 | -0.097 | 0.0036 | 0.5717 | 7.84058E-10 | SIG |
| 217 | GL | RR | 1 | 1018229059 | 10 | 18229059 | 9.8837 | -0.1078 | 0.0077 | 1.2161 | 1.51503E-11 | SIG |
| 218 | GL | RR | 1 | 1118043760 | 11 | 18043760 | 7.7372 | -0.0954 | 0.0069 | 1.0941 | 2.38593E-09 | SIG |
| 219 | GL | RR | 1 | 1219921339 | 12 | 19921339 | 24.9033 | -0.1972 | 0.0137 | 2.1729 | 1.25204E-25 | SIG |
| 220 | GL | RR | 2 | 125212877 | 1 | 25212877 | 24.6341 | -0.2021 | 0.014 | 2.1294 | 1.72846E-26 | SIG |
| 221 | GL | RR | 2 | 316708508 | 3 | 16708508 | 46.204 | 0.3311 | 0.1055 | 15.9983 | 3.41725E-48 | SIG |
| 222 | GL | RR | 2 | 334161467 | 3 | 34161467 | 17.0358 | 0.1582 | 0.0101 | 1.5328 | 8.2049E-19 | SIG |
| 223 | GL | RR | 2 | 405112378 | 4 | 5112378 | 20.4127 | -0.1773 | 0.006 | 0.9112 | 3.15423E-22 | SIG |
| 224 | GL | RR | 2 | 406883844 | 4 | 6883844 | 16.9095 | -0.1571 | 0.0085 | 1.286 | 1.23346E-17 | SIG |
| 225 | GL | RR | 2 | 505413770 | 5 | 5413770 | 14.3552 | 0.1418 | 0.0117 | 1.7693 | 4.27416E-16 | SIG |
| 226 | GL | RR | 2 | 520889199 | 5 | 20889199 | 17.7093 | 0.1658 | 0.0059 | 0.899 | 1.95588E-18 | SIG |
| 227 | GL | RR | 2 | 601623846 | 6 | 1623846 | 8.2691 | -0.1027 | 0.0105 | 1.5926 | 6.79347E-10 | SIG |
| 228 | GL | RR | 2 | 606777639 | 6 | 6777639 | 11.6929 | 0.1262 | 0.0142 | 2.1592 | 2.16849E-13 | SIG |
| 229 | GL | RR | 2 | 820715449 | 8 | 20715449 | 13.6741 | -0.1418 | 0.0115 | 1.7488 | 2.1205E-14 | SIG |
| 230 | GL | RR | 2 | 920512658 | 9 | 20512658 | 5.5378 | -0.0831 | 0.0041 | 0.6177 | 4.42035E-07 | SUG |
| 231 | GL | RR | 2 | 1014508748 | 10 | 14508748 | 8.1257 | -0.1017 | 0.0094 | 1.4201 | 9.52897E-10 | SIG |
| 232 | GL | RR | 2 | 1108501237 | 11 | 8501237 | 12.5957 | -0.1405 | 0.0094 | 1.4295 | 2.53936E-13 | SIG |
| 233 | GL | RR | 2 | 1117830860 | 11 | 17830860 | 5.5426 | 0.0824 | 0.0065 | 0.9799 | 4.37025E-07 | SUG |
| 234 | GL | RR | 2 | 1118586493 | 11 | 18586493 | 3.8131 | -0.0677 | 0.0041 | 0.6253 | 2.78514E-05 | SUG |
| 235 | GL | RR | MEJA | 106036854 | 1 | 6036854 | 13.6295 | -0.0601 | 0.0033 | 0.5089 | 2.33027E-15 | SIG |
| 236 | GL | RR | MEJA | 123144702 | 1 | 23144702 | 40.4568 | -0.1161 | 0.0055 | 0.8595 | 3.50537E-41 | SIG |
| 237 | GL | RR | MEJA | 204868399 | 2 | 4868399 | 13.3913 | -0.0597 | 0.0032 | 0.4902 | 4.06751E-15 | SIG |
| 238 | GL | RR | MEJA | 316708508 | 3 | 16708508 | 119.44 | 0.2772 | 0.0739 | 11.5002 | 1.2455E-121 | SIG |
| 239 | GL | RR | MEJA | 321140760 | 3 | 21140760 | 16.7587 | 0.0675 | 0.0038 | 0.5967 | 1.56554E-18 | SIG |
| 240 | GL | RR | MEJA | 334087282 | 3 | 34087282 | 55.8497 | 0.1436 | 0.0039 | 0.6133 | 7.03947E-58 | SIG |
| 241 | GL | RR | MEJA | 401015786 | 4 | 1015786 | 8.1228 | -0.0455 | 0.0009 | 0.1475 | 9.59444E-10 | SIG |
| 242 | GL | RR | MEJA | 403855798 | 4 | 3855798 | 72.4213 | -0.1753 | 0.0072 | 1.1265 | 1.66151E-74 | SIG |
| 243 | GL | RR | MEJA | 404591488 | 4 | 4591488 | 15.573 | 0.0647 | 0.0018 | 0.2868 | 2.4881E-17 | SIG |
| 244 | GL | RR | MEJA | 406883844 | 4 | 6883844 | 29.7445 | -0.0948 | 0.003 | 0.4691 | 1.8054E-30 | SIG |
| 245 | GL | RR | MEJA | 409493312 | 4 | 9493312 | 9.6352 | -0.0516 | 0.0009 | 0.143 | 2.31824E-10 | SIG |
| 246 | GL | RR | MEJA | 435129844 | 4 | 35129844 | 34.6613 | -0.1043 | 0.0044 | 0.6827 | 1.37316E-36 | SIG |
| 247 | GL | RR | MEJA | 505914985 | 5 | 5914985 | 48.789 | 0.1308 | 0.0059 | 0.9154 | 8.65105E-51 | SIG |
| 248 | GL | RR | MEJA | 606533624 | 6 | 6533624 | 14.0836 | 0.0622 | 0.0024 | 0.3777 | 8.06177E-16 | SIG |
| 249 | GL | RR | MEJA | 606777283 | 6 | 6777283 | 10.2356 | 0.0514 | 0.0024 | 0.366 | 6.62709E-12 | SIG |
| 250 | GL | RR | MEJA | 614171782 | 6 | 14171782 | 10.1675 | -0.0513 | 0.0024 | 0.3667 | 7.77554E-12 | SIG |
| 251 | GL | RR | MEJA | 627045117 | 6 | 27045117 | 35.5486 | -0.1059 | 0.0029 | 0.4524 | 1.75788E-37 | SIG |
| 252 | GL | RR | MEJA | 719727567 | 7 | 19727567 | 27.594 | -0.0908 | 0.0025 | 0.3895 | 1.79297E-29 | SIG |
| 253 | GL | RR | MEJA | 724620377 | 7 | 24620377 | 43.7233 | -0.1214 | 0.0057 | 0.8801 | 1.0621E-45 | SIG |
| 254 | GL | RR | MEJA | 803954829 | 8 | 3954829 | 15.6762 | -0.065 | 0.0033 | 0.5183 | 1.95548E-17 | SIG |
| 255 | GL | RR | MEJA | 820719085 | 8 | 20719085 | 16.7466 | -0.0669 | 0.0031 | 0.4848 | 1.79495E-17 | SIG |
| 256 | GL | RR | MEJA | 906986093 | 9 | 6986093 | 22.4094 | 0.0799 | 0.0028 | 0.4397 | 3.03668E-24 | SIG |
| 257 | GL | RR | MEJA | 916419362 | 9 | 16419362 | 28.3219 | 0.0919 | 0.0027 | 0.4248 | 3.31249E-30 | SIG |
| 258 | GL | RR | MEJA | 920512658 | 9 | 20512658 | 23.6421 | -0.083 | 0.0041 | 0.6317 | 1.73136E-25 | SIG |
| 259 | GL | RR | MEJA | 1014508748 | 10 | 14508748 | 14.1303 | -0.0613 | 0.0034 | 0.5296 | 7.22814E-16 | SIG |
| 260 | GL | RR | MEJA | 1108501237 | 11 | 8501237 | 20.1412 | -0.0772 | 0.0026 | 0.4105 | 7.23608E-21 | SIG |
| 261 | GL | RR | MEJA | 1117830860 | 11 | 17830860 | 28.8801 | 0.0927 | 0.0082 | 1.2733 | 9.07467E-31 | SIG |
| 262 | GL | RR | MEJA | 1118586493 | 11 | 18586493 | 21.562 | -0.0782 | 0.0055 | 0.8553 | 2.1776E-23 | SIG |
| 263 | GL | RR | MEJA | 1120155299 | 11 | 20155299 | 42.6161 | -0.1281 | 0.0024 | 0.3676 | 2.42935E-43 | SIG |
| 264 | GL | RR | MEJA | 1200043637 | 12 | 43637 | 11.5608 | 0.0555 | 0.0011 | 0.1762 | 2.9553E-13 | SIG |
| 265 | GL | RR | MEJA | 1202930390 | 12 | 2930390 | 20.9647 | 0.0767 | 0.0026 | 0.4021 | 8.73542E-23 | SIG |
| 266 | TGW | RR | 1 | 111524890 | 1 | 11524890 | 9.1316 | 0.5829 | 0.2335 | 2.4494 | 7.39202E-10 | SIG |
| 267 | TGW | RR | 1 | 129860670 | 1 | 29860670 | 27.4666 | -1.2301 | 0.3232 | 3.3906 | 2.40969E-29 | SIG |
| 268 | TGW | RR | 1 | 201230631 | 2 | 1230631 | 14.6089 | 0.8175 | 0.246 | 2.5811 | 2.36288E-16 | SIG |
| 269 | TGW | RR | 1 | 226049877 | 2 | 26049877 | 29.3821 | -1.3333 | 0.4952 | 5.195 | 4.15898E-30 | SIG |
| 270 | TGW | RR | 1 | 231102971 | 2 | 31102971 | 10.8632 | 0.6784 | 0.3287 | 3.4486 | 1.51787E-12 | SIG |
| 271 | TGW | RR | 1 | 404570606 | 4 | 4570606 | 14.2645 | -0.798 | 0.2432 | 2.5515 | 5.28231E-16 | SIG |
| 272 | TGW | RR | 1 | 431723084 | 4 | 31723084 | 48.6178 | -1.9607 | 0.9902 | 10.388 | 1.28518E-50 | SIG |
| 273 | TGW | RR | 1 | 505895833 | 5 | 5895833 | 5.0426 | 0.4424 | 0.1944 | 2.0398 | 1.44398E-06 | SUG |
| 274 | TGW | RR | 1 | 612697211 | 6 | 12697211 | 21.9412 | 1.0513 | 0.2361 | 2.4767 | 9.01799E-24 | SIG |
| 275 | TGW | RR | 1 | 615626457 | 6 | 15626457 | 12.2696 | -0.7475 | 0.2989 | 3.1354 | 5.38128E-13 | SIG |
| 276 | TGW | RR | 1 | 810690144 | 8 | 10690144 | 4.8643 | -0.4367 | 0.1448 | 1.5195 | 2.21385E-06 | SUG |
| 277 | TGW | RR | 1 | 1010606927 | 10 | 10606927 | 8.4875 | 0.5908 | 0.2683 | 2.8148 | 4.05769E-10 | SIG |
| 278 | TGW | RR | 1 | 1103362215 | 11 | 3362215 | 15.2289 | 0.836 | 0.2416 | 2.5342 | 5.55424E-17 | SIG |
| 279 | TGW | RR | 1 | 1113681900 | 11 | 13681900 | 20.6606 | -1.0098 | 0.1949 | 2.0446 | 1.77198E-22 | SIG |
| 280 | TGW | RR | 1 | 1113977759 | 11 | 13977759 | 8.0962 | 0.5741 | 0.3288 | 3.4495 | 8.0188E-09 | SIG |
| 281 | TGW | RR | 1 | 1200833377 | 12 | 833377 | 16.6818 | 0.8793 | 0.3546 | 3.7194 | 1.87315E-18 | SIG |
| 282 | TGW | RR | 2 | 122612838 | 1 | 22612838 | 25.2357 | 0.9938 | 0.2328 | 2.895 | 4.27432E-27 | SIG |
| 283 | TGW | RR | 2 | 126809821 | 1 | 26809821 | 6.5098 | -0.463 | 0.1812 | 2.2534 | 3.09371E-07 | SUG |
| 284 | TGW | RR | 2 | 140053361 | 1 | 40053361 | 13.9971 | 0.6792 | 0.4614 | 5.7361 | 9.86817E-16 | SIG |
| 285 | TGW | RR | 2 | 225038930 | 2 | 25038930 | 21.5681 | -0.9163 | 0.2752 | 3.4211 | 2.70813E-22 | SIG |
| 286 | TGW | RR | 2 | 431939665 | 4 | 31939665 | 12.4957 | -0.6344 | 0.1216 | 1.5113 | 3.30691E-14 | SIG |
| 287 | TGW | RR | 2 | 501981355 | 5 | 1981355 | 33.5621 | 1.2315 | 0.3597 | 4.4718 | 1.75291E-35 | SIG |
| 288 | TGW | RR | 2 | 511152752 | 5 | 11152752 | 33.0985 | -1.2139 | 0.4636 | 5.7634 | 7.99348E-34 | SIG |
| 289 | TGW | RR | 2 | 611905299 | 6 | 11905299 | 16.8987 | -0.7609 | 0.2065 | 2.567 | 1.26441E-17 | SIG |
| 290 | TGW | RR | 2 | 628657023 | 6 | 28657023 | 11.5382 | 0.6052 | 0.3615 | 4.494 | 2.89892E-12 | SIG |
| 291 | TGW | RR | 2 | 708761424 | 7 | 8761424 | 21.7612 | -0.8699 | 0.1804 | 2.2431 | 1.73631E-22 | SIG |
| 292 | TGW | RR | 2 | 808395003 | 8 | 8395003 | 11.8312 | -0.618 | 0.2301 | 2.8606 | 1.47639E-12 | SIG |
| 293 | TGW | RR | 2 | 826111247 | 8 | 26111247 | 28.202 | 1.0764 | 0.2984 | 3.7103 | 4.37429E-30 | SIG |
| 294 | TGW | RR | 2 | 920866738 | 9 | 20866738 | 23.7992 | 0.954 | 0.2145 | 2.6674 | 1.20191E-25 | SIG |
| 295 | TGW | RR | 2 | 1016892211 | 10 | 16892211 | 17.8409 | -0.6998 | 0.3705 | 4.607 | 1.4446E-18 | SIG |
| 296 | TGW | RR | 2 | 1103476187 | 11 | 3476187 | 12.9448 | -0.6459 | 0.2554 | 3.1759 | 1.1559E-14 | SIG |
| 297 | TGW | RR | 2 | 1118422045 | 11 | 18422045 | 19.581 | -0.8392 | 0.5922 | 7.3634 | 2.62877E-20 | SIG |
| 298 | TGW | RR | 2 | 1124346080 | 11 | 24346080 | 7.3689 | -0.4671 | 0.218 | 2.71 | 5.70206E-09 | SIG |
| 299 | TGW | RR | MEJA | 100171150 | 1 | 171150 | 7.2519 | 0.0324 | 0.1082 | 1.2237 | 5.60194E-08 | SUG |
| 300 | TGW | RR | MEJA | 107261596 | 1 | 7261596 | 7.3262 | -0.3351 | 0.0567 | 0.6417 | 6.30859E-09 | SIG |
| 301 | TGW | RR | MEJA | 121465134 | 1 | 21465134 | 9.2079 | 0.3807 | 0.1101 | 1.2453 | 7.43027E-11 | SIG |
| 302 | TGW | RR | MEJA | 135730043 | 1 | 35730043 | 8.0219 | -0.3564 | 0.12 | 1.3574 | 9.51476E-09 | SIG |
| 303 | TGW | RR | MEJA | 140086802 | 1 | 40086802 | 15.3981 | 0.4902 | 0.2442 | 2.7622 | 4.00412E-16 | SIG |
| 304 | TGW | RR | MEJA | 201230631 | 2 | 1230631 | 16.1277 | 0.512 | 0.0965 | 1.0916 | 6.81932E-18 | SIG |
| 305 | TGW | RR | MEJA | 313505333 | 3 | 13505333 | 13.7785 | 0.4519 | 0.1165 | 1.3172 | 1.66721E-14 | SIG |
| 306 | TGW | RR | MEJA | 315602952 | 3 | 15602952 | 29.7897 | 0.7285 | 0.1932 | 2.1851 | 1.10039E-31 | SIG |
| 307 | TGW | RR | MEJA | 404570606 | 4 | 4570606 | 21.6974 | -0.6008 | 0.1379 | 1.5592 | 1.58962E-23 | SIG |
| 308 | TGW | RR | MEJA | 425092933 | 4 | 25092933 | 19.9604 | 0.597 | 0.0686 | 0.7759 | 1.09722E-20 | SIG |
| 309 | TGW | RR | MEJA | 432466735 | 4 | 32466735 | 45.3429 | -0.95 | 0.4053 | 4.5838 | 4.55835E-46 | SIG |
| 310 | TGW | RR | MEJA | 501568614 | 5 | 1568614 | 9.8156 | 0.3877 | 0.0948 | 1.0722 | 1.77811E-11 | SIG |
| 311 | TGW | RR | MEJA | 514579088 | 5 | 14579088 | 15.4061 | -0.5007 | 0.0824 | 0.9318 | 3.67341E-17 | SIG |
| 312 | TGW | RR | MEJA | 610584698 | 6 | 10584698 | 37.0771 | -0.8336 | 0.3802 | 4.3 | 5.09955E-39 | SIG |
| 313 | TGW | RR | MEJA | 816572646 | 8 | 16572646 | 27.9384 | -0.7058 | 0.0978 | 1.1059 | 1.15519E-28 | SIG |
| 314 | TGW | RR | MEJA | 817696038 | 8 | 17696038 | 5.2885 | 0.2853 | 0.0814 | 0.9206 | 8.01858E-07 | SUG |
| 315 | TGW | RR | MEJA | 905251526 | 9 | 5251526 | 7.4565 | 0.3404 | 0.1009 | 1.141 | 4.63417E-09 | SIG |
| 316 | TGW | RR | MEJA | 919843818 | 9 | 19843818 | 34.9536 | 0.8418 | 0.1745 | 1.9736 | 1.11605E-35 | SIG |
| 317 | TGW | RR | MEJA | 1010926362 | 10 | 10926362 | 5.5627 | -0.276 | 0.0495 | 0.5602 | 2.73834E-06 | SUG |
| 318 | TGW | RR | MEJA | 1103320017 | 11 | 3320017 | 39.2364 | 0.8676 | 0.2113 | 2.3899 | 3.43722E-41 | SIG |
| 319 | TGW | RR | MEJA | 1103518389 | 11 | 3518389 | 28.5826 | -0.708 | 0.3147 | 3.5595 | 1.80936E-30 | SIG |
| 320 | TGW | RR | MEJA | 1116085870 | 11 | 16085870 | 4.0992 | 0.2485 | 0.0609 | 0.6887 | 1.39438E-05 | SUG |
| 321 | TGW | RR | MEJA | 1117131649 | 11 | 17131649 | 15.4395 | 0.5045 | 0.0792 | 0.8953 | 3.63954E-16 | SIG |
| 322 | TGW | RR | MEJA | 1118422045 | 11 | 18422045 | 4.9968 | -0.2715 | 0.0623 | 0.705 | 1.00772E-05 | SUG |
| 323 | TGW | RR | MEJA | 1222584177 | 12 | 22584177 | 14.7554 | -0.4826 | 0.1194 | 1.3504 | 1.67813E-16 | SIG |

GW: grain width; GL: grain length; TGW: thousand grain weight; MC: main crop; RR: ratoon rice; MEJA: multi-environment joint analysis

**Table S24 Main-effect QTN for grain width, grain length, and thousand grain weight in main crop and ratoon rice of 159 rice accessions in single environment and multi-environment joint analysis using Q matrix**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Trait** | **MC or RR** | **Environment** | **Marker** | **Chromosome** | **Position (bp)** | **LOD** | **add** | **variance** | **r2(%)** | **P-value** | **significance** |
| 1 | GW | MC | 1 | 140476043 | 1 | 40476043 | 17.1236 | 0.0711 | 0.0049 | 5.6146 | 7.53381E-18 | SIG |
| 2 | GW | MC | 1 | 326622444 | 3 | 26622444 | 6.6722 | -0.0392 | 0.0012 | 1.3527 | 2.97209E-08 | SUG |
| 3 | GW | MC | 1 | 331660510 | 3 | 31660510 | 6.0965 | -0.0374 | 0.0013 | 1.4921 | 1.16733E-07 | SUG |
| 4 | GW | MC | 1 | 431159467 | 4 | 31159467 | 22.545 | 0.0863 | 0.0033 | 3.7496 | 2.2158E-24 | SIG |
| 5 | GW | MC | 1 | 504208472 | 5 | 4208472 | 14.5038 | -0.0633 | 0.0018 | 2.0327 | 3.02037E-16 | SIG |
| 6 | GW | MC | 1 | 505361276 | 5 | 5361276 | 9.2478 | -0.0479 | 0.0016 | 1.797 | 6.76449E-11 | SIG |
| 7 | GW | MC | 1 | 508320511 | 5 | 8320511 | 18.5035 | -0.0746 | 0.0039 | 4.4281 | 2.68469E-20 | SIG |
| 8 | GW | MC | 1 | 809925342 | 8 | 9925342 | 29.3035 | -0.1086 | 0.0025 | 2.8668 | 4.98371E-30 | SIG |
| 9 | GW | MC | 1 | 810329229 | 8 | 10329229 | 27.2041 | 0.1037 | 0.0083 | 9.429 | 4.43075E-29 | SIG |
| 10 | GW | MC | 1 | 1011713473 | 10 | 11713473 | 5.1586 | -0.0348 | 0.0007 | 0.7523 | 1.09391E-06 | SUG |
| 11 | GW | MC | 1 | 1117167095 | 11 | 17167095 | 6.5878 | -0.0403 | 0.0016 | 1.773 | 2.58506E-07 | SUG |
| 12 | GW | MC | 1 | 1125125749 | 11 | 25125749 | 11.754 | -0.055 | 0.0019 | 2.1948 | 1.87937E-13 | SIG |
| 13 | GW | MC | 1 | 1206317244 | 12 | 6317244 | 3.8527 | 0.0293 | 0.0008 | 0.938 | 2.53034E-05 | SUG |
| 14 | GW | MC | 2 | 140476043 | 1 | 40476043 | 19.1758 | 0.0682 | 0.0046 | 5.0728 | 6.68261E-20 | SIG |
| 15 | GW | MC | 2 | 201165732 | 2 | 1165732 | 21.8807 | 0.0754 | 0.0019 | 2.0622 | 1.0379E-23 | SIG |
| 16 | GW | MC | 2 | 314763587 | 3 | 14763587 | 6.5998 | 0.0355 | 0.0012 | 1.3254 | 3.52939E-08 | SUG |
| 17 | GW | MC | 2 | 326844557 | 3 | 26844557 | 9.8773 | -0.0443 | 0.0019 | 2.0867 | 1.53817E-11 | SIG |
| 18 | GW | MC | 2 | 420400208 | 4 | 20400208 | 23.5701 | -0.0799 | 0.0013 | 1.4429 | 2.04668E-25 | SIG |
| 19 | GW | MC | 2 | 423538685 | 4 | 23538685 | 5.6833 | -0.0342 | 0.0011 | 1.1622 | 2.0743E-06 | SUG |
| 20 | GW | MC | 2 | 504775669 | 5 | 4775669 | 13.8669 | -0.0359 | 0.0028 | 3.0877 | 1.36036E-14 | SIG |
| 21 | GW | MC | 2 | 505358771 | 5 | 5358771 | 28.7431 | -0.0942 | 0.0063 | 6.965 | 1.81099E-29 | SIG |
| 22 | GW | MC | 2 | 701743812 | 7 | 1743812 | 10.6038 | -0.0468 | 0.001 | 1.1555 | 2.79042E-12 | SIG |
| 23 | GW | MC | 2 | 907776660 | 9 | 7776660 | 15.3839 | 0.0586 | 0.0008 | 0.8978 | 3.86871E-17 | SIG |
| 24 | GW | MC | 2 | 910486075 | 9 | 10486075 | 12.5618 | 0.0518 | 0.0025 | 2.7227 | 2.83301E-14 | SIG |
| 25 | GW | MC | 2 | 1116995448 | 11 | 16995448 | 16.1202 | -0.0608 | 0.0013 | 1.4708 | 7.59262E-17 | SIG |
| 26 | GW | MC | 2 | 1125261662 | 11 | 25261662 | 11.3025 | 0.048 | 0.0023 | 2.5276 | 5.41563E-13 | SIG |
| 27 | GW | MC | MEJA | 128170409 | 1 | 28170409 | 13.8449 | 0.0309 | 0.001 | 1.0742 | 1.40857E-15 | SIG |
| 28 | GW | MC | MEJA | 134815173 | 1 | 34815173 | 26.8606 | -0.0457 | 0.0006 | 0.7069 | 9.83432E-29 | SIG |
| 29 | GW | MC | MEJA | 140476043 | 1 | 40476043 | 26.7642 | 0.0446 | 0.002 | 2.3036 | 1.72514E-27 | SIG |
| 30 | GW | MC | MEJA | 201236423 | 2 | 1236423 | 38.7668 | 0.0585 | 0.0012 | 1.3784 | 1.01932E-40 | SIG |
| 31 | GW | MC | MEJA | 219799308 | 2 | 19799308 | 4.2375 | 0.016 | 0.0002 | 0.2201 | 5.79031E-05 | SUG |
| 32 | GW | MC | MEJA | 220138937 | 2 | 20138937 | 5.8795 | 0.019 | 0.0004 | 0.4028 | 1.95689E-07 | SUG |
| 33 | GW | MC | MEJA | 313813715 | 3 | 13813715 | 27.7314 | -0.0465 | 0.0013 | 1.4914 | 1.30341E-29 | SIG |
| 34 | GW | MC | MEJA | 322032925 | 3 | 22032925 | 7.6972 | -0.022 | 0.0001 | 0.1687 | 2.00967E-08 | SIG |
| 35 | GW | MC | MEJA | 323970533 | 3 | 23970533 | 26.8433 | -0.0438 | 0.0003 | 0.3897 | 1.43792E-27 | SIG |
| 36 | GW | MC | MEJA | 504631781 | 5 | 4631781 | 55.9965 | -0.0784 | 0.0041 | 4.5799 | 5.014E-58 | SIG |
| 37 | GW | MC | MEJA | 505466023 | 5 | 5466023 | 12.6484 | 0.0294 | 0.0008 | 0.9537 | 2.31334E-14 | SIG |
| 38 | GW | MC | MEJA | 508182309 | 5 | 8182309 | 24.942 | -0.0434 | 0.0015 | 1.7054 | 8.45378E-27 | SIG |
| 39 | GW | MC | MEJA | 600023671 | 6 | 23671 | 16.6264 | -0.0365 | 0.0011 | 1.1848 | 2.36693E-17 | SIG |
| 40 | GW | MC | MEJA | 810329229 | 8 | 10329229 | 38.9909 | 0.0607 | 0.0028 | 3.1942 | 6.06745E-41 | SIG |
| 41 | GW | MC | MEJA | 816385094 | 8 | 16385094 | 18.7139 | -0.0375 | 0.0005 | 0.5269 | 1.93549E-19 | SIG |
| 42 | GW | MC | MEJA | 826515715 | 8 | 26515715 | 10.0799 | 0.0255 | 0.0006 | 0.7217 | 9.55458E-12 | SIG |
| 43 | GW | MC | MEJA | 910486075 | 9 | 10486075 | 15.7431 | 0.033 | 0.001 | 1.1299 | 1.67276E-17 | SIG |
| 44 | GW | MC | MEJA | 1101221125 | 11 | 1221125 | 37.1215 | 0.0582 | 0.001 | 1.1747 | 7.58364E-38 | SIG |
| 45 | GW | MC | MEJA | 1117149260 | 11 | 17149260 | 25.2208 | -0.0462 | 0.0018 | 2.0181 | 6.02797E-26 | SIG |
| 46 | GW | MC | MEJA | 1125624085 | 11 | 25624085 | 15.9484 | 0.033 | 0.0011 | 1.2256 | 1.03608E-17 | SIG |
| 47 | GW | MC | MEJA | 1211178871 | 12 | 11178871 | 19.2252 | 0.0381 | 0.001 | 1.1307 | 5.96297E-20 | SIG |
| 48 | GL | MC | 1 | 316708508 | 3 | 16708508 | 35.051 | 0.3596 | 0.108 | 15.1157 | 5.56673E-37 | SIG |
| 49 | GL | MC | 1 | 413796107 | 4 | 13796107 | 8.1622 | 0.1266 | 0.0067 | 0.9347 | 8.74248E-10 | SIG |
| 50 | GL | MC | 1 | 433360398 | 4 | 33360398 | 19.534 | -0.2229 | 0.0221 | 3.0868 | 2.4376E-21 | SIG |
| 51 | GL | MC | 1 | 500585798 | 5 | 585798 | 16.7948 | 0.1992 | 0.0164 | 2.2968 | 1.4393E-18 | SIG |
| 52 | GL | MC | 1 | 519329552 | 5 | 19329552 | 19.2694 | 0.2197 | 0.0144 | 2.0116 | 4.51322E-21 | SIG |
| 53 | GL | MC | 1 | 525364698 | 5 | 25364698 | 28.4998 | -0.2999 | 0.0219 | 3.0595 | 3.17127E-29 | SIG |
| 54 | GL | MC | 1 | 701179170 | 7 | 1179170 | 14.2194 | 0.178 | 0.0303 | 4.2415 | 5.8696E-16 | SIG |
| 55 | GL | MC | 1 | 724533051 | 7 | 24533051 | 14.8238 | -0.1847 | 0.0124 | 1.7313 | 1.43032E-16 | SIG |
| 56 | GL | MC | 1 | 818394489 | 8 | 18394489 | 25.3648 | 0.2711 | 0.0077 | 1.0811 | 3.1674E-27 | SIG |
| 57 | GL | MC | 1 | 906852848 | 9 | 6852848 | 14.6602 | -0.1825 | 0.0139 | 1.9414 | 2.09606E-16 | SIG |
| 58 | GL | MC | 1 | 1015482498 | 10 | 15482498 | 10.5568 | -0.1485 | 0.0074 | 1.0284 | 3.11626E-12 | SIG |
| 59 | GL | MC | 1 | 1204175263 | 12 | 4175263 | 17.9864 | -0.2091 | 0.0305 | 4.2676 | 8.95469E-20 | SIG |
| 60 | GL | MC | 1 | 1214201832 | 12 | 14201832 | 9.58 | -0.1419 | 0.0178 | 2.4925 | 3.09532E-11 | SIG |
| 61 | GL | MC | 2 | 106259714 | 1 | 6259714 | 5.1544 | 0.0836 | 0.0067 | 0.9781 | 1.10496E-06 | SUG |
| 62 | GL | MC | 2 | 206081603 | 2 | 6081603 | 7.1025 | -0.1002 | 0.0092 | 1.339 | 1.07153E-08 | SIG |
| 63 | GL | MC | 2 | 316708508 | 3 | 16708508 | 34.822 | 0.3082 | 0.0794 | 11.6067 | 9.46292E-37 | SIG |
| 64 | GL | MC | 2 | 401015786 | 4 | 1015786 | 10.6329 | -0.1275 | 0.0072 | 1.0478 | 2.60619E-12 | SIG |
| 65 | GL | MC | 2 | 431203233 | 4 | 31203233 | 8.5668 | 0.1124 | 0.0117 | 1.7086 | 3.36564E-10 | SIG |
| 66 | GL | MC | 2 | 525364698 | 5 | 25364698 | 23.0667 | -0.2161 | 0.0111 | 1.6253 | 8.59262E-24 | SIG |
| 67 | GL | MC | 2 | 621530176 | 6 | 21530176 | 18.4514 | -0.1879 | 0.0121 | 1.7642 | 3.03109E-20 | SIG |
| 68 | GL | MC | 2 | 702288888 | 7 | 2288888 | 12.979 | -0.1332 | 0.0175 | 2.5539 | 1.05079E-13 | SIG |
| 69 | GL | MC | 2 | 712384603 | 7 | 12384603 | 16.1546 | -0.169 | 0.0059 | 0.8623 | 7.01407E-17 | SIG |
| 70 | GL | MC | 2 | 818394489 | 8 | 18394489 | 40.2764 | 0.3558 | 0.0133 | 1.9465 | 3.09455E-42 | SIG |
| 71 | GL | MC | 2 | 1114067932 | 11 | 14067932 | 11.6549 | -0.0696 | 0.0189 | 2.7665 | 2.21572E-12 | SIG |
| 72 | GL | MC | 2 | 1204146868 | 12 | 4146868 | 14.5841 | -0.1583 | 0.0157 | 2.2946 | 2.50342E-16 | SIG |
| 73 | GL | MC | 2 | 1218051198 | 12 | 18051198 | 13.7088 | -0.1499 | 0.0099 | 1.4476 | 1.9362E-15 | SIG |
| 74 | GL | MC | 2 | 1222906272 | 12 | 22906272 | 8.7552 | -0.1138 | 0.0123 | 1.8041 | 2.1586E-10 | SIG |
| 75 | GL | MC | 2 | 1223901098 | 12 | 23901098 | 15.6252 | 0.1635 | 0.0202 | 2.9499 | 2.20247E-17 | SIG |
| 76 | GL | MC | MEJA | 203464709 | 2 | 3464709 | 36.8937 | -0.1542 | 0.0034 | 0.4872 | 7.79729E-39 | SIG |
| 77 | GL | MC | MEJA | 316717631 | 3 | 16717631 | 52.5223 | 0.1995 | 0.0332 | 4.7681 | 3.01712E-53 | SIG |
| 78 | GL | MC | MEJA | 316866114 | 3 | 16866114 | 29.3891 | 0.1337 | 0.0163 | 2.3419 | 2.78644E-31 | SIG |
| 79 | GL | MC | MEJA | 413501788 | 4 | 13501788 | 11.8661 | 0.0749 | 0.0026 | 0.3771 | 1.44502E-13 | SIG |
| 80 | GL | MC | MEJA | 431203233 | 4 | 31203233 | 8.0842 | 0.0609 | 0.0034 | 0.4928 | 1.051E-09 | SIG |
| 81 | GL | MC | MEJA | 433360398 | 4 | 33360398 | 57.0338 | -0.2144 | 0.0204 | 2.934 | 4.55993E-59 | SIG |
| 82 | GL | MC | MEJA | 500585798 | 5 | 585798 | 22.611 | 0.1097 | 0.005 | 0.7153 | 1.90072E-24 | SIG |
| 83 | GL | MC | MEJA | 519329552 | 5 | 19329552 | 40.9191 | 0.164 | 0.008 | 1.1514 | 6.99E-43 | SIG |
| 84 | GL | MC | MEJA | 525364698 | 5 | 25364698 | 72.0289 | -0.2646 | 0.0166 | 2.3857 | 9.41315E-73 | SIG |
| 85 | GL | MC | MEJA | 601969823 | 6 | 1969823 | 18.2664 | -0.094 | 0.0092 | 1.3179 | 5.42342E-19 | SIG |
| 86 | GL | MC | MEJA | 624698553 | 6 | 24698553 | 46.8305 | 0.1826 | 0.009 | 1.2915 | 8.02202E-49 | SIG |
| 87 | GL | MC | MEJA | 702288888 | 7 | 2288888 | 17.8087 | -0.0958 | 0.0077 | 1.1047 | 1.55592E-18 | SIG |
| 88 | GL | MC | MEJA | 716562571 | 7 | 16562571 | 19.8383 | -0.109 | 0.0025 | 0.3634 | 1.45342E-20 | SIG |
| 89 | GL | MC | MEJA | 724533051 | 7 | 24533051 | 62.4943 | -0.2333 | 0.0198 | 2.8369 | 1.50965E-64 | SIG |
| 90 | GL | MC | MEJA | 818394489 | 8 | 18394489 | 78.5299 | 0.2872 | 0.0087 | 1.246 | 1.24342E-80 | SIG |
| 91 | GL | MC | MEJA | 823153658 | 8 | 23153658 | 6.0102 | -0.0423 | 0.0019 | 0.2685 | 9.77393E-07 | SUG |
| 92 | GL | MC | MEJA | 906852848 | 9 | 6852848 | 30.1805 | -0.1329 | 0.0074 | 1.0579 | 4.44606E-32 | SIG |
| 93 | GL | MC | MEJA | 922540770 | 9 | 22540770 | 8.1595 | 0.0609 | 0.0036 | 0.5205 | 8.79878E-10 | SIG |
| 94 | GL | MC | MEJA | 1117785691 | 11 | 17785691 | 9.2556 | 0.062 | 0.0039 | 0.565 | 5.55522E-10 | SIG |
| 95 | GL | MC | MEJA | 1204415230 | 12 | 4415230 | 26.8737 | -0.1242 | 0.011 | 1.5772 | 9.53918E-29 | SIG |
| 96 | GL | MC | MEJA | 1223901098 | 12 | 23901098 | 9.039 | 0.0644 | 0.0031 | 0.4497 | 1.10589E-10 | SIG |
| 97 | TGW | MC | 1 | 128597255 | 1 | 28597255 | 5.2591 | 0.432 | 0.1503 | 1.6125 | 8.60224E-07 | SUG |
| 98 | TGW | MC | 1 | 201334322 | 2 | 1334322 | 13.6646 | 0.7641 | 0.1914 | 2.0546 | 2.14667E-15 | SIG |
| 99 | TGW | MC | 1 | 231234763 | 2 | 31234763 | 11.6622 | 0.6901 | 0.3594 | 3.8566 | 2.33019E-13 | SIG |
| 100 | TGW | MC | 1 | 308081540 | 3 | 8081540 | 19.2708 | 0.9724 | 0.4715 | 5.0598 | 5.36914E-20 | SIG |
| 101 | TGW | MC | 1 | 334733054 | 3 | 34733054 | 18.712 | 0.9477 | 0.3715 | 3.9867 | 1.65208E-20 | SIG |
| 102 | TGW | MC | 1 | 421023194 | 4 | 21023194 | 23.3256 | -1.1227 | 0.7788 | 8.3576 | 3.61135E-25 | SIG |
| 103 | TGW | MC | 1 | 520615822 | 5 | 20615822 | 16.0957 | -0.8565 | 0.2852 | 3.0609 | 7.34876E-18 | SIG |
| 104 | TGW | MC | 1 | 701080125 | 7 | 1080125 | 8.0755 | -0.5647 | 0.2711 | 2.9096 | 8.40927E-09 | SIG |
| 105 | TGW | MC | 1 | 801493649 | 8 | 1493649 | 10.9137 | 0.136 | 0.4496 | 4.8254 | 1.22092E-11 | SIG |
| 106 | TGW | MC | 1 | 808787015 | 8 | 8787015 | 17.4512 | -0.9229 | 0.5215 | 5.5971 | 3.11629E-19 | SIG |
| 107 | TGW | MC | 1 | 1013414896 | 10 | 13414896 | 35.3806 | -1.647 | 0.5869 | 6.298 | 4.17526E-36 | SIG |
| 108 | TGW | MC | 1 | 1020319057 | 10 | 20319057 | 18.0652 | 0.9502 | 0.2247 | 2.4117 | 7.4522E-20 | SIG |
| 109 | TGW | MC | 1 | 1211816442 | 12 | 11816442 | 9.948 | 0.6644 | 0.2866 | 3.0761 | 1.12806E-10 | SIG |
| 110 | TGW | MC | 2 | 139719661 | 1 | 39719661 | 6.7908 | -0.5558 | 0.1478 | 1.5768 | 2.24317E-08 | SIG |
| 111 | TGW | MC | 2 | 201334322 | 2 | 1334322 | 14.0614 | 0.8553 | 0.2398 | 2.5594 | 8.49046E-16 | SIG |
| 112 | TGW | MC | 2 | 231332457 | 2 | 31332457 | 24.4393 | 1.2897 | 1.253 | 13.3715 | 3.64444E-25 | SIG |
| 113 | TGW | MC | 2 | 316786485 | 3 | 16786485 | 12.7899 | 0.804 | 0.476 | 5.0791 | 1.66112E-14 | SIG |
| 114 | TGW | MC | 2 | 401274245 | 4 | 1274245 | 12.2406 | -0.7808 | 0.2203 | 2.3505 | 5.75217E-13 | SIG |
| 115 | TGW | MC | 2 | 421456460 | 4 | 21456460 | 19.0632 | 1.055 | 0.2631 | 2.8073 | 7.29336E-21 | SIG |
| 116 | TGW | MC | 2 | 505651540 | 5 | 5651540 | 9.4813 | 0.6763 | 0.4518 | 4.821 | 3.90419E-11 | SIG |
| 117 | TGW | MC | 2 | 506624426 | 5 | 6624426 | 11.0132 | -0.738 | 0.3264 | 3.4832 | 1.06756E-12 | SIG |
| 118 | TGW | MC | 2 | 619661779 | 6 | 19661779 | 12.0594 | -0.7814 | 0.497 | 5.304 | 9.18676E-14 | SIG |
| 119 | TGW | MC | 2 | 715650325 | 7 | 15650325 | 13.6998 | 0.8484 | 0.6078 | 6.4856 | 1.97717E-15 | SIG |
| 120 | TGW | MC | 2 | 1022657739 | 10 | 22657739 | 6.8293 | 0.0828 | 0.2664 | 2.8429 | 1.48242E-07 | SUG |
| 121 | TGW | MC | 2 | 1218171070 | 12 | 18171070 | 7.713 | -0.5901 | 0.3482 | 3.716 | 2.52646E-09 | SIG |
| 122 | TGW | MC | MEJA | 104440399 | 1 | 4440399 | 45.5274 | 0.8301 | 0.1629 | 1.7501 | 1.63458E-47 | SIG |
| 123 | TGW | MC | MEJA | 201334322 | 2 | 1334322 | 26.694 | 0.5696 | 0.1064 | 1.1431 | 1.44773E-28 | SIG |
| 124 | TGW | MC | MEJA | 231332457 | 2 | 31332457 | 69.2022 | 1.1786 | 1.0523 | 11.3093 | 6.31417E-70 | SIG |
| 125 | TGW | MC | MEJA | 304386976 | 3 | 4386976 | 7.8796 | 0.0366 | 0.0728 | 0.7822 | 1.32028E-08 | SIG |
| 126 | TGW | MC | MEJA | 316030163 | 3 | 16030163 | 21.5744 | 0.5165 | 0.0975 | 1.0479 | 2.66904E-22 | SIG |
| 127 | TGW | MC | MEJA | 335486847 | 3 | 35486847 | 44.6591 | -0.8216 | 0.3528 | 3.7913 | 1.21864E-46 | SIG |
| 128 | TGW | MC | MEJA | 606509590 | 6 | 6509590 | 16.9334 | 0.4296 | 0.1827 | 1.9639 | 1.04191E-18 | SIG |
| 129 | TGW | MC | MEJA | 624595315 | 6 | 24595315 | 48.206 | 0.8808 | 0.2321 | 2.4949 | 6.24927E-49 | SIG |
| 130 | TGW | MC | MEJA | 701027206 | 7 | 1027206 | 3.2423 | -0.1735 | 0.0281 | 0.3016 | 0.000572569 | SUG |
| 131 | TGW | MC | MEJA | 718006816 | 7 | 18006816 | 16.0732 | 0.0504 | 0.1706 | 1.8332 | 8.46026E-17 | SIG |
| 132 | TGW | MC | MEJA | 800779283 | 8 | 779283 | 21.8836 | 0.5186 | 0.1539 | 1.6543 | 1.03095E-23 | SIG |
| 133 | TGW | MC | MEJA | 808787015 | 8 | 8787015 | 16.1063 | -0.4268 | 0.1115 | 1.1987 | 7.16844E-18 | SIG |
| 134 | TGW | MC | MEJA | 811983096 | 8 | 11983096 | 19.8284 | -0.4835 | 0.0651 | 0.6994 | 1.48696E-20 | SIG |
| 135 | TGW | MC | MEJA | 902228113 | 9 | 2228113 | 17.8491 | -0.4523 | 0.1003 | 1.078 | 1.41768E-18 | SIG |
| 136 | TGW | MC | MEJA | 912157401 | 9 | 12157401 | 8.4664 | 0.291 | 0.0798 | 0.8571 | 3.4188E-09 | SIG |
| 137 | TGW | MC | MEJA | 1013414896 | 10 | 13414896 | 50.6161 | -0.9334 | 0.1963 | 2.1101 | 2.43095E-51 | SIG |
| 138 | TGW | MC | MEJA | 1013915559 | 10 | 13915559 | 11.209 | -0.3659 | 0.0518 | 0.5564 | 6.18662E-12 | SIG |
| 139 | TGW | MC | MEJA | 1016066492 | 10 | 16066492 | 62.0748 | -1.0775 | 0.3509 | 3.7714 | 8.46272E-63 | SIG |
| 140 | TGW | MC | MEJA | 1020319057 | 10 | 20319057 | 25.3428 | 0.5662 | 0.0798 | 0.8576 | 3.33347E-27 | SIG |
| 141 | TGW | MC | MEJA | 1105109969 | 11 | 5109969 | 26.6095 | 0.6006 | 0.105 | 1.1285 | 2.46289E-27 | SIG |
| 142 | TGW | MC | MEJA | 1117579299 | 11 | 17579299 | 17.0636 | 0.4311 | 0.1716 | 1.8447 | 8.65123E-18 | SIG |
| 143 | GW | RR | 1 | 331660510 | 3 | 31660510 | 11.4522 | -0.0453 | 0.0019 | 2.9624 | 3.8131E-13 | SIG |
| 144 | GW | RR | 1 | 334749626 | 3 | 34749626 | 23.6811 | -0.0773 | 0.0015 | 2.3682 | 2.0881E-24 | SIG |
| 145 | GW | RR | 1 | 504887394 | 5 | 4887394 | 11.7447 | -0.0458 | 0.0019 | 2.8804 | 1.92081E-13 | SIG |
| 146 | GW | RR | 1 | 505357438 | 5 | 5357438 | 10.2018 | -0.0421 | 0.0012 | 1.8724 | 7.17371E-12 | SIG |
| 147 | GW | RR | 1 | 508237047 | 5 | 8237047 | 10.0911 | -0.042 | 0.0013 | 1.9853 | 9.30603E-12 | SIG |
| 148 | GW | RR | 1 | 514400275 | 5 | 14400275 | 13.3007 | -0.0498 | 0.0006 | 0.9141 | 5.02752E-15 | SIG |
| 149 | GW | RR | 1 | 615329899 | 6 | 15329899 | 12.6148 | -0.0518 | 0.001 | 1.5509 | 2.43055E-13 | SIG |
| 150 | GW | RR | 1 | 805990045 | 8 | 5990045 | 10.5446 | -0.044 | 0.0015 | 2.2954 | 2.85617E-11 | SIG |
| 151 | GW | RR | 1 | 809892381 | 8 | 9892381 | 14.9327 | -0.0541 | 0.0007 | 1.0819 | 1.16919E-15 | SIG |
| 152 | GW | RR | 1 | 906961682 | 9 | 6961682 | 16.898 | 0.0582 | 0.0014 | 2.1686 | 1.13144E-18 | SIG |
| 153 | GW | RR | 1 | 1100505957 | 11 | 505957 | 17.5536 | 0.06 | 0.0016 | 2.5041 | 2.79954E-18 | SIG |
| 154 | GW | RR | 1 | 1117167095 | 11 | 17167095 | 6.2798 | -0.0326 | 0.001 | 1.5764 | 5.25298E-07 | SUG |
| 155 | GW | RR | 1 | 1126344986 | 11 | 26344986 | 13.1399 | 0.0496 | 0.0024 | 3.7709 | 7.32358E-15 | SIG |
| 156 | GW | RR | 1 | 1206235646 | 12 | 6235646 | 7.2258 | 0.0349 | 0.0012 | 1.8462 | 8.00164E-09 | SIG |
| 157 | GW | RR | 1 | 1210323387 | 12 | 10323387 | 9.746 | 0.0411 | 0.0015 | 2.2485 | 2.09434E-11 | SIG |
| 158 | GW | RR | 2 | 213494629 | 2 | 13494629 | 7.816 | 0.0096 | 0.0009 | 1.4383 | 1.52849E-08 | SIG |
| 159 | GW | RR | 2 | 223888162 | 2 | 23888162 | 19.3163 | -0.0545 | 0.0011 | 1.649 | 4.04556E-21 | SIG |
| 160 | GW | RR | 2 | 327019634 | 3 | 27019634 | 5.4418 | 0.0253 | 0.0006 | 0.8758 | 3.61745E-06 | SUG |
| 161 | GW | RR | 2 | 331294993 | 3 | 31294993 | 7.3088 | 0.031 | 0.0009 | 1.3494 | 4.91428E-08 | SUG |
| 162 | GW | RR | 2 | 334717822 | 3 | 34717822 | 33.3841 | -0.0852 | 0.0024 | 3.6908 | 2.64801E-35 | SIG |
| 163 | GW | RR | 2 | 414029946 | 4 | 14029946 | 16.5921 | -0.0497 | 0.0015 | 2.3092 | 2.30891E-18 | SIG |
| 164 | GW | RR | 2 | 504890865 | 5 | 4890865 | 14.8471 | -0.0455 | 0.0018 | 2.8467 | 1.42364E-15 | SIG |
| 165 | GW | RR | 2 | 506015422 | 5 | 6015422 | 6.6755 | -0.0286 | 0.0008 | 1.2346 | 2.94935E-08 | SUG |
| 166 | GW | RR | 2 | 514043668 | 5 | 14043668 | 8.7305 | 0.0328 | 0.0011 | 1.6527 | 1.8612E-09 | SIG |
| 167 | GW | RR | 2 | 808322454 | 8 | 8322454 | 7.9285 | 0.0299 | 0.001 | 1.5451 | 1.1797E-08 | SIG |
| 168 | GW | RR | 2 | 907794065 | 9 | 7794065 | 12.7174 | 0.0403 | 0.0008 | 1.1787 | 1.91906E-13 | SIG |
| 169 | GW | RR | 2 | 1100462294 | 11 | 462294 | 21.4543 | 0.059 | 0.0014 | 2.2312 | 2.79757E-23 | SIG |
| 170 | GW | RR | 2 | 1107626245 | 11 | 7626245 | 33.709 | -0.0859 | 0.0015 | 2.3439 | 1.24709E-35 | SIG |
| 171 | GW | RR | 2 | 1119233702 | 11 | 19233702 | 19.7632 | -0.056 | 0.0006 | 1.0036 | 1.728E-20 | SIG |
| 172 | GW | RR | 2 | 1126041008 | 11 | 26041008 | 21.4017 | 0.0591 | 0.0035 | 5.4163 | 3.16148E-23 | SIG |
| 173 | GW | RR | 2 | 1206958480 | 12 | 6958480 | 9.3359 | 0.0346 | 0.0011 | 1.6932 | 4.61764E-10 | SIG |
| 174 | GW | RR | 2 | 1212942520 | 12 | 12942520 | 18.72 | 0.054 | 0.0015 | 2.3457 | 1.90842E-19 | SIG |
| 175 | GW | RR | MEJA | 128170409 | 1 | 28170409 | 7.0988 | 0.0239 | 0.0006 | 0.8736 | 1.081E-08 | SIG |
| 176 | GW | RR | MEJA | 128963821 | 1 | 28963821 | 11.0072 | -0.0299 | 0.0003 | 0.4967 | 1.08279E-12 | SIG |
| 177 | GW | RR | MEJA | 331660510 | 3 | 31660510 | 11.5507 | -0.0308 | 0.0009 | 1.362 | 3.02644E-13 | SIG |
| 178 | GW | RR | MEJA | 334749626 | 3 | 34749626 | 55.6746 | -0.0901 | 0.0018 | 2.7522 | 2.12546E-56 | SIG |
| 179 | GW | RR | MEJA | 413817255 | 4 | 13817255 | 19.574 | -0.0418 | 0.001 | 1.5399 | 2.22087E-21 | SIG |
| 180 | GW | RR | MEJA | 504890865 | 5 | 4890865 | 36.9838 | -0.0641 | 0.0036 | 5.5412 | 1.04116E-37 | SIG |
| 181 | GW | RR | MEJA | 514043673 | 5 | 14043673 | 6.9961 | 0.0233 | 0.0005 | 0.8399 | 1.00959E-07 | SUG |
| 182 | GW | RR | MEJA | 519309079 | 5 | 19309079 | 32.2117 | -0.0574 | 0.0007 | 1.0365 | 4.00764E-34 | SIG |
| 183 | GW | RR | MEJA | 806428588 | 8 | 6428588 | 7.6109 | -0.0009 | 0.0006 | 0.8482 | 2.45136E-08 | SIG |
| 184 | GW | RR | MEJA | 808422704 | 8 | 8422704 | 4.4671 | -0.0184 | 0.0003 | 0.4863 | 3.41224E-05 | SUG |
| 185 | GW | RR | MEJA | 906272138 | 9 | 6272138 | 22.6644 | -0.0455 | 0.0006 | 0.9652 | 2.1701E-23 | SIG |
| 186 | GW | RR | MEJA | 907177752 | 9 | 7177752 | 17.2254 | 0.0388 | 0.0007 | 1.0184 | 5.95923E-18 | SIG |
| 187 | GW | RR | MEJA | 910486075 | 9 | 10486075 | 4.2651 | 0.0181 | 0.0003 | 0.4615 | 9.34471E-06 | SUG |
| 188 | GW | RR | MEJA | 1013144659 | 10 | 13144659 | 9.3313 | 0.0276 | 0.0003 | 0.5281 | 5.55654E-11 | SIG |
| 189 | GW | RR | MEJA | 1100462294 | 11 | 462294 | 30.0347 | 0.0547 | 0.0012 | 1.9062 | 6.23571E-32 | SIG |
| 190 | GW | RR | MEJA | 1119009026 | 11 | 19009026 | 44.0179 | -0.0722 | 0.0014 | 2.2014 | 9.63192E-45 | SIG |
| 191 | GW | RR | MEJA | 1125735889 | 11 | 25735889 | 15.8163 | -0.0372 | 0.0008 | 1.2337 | 1.41029E-17 | SIG |
| 192 | GW | RR | MEJA | 1126041008 | 11 | 26041008 | 21.1015 | 0.0438 | 0.0019 | 2.9502 | 6.35395E-23 | SIG |
| 193 | GW | RR | MEJA | 1205779427 | 12 | 5779427 | 13.4468 | -0.0334 | 0.0011 | 1.6748 | 3.57221E-15 | SIG |
| 194 | GW | RR | MEJA | 1227465140 | 12 | 27465140 | 36.6599 | 0.0646 | 0.0013 | 2.0147 | 2.19487E-37 | SIG |
| 195 | GL | RR | 1 | 105286322 | 1 | 5286322 | 11.0077 | -0.1247 | 0.0125 | 1.9952 | 1.08146E-12 | SIG |
| 196 | GL | RR | 1 | 130551892 | 1 | 30551892 | 10.0797 | 0.1197 | 0.0035 | 0.5539 | 9.55748E-12 | SIG |
| 197 | GL | RR | 1 | 203464709 | 2 | 3464709 | 34.6122 | -0.2973 | 0.0126 | 2.0111 | 1.53861E-36 | SIG |
| 198 | GL | RR | 1 | 211127824 | 2 | 11127824 | 10.9385 | 0.1247 | 0.0077 | 1.2336 | 1.27204E-12 | SIG |
| 199 | GL | RR | 1 | 218536168 | 2 | 18536168 | 20.9306 | -0.1927 | 0.0099 | 1.584 | 9.45657E-23 | SIG |
| 200 | GL | RR | 1 | 220073320 | 2 | 20073320 | 6.5252 | -0.0857 | 0.0072 | 1.1451 | 2.98585E-07 | SUG |
| 201 | GL | RR | 1 | 316708508 | 3 | 16708508 | 32.8677 | 0.2795 | 0.0653 | 10.412 | 8.76352E-35 | SIG |
| 202 | GL | RR | 1 | 325129163 | 3 | 25129163 | 8.0181 | 0.1039 | 0.0098 | 1.5663 | 9.59892E-09 | SIG |
| 203 | GL | RR | 1 | 405647187 | 4 | 5647187 | 10.1194 | -0.1182 | 0.0038 | 0.6092 | 7.60293E-11 | SIG |
| 204 | GL | RR | 1 | 602130119 | 6 | 2130119 | 13.6394 | 0.1436 | 0.0164 | 2.6083 | 2.27726E-15 | SIG |
| 205 | GL | RR | 1 | 604799710 | 6 | 4799710 | 4.5567 | -0.0748 | 0.0044 | 0.7029 | 4.63185E-06 | SUG |
| 206 | GL | RR | 1 | 616448073 | 6 | 16448073 | 11.5144 | -0.0089 | 0.015 | 2.3891 | 3.06202E-12 | SIG |
| 207 | GL | RR | 1 | 616645152 | 6 | 16645152 | 15.1696 | -0.1548 | 0.0234 | 3.728 | 6.37904E-17 | SIG |
| 208 | GL | RR | 1 | 724964429 | 7 | 24964429 | 11.2229 | -0.1268 | 0.0048 | 0.7698 | 6.52746E-13 | SIG |
| 209 | GL | RR | 1 | 1117942058 | 11 | 17942058 | 7.2966 | -0.0997 | 0.0099 | 1.5799 | 6.76696E-09 | SIG |
| 210 | GL | RR | 2 | 105307303 | 1 | 5307303 | 8.6829 | -0.1114 | 0.0102 | 1.5652 | 2.55936E-10 | SIG |
| 211 | GL | RR | 2 | 106382838 | 1 | 6382838 | 8.4984 | -0.1099 | 0.0119 | 1.8251 | 3.95419E-10 | SIG |
| 212 | GL | RR | 2 | 316708508 | 3 | 16708508 | 30.0472 | 0.2662 | 0.0592 | 9.1082 | 6.05662E-32 | SIG |
| 213 | GL | RR | 2 | 323679384 | 3 | 23679384 | 18.7845 | 0.1845 | 0.0081 | 1.2481 | 1.39552E-20 | SIG |
| 214 | GL | RR | 2 | 334087282 | 3 | 34087282 | 19.3813 | 0.1879 | 0.0072 | 1.1105 | 3.47825E-21 | SIG |
| 215 | GL | RR | 2 | 404758399 | 4 | 4758399 | 32.5564 | -0.286 | 0.0141 | 2.1642 | 1.80279E-34 | SIG |
| 216 | GL | RR | 2 | 420737161 | 4 | 20737161 | 13.4944 | 0.1465 | 0.0057 | 0.8828 | 3.19574E-15 | SIG |
| 217 | GL | RR | 2 | 422021281 | 4 | 22021281 | 10.8665 | 0.1285 | 0.0155 | 2.3894 | 1.36112E-11 | SIG |
| 218 | GL | RR | 2 | 602000963 | 6 | 2000963 | 10.5265 | 0.1269 | 0.0126 | 1.9447 | 3.34596E-12 | SIG |
| 219 | GL | RR | 2 | 627016141 | 6 | 27016141 | 13.6259 | -0.1481 | 0.0103 | 1.5888 | 2.35004E-15 | SIG |
| 220 | GL | RR | 2 | 702255614 | 7 | 2255614 | 10.5597 | -0.1271 | 0.0161 | 2.4814 | 3.09492E-12 | SIG |
| 221 | GL | RR | 2 | 725124146 | 7 | 25124146 | 32.1281 | -0.2851 | 0.0195 | 3.0058 | 4.86461E-34 | SIG |
| 222 | GL | RR | 2 | 820715449 | 8 | 20715449 | 9.7133 | -0.1243 | 0.0105 | 1.6108 | 1.93653E-10 | SIG |
| 223 | GL | RR | 2 | 1116841934 | 11 | 16841934 | 8.7542 | -0.1193 | 0.0103 | 1.5856 | 1.7626E-09 | SIG |
| 224 | GL | RR | 2 | 1222906272 | 12 | 22906272 | 5.604 | -0.0869 | 0.0072 | 1.1063 | 3.77406E-07 | SUG |
| 225 | GL | RR | MEJA | 105286322 | 1 | 5286322 | 19.8025 | -0.1052 | 0.0089 | 1.3989 | 1.30473E-21 | SIG |
| 226 | GL | RR | MEJA | 131330968 | 1 | 31330968 | 26.8628 | -0.1351 | 0.0042 | 0.666 | 1.37455E-27 | SIG |
| 227 | GL | RR | MEJA | 316708508 | 3 | 16708508 | 78.1825 | 0.2975 | 0.074 | 11.6104 | 2.77318E-80 | SIG |
| 228 | GL | RR | MEJA | 334087282 | 3 | 34087282 | 36.3241 | 0.1565 | 0.005 | 0.7866 | 2.91665E-38 | SIG |
| 229 | GL | RR | MEJA | 406883844 | 4 | 6883844 | 20.9996 | -0.1106 | 0.0045 | 0.7044 | 1.00264E-21 | SIG |
| 230 | GL | RR | MEJA | 514607988 | 5 | 14607988 | 19.425 | -0.104 | 0.0035 | 0.5565 | 3.14169E-21 | SIG |
| 231 | GL | RR | MEJA | 602130119 | 6 | 2130119 | 24.7884 | 0.1216 | 0.0117 | 1.841 | 1.20787E-26 | SIG |
| 232 | GL | RR | MEJA | 606777283 | 6 | 6777283 | 17.7358 | 0.0984 | 0.0088 | 1.3866 | 1.60542E-19 | SIG |
| 233 | GL | RR | MEJA | 611986480 | 6 | 11986480 | 5.4758 | -0.0512 | 0.0015 | 0.2431 | 5.12568E-07 | SUG |
| 234 | GL | RR | MEJA | 616291330 | 6 | 16291330 | 10.6426 | -0.0744 | 0.0054 | 0.8493 | 2.54781E-12 | SIG |
| 235 | GL | RR | MEJA | 616496495 | 6 | 16496495 | 23.581 | -0.1222 | 0.0079 | 1.2334 | 2.62937E-24 | SIG |
| 236 | GL | RR | MEJA | 625506895 | 6 | 25506895 | 6.1836 | -0.0546 | 0.0024 | 0.3842 | 9.48995E-08 | SUG |
| 237 | GL | RR | MEJA | 714471382 | 7 | 14471382 | 23.272 | -0.1229 | 0.0054 | 0.8477 | 5.35622E-24 | SIG |
| 238 | GL | RR | MEJA | 724964429 | 7 | 24964429 | 28.4517 | -0.133 | 0.0053 | 0.8342 | 2.45096E-30 | SIG |
| 239 | GL | RR | MEJA | 728370748 | 7 | 28370748 | 8.0007 | -0.0627 | 0.0016 | 0.2554 | 1.28025E-09 | SIG |
| 240 | GL | RR | MEJA | 818538960 | 8 | 18538960 | 29.7184 | 0.1363 | 0.0055 | 0.8669 | 1.91739E-30 | SIG |
| 241 | GL | RR | MEJA | 820715449 | 8 | 20715449 | 25.8924 | -0.1315 | 0.0117 | 1.8438 | 1.28399E-26 | SIG |
| 242 | GL | RR | MEJA | 1117749520 | 11 | 17749520 | 9.648 | 0.0701 | 0.0046 | 0.7233 | 2.25077E-10 | SIG |
| 243 | GL | RR | MEJA | 1220922577 | 12 | 20922577 | 13.8147 | -0.0788 | 0.0069 | 1.083 | 1.5339E-14 | SIG |
| 244 | GL | RR | MEJA | 1224378744 | 12 | 24378744 | 53.7492 | 0.2113 | 0.0106 | 1.6567 | 9.03984E-56 | SIG |
| 245 | TGW | RR | 1 | 116843929 | 1 | 16843929 | 3.5053 | -0.4602 | 0.1991 | 1.9767 | 5.8775E-05 | SUG |
| 246 | TGW | RR | 1 | 225050031 | 2 | 25050031 | 17.5623 | -1.1933 | 0.3907 | 3.8793 | 2.40511E-19 | SIG |
| 247 | TGW | RR | 1 | 231234763 | 2 | 31234763 | 16.5073 | 1.1273 | 0.9589 | 9.521 | 2.8138E-18 | SIG |
| 248 | TGW | RR | 1 | 316860759 | 3 | 16860759 | 14.9949 | 1.0559 | 0.5502 | 5.4634 | 9.59182E-17 | SIG |
| 249 | TGW | RR | 1 | 330465188 | 3 | 30465188 | 18.262 | -1.2156 | 0.3522 | 3.4974 | 4.71174E-20 | SIG |
| 250 | TGW | RR | 1 | 334603105 | 3 | 34603105 | 6.4123 | 0.6333 | 0.2671 | 2.652 | 5.5101E-08 | SUG |
| 251 | TGW | RR | 1 | 404708103 | 4 | 4708103 | 11.4124 | -0.9139 | 0.4568 | 4.5361 | 4.18555E-13 | SIG |
| 252 | TGW | RR | 1 | 909860435 | 9 | 9860435 | 16.0162 | 1.1092 | 0.3697 | 3.6709 | 8.84509E-18 | SIG |
| 253 | TGW | RR | 1 | 1000463104 | 10 | 463104 | 12.6179 | -0.9918 | 0.273 | 2.7111 | 2.41328E-13 | SIG |
| 254 | TGW | RR | 1 | 1124975065 | 11 | 24975065 | 10.696 | 0.8496 | 0.4429 | 4.3975 | 2.2476E-12 | SIG |
| 255 | TGW | RR | 1 | 1212726597 | 12 | 12726597 | 6.2594 | -0.6247 | 0.3626 | 3.6003 | 7.92465E-08 | SUG |
| 256 | TGW | RR | 1 | 1218076754 | 12 | 18076754 | 5.2973 | -0.5822 | 0.2606 | 2.5881 | 7.85124E-07 | SUG |
| 257 | TGW | RR | 2 | 136231866 | 1 | 36231866 | 15.8551 | 1.1778 | 0.5859 | 6.5847 | 1.39807E-16 | SIG |
| 258 | TGW | RR | 2 | 316746142 | 3 | 16746142 | 8.6665 | 0.7924 | 0.5153 | 5.7912 | 2.66021E-10 | SIG |
| 259 | TGW | RR | 2 | 321432053 | 3 | 21432053 | 6.9048 | 0.689 | 0.3114 | 3.5001 | 1.24593E-07 | SUG |
| 260 | TGW | RR | 2 | 330923484 | 3 | 30923484 | 15.8324 | 1.1387 | 1.3302 | 14.949 | 1.47308E-16 | SIG |
| 261 | TGW | RR | 2 | 912157401 | 9 | 12157401 | 7.0546 | 0.6978 | 0.4698 | 5.28 | 8.82355E-08 | SUG |
| 262 | TGW | RR | 2 | 1113147262 | 11 | 13147262 | 8.5139 | -0.8343 | 0.1799 | 2.0215 | 3.065E-09 | SIG |
| 263 | TGW | RR | 2 | 1114219838 | 11 | 14219838 | 7.9381 | 0.7553 | 0.552 | 6.2033 | 1.15395E-08 | SIG |
| 264 | TGW | RR | 2 | 1122488893 | 11 | 22488893 | 10.0497 | 0.864 | 0.4302 | 4.8348 | 8.92527E-11 | SIG |
| 265 | TGW | RR | 2 | 1125403331 | 11 | 25403331 | 19.0333 | 1.321 | 0.6731 | 7.5642 | 7.81912E-21 | SIG |
| 266 | TGW | RR | 2 | 1226496493 | 12 | 26496493 | 10.4215 | 0.8943 | 0.6892 | 7.7453 | 3.79191E-11 | SIG |
| 267 | TGW | RR | MEJA | 130178104 | 1 | 30178104 | 24.3908 | 0.8067 | 0.1551 | 1.625 | 3.04119E-26 | SIG |
| 268 | TGW | RR | MEJA | 135730043 | 1 | 35730043 | 8.215 | -0.3776 | 0.1548 | 1.6215 | 6.09993E-09 | SIG |
| 269 | TGW | RR | MEJA | 209639175 | 2 | 9639175 | 11.8507 | 0.5346 | 0.2222 | 2.3277 | 1.49817E-13 | SIG |
| 270 | TGW | RR | MEJA | 220073320 | 2 | 20073320 | 14.1549 | -0.5867 | 0.2965 | 3.1067 | 7.00853E-15 | SIG |
| 271 | TGW | RR | MEJA | 234221194 | 2 | 34221194 | 23.2131 | -0.7783 | 0.1805 | 1.8912 | 4.69056E-25 | SIG |
| 272 | TGW | RR | MEJA | 316746142 | 3 | 16746142 | 15.3296 | 0.6055 | 0.3009 | 3.1521 | 4.39123E-17 | SIG |
| 273 | TGW | RR | MEJA | 330465188 | 3 | 30465188 | 19.7028 | -0.7063 | 0.1189 | 1.2457 | 1.64554E-21 | SIG |
| 274 | TGW | RR | MEJA | 334603105 | 3 | 34603105 | 7.6097 | 0.4129 | 0.1136 | 1.1896 | 3.22553E-09 | SIG |
| 275 | TGW | RR | MEJA | 335460643 | 3 | 35460643 | 24.1383 | -0.8017 | 0.3379 | 3.5401 | 7.28844E-25 | SIG |
| 276 | TGW | RR | MEJA | 615164468 | 6 | 15164468 | 13.1059 | -0.5467 | 0.3059 | 3.2054 | 7.84491E-14 | SIG |
| 277 | TGW | RR | MEJA | 809047476 | 8 | 9047476 | 8.1283 | -0.4299 | 0.0981 | 1.0274 | 9.47197E-10 | SIG |
| 278 | TGW | RR | MEJA | 909834183 | 9 | 9834183 | 32.1967 | 0.9645 | 0.3051 | 3.196 | 4.14947E-34 | SIG |
| 279 | TGW | RR | MEJA | 919802752 | 9 | 19802752 | 7.3308 | -0.4028 | 0.1449 | 1.5181 | 6.24072E-09 | SIG |
| 280 | TGW | RR | MEJA | 1003974680 | 10 | 3974680 | 10.5848 | 0.5107 | 0.2424 | 2.5395 | 2.60382E-11 | SIG |
| 281 | TGW | RR | MEJA | 1116327428 | 11 | 16327428 | 14.4138 | 0.5828 | 0.3349 | 3.5083 | 3.86163E-15 | SIG |
| 282 | TGW | RR | MEJA | 1117803729 | 11 | 17803729 | 7.907 | 0.4176 | 0.1572 | 1.6465 | 1.23966E-08 | SIG |
| 283 | TGW | RR | MEJA | 1125987286 | 11 | 25987286 | 32.6882 | 0.9835 | 0.3224 | 3.378 | 1.32826E-34 | SIG |

GW: grain width; GL: grain length; TGW: thousand grain weight; MC: main crop; RR: ratoon rice; MEJA: multi-environment joint analysis

**Table S25 QTN-by-environment interactions for grain width, grain length, and thousand grain weight in main crop and ratoon rice of 159 rice accessions using evolutionary population**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Trait** | **MC or RR** | **Marker** | **Chromosome** | **Position (bp)** | **LOD (QE)** | **add\*env1** | **add\*env2** | **variance** | **r2(%)** | **P-value** | **significance** |
| 1 | TGW | MC | 1221081445 | 12 | 21081445 | 22.7628 | -0.5975 | 0.5975 | 0.324 | 3.4818 | 1.72988E-23 | SIG |
| 2 | GW | RR | 207733574 | 2 | 7733574 | 11.5029 | -0.0246 | 0.0246 | 0.0006 | 0.7436 | 3.38529E-13 | SIG |
| 3 | GW | RR | 1000710130 | 10 | 710130 | 6.7857 | -0.0186 | 0.0186 | 0.0003 | 0.4236 | 2.27061E-08 | SIG |
| 4 | GL | RR | 420414980 | 4 | 20414980 | 20.7638 | -0.0765 | 0.0765 | 0.0058 | 0.9097 | 1.39379E-22 | SIG |
| 5 | GL | RR | 626752211 | 6 | 26752211 | 23.6848 | 0.0818 | -0.0818 | 0.0068 | 1.0544 | 2.07062E-24 | SIG |
| 6 | TGW | RR | 419524638 | 4 | 19524638 | 6.503 | -0.3098 | 0.3098 | 0.0966 | 1.0919 | 3.14239E-07 | SUG |
| 7 | TGW | RR | 516578452 | 5 | 16578452 | 21.4266 | -0.606 | 0.606 | 0.3673 | 4.1535 | 2.98334E-23 | SIG |
| 8 | TGW | RR | 715307889 | 7 | 15307889 | 9.2854 | -0.3787 | 0.3787 | 0.1434 | 1.6221 | 6.19102E-11 | SIG |
| 9 | TGW | RR | 1116753283 | 11 | 16753283 | 17.0483 | 0.5317 | -0.5317 | 0.2827 | 3.197 | 7.97074E-19 | SIG |

GW: grain width; GL: grain length; TGW: thousand grain weight; MC: main crop; RR: ratoon rice

**Table S26 QTN-by-environment interactions for grain width, grain length, and thousand grain weight in main crop and ratoon rice of 159 rice accessions using Q matrix**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Trait** | **MC or RR** | **Marker** | **Chromosome** | **Position (bp)** | **LOD (QE)** | **add\*env1** | **add\*env2** | **variance** | **r2(%)** | **P-value** | **significance** |
| TGW | MC | 420947566 | 4 | 20947566 | 4.5597 | -0.2086 | 0.2086 | 0.0435 | 0.4675 | 4.60E-06 | SUG |
| TGW | MC | 805244100 | 8 | 5244100 | 5.1678 | -0.2228 | 0.2228 | 0.0496 | 0.5333 | 1.07E-06 | SUG |
| TGW | MC | 1221081445 | 12 | 21081445 | 20.3266 | -0.5096 | 0.5096 | 0.2364 | 2.5403 | 4.72E-21 | SIG |
| TGW | MC | 1223044143 | 12 | 23044143 | 5.1663 | 0.2237 | -0.2237 | 0.0501 | 0.538 | 1.07E-06 | SUG |
| TGW | RR | 505434037 | 5 | 5434037 | 9.473 | -0.4632 | 0.4632 | 0.2146 | 2.2479 | 3.98E-11 | SIG |
| TGW | RR | 516648952 | 5 | 16648952 | 64.3049 | -1.6589 | 1.6589 | 2.788 | 29.21 | 4.98E-65 | SIG |

GW: grain width; GL: grain length; TGW: thousand grain weight; MC: main crop; RR: ratoon rice

**Table S27 Known genes around main-effect QTNs and QEIs of rice grain size in main crop and ratoon rice using evolutionary population structure**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Trait** | **MC/RR** | **Chr** | **Posi (bp)** | **LOD scores of Q and QEI detection in different datasets** | | | | **R2 (%)** | **Known genes** | **Reference** |
| **I** | | **II** | **I+II** |
| GW | Both | 5 | 5357438~5361276 | 28.69~20.2645 | 16.6238~17.4274 | | 52.7153~41.1839 | 2.0292~10.2534 | *GW5* | Weng et al., 2008 |
|  | Both | 5 | 6015422~6052088 |  | 11.791 | | 9.3278 | 0.8856~2.6493 | *JMJ703* | Cui et al., 2013 |
|  | MC | 8 | 26714889 | 12.7967 |  | | 42.6112 | 1.0379~1.4184 | *WTG1* | Huang et al., 2017 |
| GL | Both | 3 | 16708508~16746142 | 26.1652~33.5357 | 35.1278~46.204 | | 88.325~119.44 | 6.0501~17.7195 | *GS3* | Mao et al., 2010 |
|  | MC | 3 | 25129163 |  |  | | 22.5203 | 1.8712 | *GL3.1* | Qi et al., 2012 |
|  | RR | 5 | 5413770~5914985 |  | 14.3552 | | 48.789 | 0.9154~1.7693 | *GW5* | Weng et al., 2008 |
|  | RR | 6 | 1623846 |  | 8.2691 | |  | 1.5926 | *OsACS6* | Matsushima et al., 2016 |
|  | Both | 7 | 24533051 | 19.2738 |  | | 43.7233 | 0.8801~3.178 | *GW7* | Wang et al., 2015 |
| TGW | RR | 2 | 31102971 | 10.8632 |  | |  | 3.4486 | *OsNF-YB1* | Xu et al., 2016 |
|  | MC | 3 | 35437797~35486847 | 15.9056 | 8.5083 | | 12.3697 | 0.866~4.5181 | *qTGW3* | Ying et al., 2018 |
|  | RR | 4 | 4570606 | 14.2645 |  | | 21.6974 | 1.5592~2.5515 | *ETR2* | Wuriyanghan et al., 2009 |

GW: grain width; GL: grain length; TGW: thousand grain weight; MC: main crop; RR: ratoon rice

**Table S28 Known genes around main-effect QTNs and QEIs of rice grain size in main crop and ratoon rice using Q matrix**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Trait** | **MC/RR** | **Chr** | **Posi (bp)** | **LOD scores of Q and QEI detection in different datasets** | | | **R2 (%)** | **Known genes** | **Reference** |
| I | II | I+II |
| GW | MC | 3 | 13813715~14763587 |  | 6.5998 | 27.7314 | 1.3254~1.4914 | *VLN2* | Wu et al., 2015 |
|  | MC | 4 | 23538685 |  | 5.6833 |  | 1.1622 | *D11* | Zhu et al., 2015 |
|  | Both | 5 | 5357438~5466023 | 9.2478~10.2018 | 28.7431 | 12.6484 | 0.9537~6.9650 | *GW5* | Weng et al., 2008 |
|  | RR | 5 | 6015422 |  | 6.6755 |  | 1.2346 | *JMJ703* | Cui et al., 2013 |
| GL | Both | 3 | 16708508~16717631 | 32.8677~35.051 | 30.0472~34.822 | 52.5223~78.1825 | 4.7681~15.1157 | *GS3* | Mao et al., 2010 |
|  | RR | 3 | 25129163 | 8.0181 |  |  | 1.5663 | *GL3.1* | Qi et al., 2012 |
|  | MC | 7 | 24533051 | 14.8238 |  | 62.4943 | 1.7313~2.8369 | *GW7* | Wang et al., 2015 |
|  | MC | 3 | 4386976 |  |  | 7.8796 | 0.7822 | *OsLG3* | Yu et al., 2017 |
|  | Both | 3 | 35486847~35460643 |  |  | 24.1383~44.6591 | 3.5401~3.7913 | *qTGW3* | Ying et al., 2018 |
|  | RR | 4 | 4708103 | 11.4124 |  |  | 4.5361 | *ETR2* | Wuriyanghan et al., 2009 |
|  | Both | 5 | 5434037 |  |  | 9.473 QE | 2.2479 | *GW5* | Weng et al., 2008 |
|  | MC | 12 | 23044143 |  |  | 5.1663QE | 0.538 | *OsSar1b* | Tian et al., 2013 |

GW: grain width; GL: grain length; TGW: thousand grain weight; MC: main crop; RR: ratoon rice

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**Table S29 Main-effect QTNs interactions and QTN-by-environment interactions for grain width when the main crop and ratoon rice datasets were jointly analyzed in environment 1 via 3VmrMLM**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Main effect QTNs for grain width | | | | | |  | QTN-by-environment interactions for grain width | | | | | | |
| No. | Chr | Position (bp) | LOD (Q) | add | r2(%) |  | No. | Chr | Position (bp) | LOD (QE) | add\*env1 | add\*env2 | r2(%) |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | |  | ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | |
|
| 1 | 2 | 1236423 | 13.9233 | 0.0376 | 0.6609 |  | 1 | 5 | 18761512 | 9.1794 | -0.0297 | 0.0297 | 1.1592 |
| 2 | 3 | 26622488 | 11.9991 | -0.0353 | 1.2717 |  |  |  |  |  |  |  |  |
| 3 | 3 | 31660510 | 22.1448 | -0.0498 | 3.0409 |  |  |  |  |  |  |  |  |
| 4 | 3 | 33307806 | 10.8549 | -0.0326 | 0.4576 |  |  |  |  |  |  |  |  |
| 5 | 4 | 21031164 | 36.4387 | -0.069 | 2.4074 |  |  |  |  |  |  |  |  |
| 6 | 5 | 5361276 | 33.008 | -0.065 | 3.8003 |  |  |  |  |  |  |  |  |
| 7 | 5 | 14043668 | 20.7247 | 0.0485 | 2.9809 |  |  |  |  |  |  |  |  |
| 8 | 7 | 3821846 | 14.983 | -0.039 | 0.5499 |  |  |  |  |  |  |  |  |
| 9 | 7 | 7640833 | 9.7088 | -0.0307 | 0.6701 |  |  |  |  |  |  |  |  |
| 10 | 8 | 5990045 | 18.1193 | -0.045 | 2.097 |  |  |  |  |  |  |  |  |
| 11 | 8 | 9925342 | 17.7994 | -0.0432 | 0.8156 |  |  |  |  |  |  |  |  |
| 12 | 8 | 10329229 | 14.9132 | 0.0404 | 1.6442 |  |  |  |  |  |  |  |  |
| 13 | 11 | 1239118 | 40.6084 | 0.0779 | 1.4798 |  |  |  |  |  |  |  |  |
| 14 | 11 | 7833619 | 9.9521 | -0.0313 | 1.0156 |  |  |  |  |  |  |  |  |
| 15 | 11 | 26344986 | 35.0984 | 0.0678 | 5.9665 |  |  |  |  |  |  |  |  |
| 16 | 12 | 6951278 | 8.938 | 0.0274 | 1.0193 |  |  |  |  |  |  |  |  |
| 17 | 12 | 11103678 | 22.6023 | 0.0505 | 3.0877 |  |  |  |  |  |  |  |  |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | |  | ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | |
|  |  |  |  |  |  |  | 1 | 11 | 6601331 | 5.7735 | 0.0234 | -0.0234 | 0.716 |

**Table S30 Main-effect QTNs interactions and QTN-by-environment interactions for grain width when the main crop and ratoon rice datasets were jointly analyzed in environment 2 via 3VmrMLM**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Main effect QTNs for grain width | | | | | |  | QTN-by-environment interactions for grain width | | | | | | |
| No. | Chr | Position (bp) | LOD (Q) | add | r2(%) |  | No. | Chr | Position (bp) | LOD (QE) | add\*env1 | add\*env2 | r2(%) |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | |  | ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | |
|
| 1 | 1 | 28963821 | 23.4791 | -0.0488 | 1.1115 |  | 1 | 2 | 3127611 | 10.8653 | -0.0308 | 0.0308 | 1.2327 |
| 2 | 2 | 1186658 | 23.333 | 0.0486 | 1.0127 |  | 2 | 7 | 497250 | 20.6014 | -0.0448 | 0.0448 | 2.5999 |
| 3 | 3 | 26661478 | 7.6167 | 0.0253 | 0.7601 |  | 3 | 7 | 6720541 | 8.0963 | 0.0264 | -0.0264 | 0.8998 |
| 4 | 3 | 35144023 | 9.7719 | 0.0285 | 1.1014 |  |  |  |  |  |  |  |  |
| 5 | 5 | 4631781 | 40.5099 | -0.0707 | 4.2871 |  |  |  |  |  |  |  |  |
| 6 | 5 | 4775669 | 17.4243 | -0.0412 | 1.9806 |  |  |  |  |  |  |  |  |
| 7 | 5 | 5358771 | 14.8852 | -0.0358 | 1.232 |  |  |  |  |  |  |  |  |
| 8 | 5 | 14043668 | 7.683 | 0.0256 | 0.849 |  |  |  |  |  |  |  |  |
| 9 | 8 | 8422704 | 24.1714 | -0.0496 | 2.9834 |  |  |  |  |  |  |  |  |
| 10 | 9 | 6986114 | 14.1681 | 0.0365 | 0.7945 |  |  |  |  |  |  |  |  |
| 11 | 11 | 25125749 | 23.2151 | -0.0483 | 1.9175 |  |  |  |  |  |  |  |  |
| 12 | 11 | 26344986 | 8.0167 | 0.0263 | 0.8893 |  |  |  |  |  |  |  |  |
| 13 | 12 | 10942857 | 16.2536 | 0.0388 | 1.6618 |  |  |  |  |  |  |  |  |
| 14 | 12 | 11690509 | 22.9219 | -0.0497 | 1.2527 |  |  |  |  |  |  |  |  |
| 15 | 12 | 27465140 | 33.6745 | 0.0633 | 1.6138 |  |  |  |  |  |  |  |  |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | |  | ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | |
| 1 | 6 | 23061482 | 5.4834 | -0.0216 | 0.3692 |  | 1 | 5 | 4781561 | 4.8934 | 0.0205 | 0.0205 | 0.5455 |
| 2 | 8 | 28419017 | 6.7614 | 0.0266 | 0.5783 |  | 2 | 10 | 11641409 | 5.2518 | -0.0208 | -0.0208 | 0.5612 |

**Table S31 Main-effect QTNs interactions and QTN-by-environment interactions for grain length when the main crop and ratoon rice datasets were jointly analyzed in environment 1 via 3VmrMLM**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Marker** | **Chr** | **Position (bp)** | **LOD score** | **Additive** | **Variance** | **r2(%)** | **P-value** | **Significance** |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | | | | |
| 1 | 105376057 | 1 | 5376057 | 12.4027 | -0.0978 | 0.0077 | 1.086 | 4.1118E-14 | SIG |
| 2 | 203464709 | 2 | 3464709 | 69.6256 | -0.3293 | 0.0155 | 2.1833 | 1.05827E-71 | SIG |
| 3 | 316708508 | 3 | 16708508 | 59.7811 | 0.2829 | 0.0669 | 9.4351 | 7.97198E-62 | SIG |
| 4 | 321162002 | 3 | 21162002 | 10.1926 | 0.0876 | 0.0061 | 0.8539 | 7.3306E-12 | SIG |
| 5 | 323679384 | 3 | 23679384 | 39.8181 | 0.2055 | 0.0101 | 1.4199 | 8.93891E-42 | SIG |
| 6 | 421998574 | 4 | 21998574 | 13.7777 | 0.1038 | 0.0093 | 1.3134 | 1.64783E-15 | SIG |
| 7 | 514607988 | 5 | 14607988 | 13.2037 | -0.1013 | 0.0034 | 0.475 | 6.30836E-15 | SIG |
| 8 | 602130119 | 6 | 2130119 | 9.0506 | 0.0824 | 0.0054 | 0.7601 | 1.07608E-10 | SIG |
| 9 | 605429644 | 6 | 5429644 | 34.5825 | 0.1857 | 0.0124 | 1.752 | 1.64823E-36 | SIG |
| 10 | 616645152 | 6 | 16645152 | 17.686 | -0.1213 | 0.0143 | 2.0245 | 1.80283E-19 | SIG |
| 11 | 702288888 | 7 | 2288888 | 10.8368 | -0.0893 | 0.007 | 0.981 | 1.45739E-11 | SIG |
| 12 | 724964429 | 7 | 24964429 | 21.0042 | -0.134 | 0.0054 | 0.7612 | 7.96852E-23 | SIG |
| 13 | 818394489 | 8 | 18394489 | 39.4415 | 0.2031 | 0.0043 | 0.6124 | 2.13763E-41 | SIG |
| 14 | 823153658 | 8 | 23153658 | 11.8865 | -0.0607 | 0.008 | 1.1321 | 1.30005E-12 | SIG |
| 15 | 908584051 | 9 | 8584051 | 11.4112 | -0.0937 | 0.0087 | 1.2278 | 3.8834E-12 | SIG |
| 16 | 1015482498 | 10 | 15482498 | 32.6897 | -0.1794 | 0.0107 | 1.5139 | 1.32372E-34 | SIG |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | | | | |
| 1 | 231287545 | 2 | 31287545 | 3.7323 | -0.0519 | 0.0027 | 0.3757 | 3.38696E-05 | SUG |
| 2 | 1224137319 | 12 | 24137319 | 5.6547 | -0.0643 | 0.004 | 0.561 | 3.34E-07 | SUG |

**Table S32 Main-effect QTNs interactions and QTN-by-environment interactions for grain length when the main crop and ratoon rice datasets were jointly analyzed in environment 2 via 3VmrMLM**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Main effect QTNs for grain length | | | | | |  | QTN-by-environment interactions for grain length | | | | | | |
| No. | Chr | Position (bp) | LOD (Q) | add | r2(%) |  | No. | Chr | Position (bp) | LOD (QE) | add\*env1 | add\*env2 | r2(%) |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | |  | ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | |
|
| 1 | 1 | 12352948 | 32.9666 | -0.1932 | 1.461 |  |  |  |  |  |  |  |  |
| 2 | 2 | 20073320 | 8.6547 | -0.0927 | 1.0107 |  |  |  |  |  |  |  |  |
| 3 | 3 | 10436032 | 24.4342 | 0.1599 | 1.2469 |  |  |  |  |  |  |  |  |
| 4 | 3 | 16708508 | 70.1377 | 0.3503 | 14.7467 |  |  |  |  |  |  |  |  |
| 5 | 3 | 34087282 | 20.3814 | 0.1402 | 0.5783 |  |  |  |  |  |  |  |  |
| 6 | 4 | 31182803 | 7.1216 | 0.0778 | 0.8447 |  |  |  |  |  |  |  |  |
| 7 | 5 | 25364698 | 34.476 | -0.1984 | 1.3906 |  |  |  |  |  |  |  |  |
| 8 | 6 | 2130119 | 8.6569 | 0.0861 | 0.8462 |  |  |  |  |  |  |  |  |
| 9 | 7 | 2255614 | 12.5942 | -0.1071 | 1.6465 |  |  |  |  |  |  |  |  |
| 10 | 7 | 13252917 | 28.0827 | -0.1706 | 1.4847 |  |  |  |  |  |  |  |  |
| 11 | 12 | 4146868 | 24.3972 | -0.1591 | 2.2795 |  |  |  |  |  |  |  |  |
| 12 | 12 | 8047799 | 15.4009 | -0.1277 | 0.3736 |  |  |  |  |  |  |  |  |
| 13 | 12 | 14683417 | 12.186 | 0.1041 | 0.6929 |  |  |  |  |  |  |  |  |
| 14 | 12 | 22906272 | 12.4488 | -0.1054 | 1.5216 |  |  |  |  |  |  |  |  |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | |  | ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | |
| 1 | 6 | 6533545 | 4.3174 | 0.0594 | 0.5038 |  | 1 | 9 | 22674685 | 6.0692 | 0.0711 | -0.0711 | 0.7275 |
| 2 | 8 | 20719085 | 5.3392 | -0.0663 | 0.5171 |  |  |  |  |  |  |  |  |
| 3 | 12 | 12278648 | 4.2123 | 0.0584 | 0.4572 |  |  |  |  |  |  |  |  |

**Table S33 Main-effect QTNs interactions and QTN-by-environment interactions for thousand grain weigth when the MC and RR datasets were jointly analyzed in environment 1 via 3VmrMLM**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Main effect QTNs for thousand grain weight | | | | | |  | QTN-by-environment interactions for thousand grain weight | | | | | | |
| No. | Chr | Position (bp) | LOD (Q) | add | r2(%) |  | No. | Chr | Position (bp) | LOD (QE) | add\*env1 | add\*env2 | r2(%) |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | |  | ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | |
|
| 1 | 1 | 22418320 | 29.6574 | 0.8972 | 1.926 |  | 1 | 1 | 23822271 | 8.0595 | 0.4171 | -0.4171 | 1.6849 |
| 2 | 1 | 30228079 | 24.1189 | 0.7735 | 1.5792 |  | 2 | 3 | 34731922 | 11.2702 | -0.4926 | 0.4926 | 2.3947 |
| 3 | 3 | 35491798 | 18.7588 | -0.6621 | 2.3506 |  | 3 | 4 | 3684764 | 15.4115 | 0.5973 | -0.5973 | 3.5203 |
| 4 | 5 | 5651540 | 15.7353 | 0.6046 | 3.5625 |  | 4 | 4 | 28669807 | 15.2536 | -0.5883 | 0.5883 | 3.415 |
| 5 | 5 | 12385186 | 17.6721 | -0.6524 | 2.8596 |  | 5 | 6 | 2928548 | 13.1896 | -0.5434 | 0.5434 | 2.9139 |
| 6 | 7 | 10299436 | 27.8927 | -0.8497 | 1.2258 |  |  |  |  |  |  |  |  |
| 7 | 10 | 13915559 | 19.5395 | -0.7335 | 2.0254 |  |  |  |  |  |  |  |  |
| 8 | 11 | 17579299 | 16.7535 | 0.6199 | 3.4871 |  |  |  |  |  |  |  |  |
| 9 | 11 | 20935140 | 21.5605 | -0.7309 | 0.9309 |  |  |  |  |  |  |  |  |
| 10 | 11 | 24662073 | 10.5609 | -0.459 | 1.046 |  |  |  |  |  |  |  |  |
| 11 | 12 | 774947 | 36.2048 | 1.024 | 9.7164 |  |  |  |  |  |  |  |  |
| 12 | 12 | 18076754 | 18.4828 | -0.6779 | 3.4865 |  |  |  |  |  |  |  |  |
| 13 | 12 | 20867041 | 8.3727 | 0.4125 | 1.1219 |  |  |  |  |  |  |  |  |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | |  | ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | |
| 1 | 2 | 31234763 | 5.9872 | 0.3491 | 0.9072 |  | 1 | 7 | 1176205 | 4.2237 | -0.2905 | 0.2905 | 0.8326 |
| 2 | 2 | 31262967 | 5.9872 | 0.3491 | 0.9072 |  | 2 | 11 | 22930659 | 5.2075 | -0.3302 | 0.3302 | 1.076 |
| 3 | 2 | 31309615 | 5.9872 | 0.3491 | 0.9072 |  |  |  |  |  |  |  |  |

**Table S34 Main-effect QTNs interactions and QTN-by-environment interactions for thousand grain weigth when the MC and RR datasets were jointly analyzed in environment 2 via 3VmrMLM**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Main effect QTNs for thousand grain weight | | | | | |  | QTN-by-environment interactions for thousand grain weight | | | | | | |
| No. | Chr | Position (bp) | LOD (Q) | add | r2(%) |  | No. | Chr | Position (bp) | LOD (QE) | add\*env1 | add\*env2 | r2(%) |
| ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | |  | ***Significant QTNs at the critical P-value of 2.48e-08 (=0.05/m, where m is the number of markers)*** | | | | | | |
|
| 1 | 1 | 4921429 | 8.477 | 0.1293 | 1.1634 |  | 1 | 1 | 3937469 | 9.9189 | -0.347 | 0.347 | 1.4093 |
| 2 | 1 | 21033494 | 25.4064 | 0.6287 | 0.8667 |  | 2 | 1 | 13571544 | 7.9299 | 0.3309 | -0.3309 | 1.1244 |
| 3 | 1 | 39719661 | 10.0678 | -0.3771 | 0.6525 |  | 3 | 2 | 15185862 | 9.4869 | -0.3591 | 0.3591 | 1.3521 |
| 4 | 2 | 1334322 | 12.7588 | 0.4247 | 0.7072 |  | 4 | 5 | 16535916 | 12.5831 | -0.4228 | 0.4228 | 1.8352 |
| 5 | 2 | 25079124 | 41.8943 | -0.8722 | 1.7083 |  | 5 | 6 | 3041865 | 12.7082 | -0.4251 | 0.4251 | 1.8551 |
| 6 | 3 | 6596936 | 22.0626 | 0.5784 | 0.9586 |  |  |  |  |  |  |  |  |
| 7 | 3 | 13505333 | 12.4442 | 0.429 | 0.7454 |  |  |  |  |  |  |  |  |
| 8 | 3 | 21041714 | 8.4363 | 0.3398 | 1.1776 |  |  |  |  |  |  |  |  |
| 9 | 3 | 34099731 | 11.9966 | 0.4159 | 0.4413 |  |  |  |  |  |  |  |  |
| 10 | 4 | 27688228 | 11.4517 | -0.4028 | 1.6542 |  |  |  |  |  |  |  |  |
| 11 | 4 | 31939665 | 54.8476 | -1.0415 | 3.3633 |  |  |  |  |  |  |  |  |
| 12 | 5 | 6677633 | 10.5732 | -0.3847 | 0.9347 |  |  |  |  |  |  |  |  |
| 13 | 6 | 11905469 | 22.3925 | -0.5928 | 1.1927 |  |  |  |  |  |  |  |  |
| 14 | 8 | 6562776 | 42.518 | 0.9363 | 1.9633 |  |  |  |  |  |  |  |  |
| 15 | 8 | 17687290 | 11.6247 | -0.4098 | 1.7144 |  |  |  |  |  |  |  |  |
| 16 | 8 | 22332745 | 21.9449 | -0.5784 | 0.8899 |  |  |  |  |  |  |  |  |
| 17 | 10 | 6151974 | 10.6351 | 0.3896 | 1.0674 |  |  |  |  |  |  |  |  |
| 18 | 10 | 20319057 | 18.3668 | 0.5305 | 0.7059 |  |  |  |  |  |  |  |  |
| 19 | 11 | 3518389 | 8.0601 | -0.3317 | 0.7092 |  |  |  |  |  |  |  |  |
| 20 | 11 | 16528346 | 8.2893 | -0.3324 | 1.1 |  |  |  |  |  |  |  |  |
| 21 | 11 | 17131649 | 15.5669 | 0.4831 | 0.7597 |  |  |  |  |  |  |  |  |
| 22 | 11 | 18422045 | 17.1965 | -0.5028 | 2.1818 |  |  |  |  |  |  |  |  |
| 23 | 11 | 24346080 | 9.5536 | -0.3631 | 1.3524 |  |  |  |  |  |  |  |  |
| 24 | 12 | 10698465 | 12.6813 | -0.4315 | 1.3214 |  |  |  |  |  |  |  |  |
| ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | |  | ***Suggested QTNs with the LOD score ≥ 3.0 but the P-value > 0.05/m, where m is the number of markers*** | | | | | | |
| 1 | 6 | 28648301 | 5.0909 | 0.261 | 0.6777 |  | 1 | 5 | 27885076 | 6.1393 | -0.2893 | 0.2893 | 0.8591 |
| 2 | 12 | 424245 | 4.8449 | -0.224 | 0.6631 |  | 2 | 11 | 19057049 | 6.5466 | 0.2982 | -0.2982 | 0.913 |

**Table S35 Known genes around QTNs that were mined by the main crop and ratoon rice joint analysis in each environment**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Trait** | **No.** | **Chr** | **Posi (bp)** | **LOD scores of QTN in two environmets** | | **R2 (%)** | **Significance** | **Comparative genomics analysis** | | **Reference** |
|
| **I** | **II** | **Known genes** | **Distance (kb)** |
| Grain width | 1 | 5 | 5358771~5361276 | 33.01 | 14.89 | 1.23~3.80 | Significant | *GW5* | 3.846~6.351 | Liu et al., 2017 |
| Grain length | 2 | 2 | 31287545 | 3.73 |  | 0.38 | Significant | *PGL2* | 136.398 | Jang et al., 2017 |
|  | 3 | 3 | 16708508 | 59.78 | 70.14 | 9.44~14.75 | Significant | *GS3* | 20.94 | Mao et al., 2010 |
| Thousand grain weight | 1 | 3 | 35491798 | 18.76 |  | 2.35 | Significant | *qTGW3* | 99.736 | Ying et al., 2018 |

**Reference:**

Jang, S., An, G., and Li, H. Y. (2017). Rice Leaf Angle and Grain Size Are Affected by the *OsBUL1* Transcriptional Activator Complex. *Plant Physiol*. 173, 688–702. [doi: 10.1104/pp.16.01653](https://doi.org/10.1104/pp.16.01653)

Liu, J., Chen, J., Zheng, X., Wu, F., Lin, Q., Heng, Y., et al. (2017). *GW5* acts in the brassinosteroid signalling pathway to regulate grain width and weight in rice. *Nat. Plants* 3, 17043. doi: 10.1038/nplants.2017.43

Mao, H., Sun, S., Yao, J., Wang, C., Yu, S., Xu, C., et al. (2010). Linking differential domain functions of the *GS3* protein to natural variation of grain size in rice. *Proc. Natl. Acad. Sci. U. S. A.* 107, 19579–19584. doi: 10.1073/pnas.1014419107

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**Table S36 Candidate genes around main-effect QTNs that were mined by the main crop and ratoon rice datasets jointly analysis**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Trait** | **No.** | **Locus** | | **LOD scores** | **r2 (%)** | **Gene differential expression analysis** | | |  | **GO annotation** | | | |
| **Chr** | **Posi (bp)** | **Gene\_ID** | **log2(Fold Change)** | **P-value** |  | **GO\_ID** | **GO\_name** | **E-value** | **Reference** |
| Grain width | 1 | 2 | 1236423 | 13.92 | 0.66 | Os02g0126400 | 1.03 | 2.43E-02 |  | GO:0009738 | abscisic acid-activated signaling pathway | 0 | Qin et al., 2021 |
|  | 2 | 3 | 35144023 | 9.77 | 1.10 | Os03g0838100 | 1.12 | 4.90E-03 |  | GO:0006468 | protein phosphorylation | 0 | Qiu et al., 2016 |
|  | 3 | 5 | 27883451 | 7.53 | 0.82 | Os05g0563400 | 1.21 | 3.27E-03 |  | GO:0009850 | auxin metabolic process | 0 | Liu et al., 2015 |
|  | 4 | 8 | 5990045 | 18.12 | 2.10 | Os08g0200500 | 1.63 | 1.04E-03 |  | GO:0006468 | protein phosphorylation | 1.59E-268 | Qiu et al., 2016 |
|  | 5 | 9 | 6986114 | 14.17 | 0.79 | Os09g0294300 | -1.6 | 3.46E-03 |  | GO:0016567 | protein ubiquitination | 2.71E-288 | Li et al., 2018 |
|  | 6 | 11 | 7833619 | 9.95 | 1.02 | Os11g0247000 | -1.87 | 7.41E-03 |  | GO:0009733 | response to auxin | 3.53E-50 | Liu et al., 2015 |
|  | 7 | 12 | 11103678 | 22.60 | 3.09 | Os12g0288000 | 1.76 | 1.42E-03 |  | GO:0009734 | auxin-activated signaling pathway | 1.27E-264 | Liu et al., 2015 |
|  | 8 | 12 | 11690509 | 22.92 | 1.25 | Os12g0297500 | 1.2 | 4.35E-02 |  | GO:0006468 | protein phosphorylation | 0 | Qiu et al., 2016 |
| Grain length | 1 | 1 | 5376057 | 12.40 | 1.09 | Os01g0197100 | 1.04 | 4.50E-03 |  | GO:0016131 | brassinosteroid metabolic process | 0 | Liu et al., 2017 |
|  | 2 | 2 | 20073320 | 8.65 | 1.01 | Os02g0538000 | 1.23 | 6.74E-03 |  | GO:0009793 | embryo development ending in seed dormancy | 0 | Figueiredo et al., 2014 | |
|  | 3 | 5 | 14607988 | 13.20 | 0.48 | Os05g0314700 | 1.11 | 3.26E-02 |  | GO:0031398 | positive regulation of protein ubiquitination | 4.82E-67 | Li et al., 2018 | |
|  | 4 | 5 | 25364698 | 34.48 | 1.39 | Os05g0514200 | 1.05 | 0.0173 |  | GO:0006468 | protein phosphorylation | 0 | Qiu et al., 2016 | | |
|  | 5 | 6 | 6533545 | 4.32 | 0.50 | Os06g0226700 | 1.06 | 0.0163 |  | GO:0009735 | response to cytokinin | 7.01E-203 | Jameson et al., 2016 | | |
|  | 6 | 8 | 20719085 | 5.34 | 0.52 | Os08g0428100 | 1.13 | 0.00712 |  | GO:0009793 | embryo development ending in seed dormancy | 2.46E-248 | Figueiredo et al., 2014 | |
|  | 7 | 12 | 22906272 | 12.45 | 1.52 | Os12g0557800 | 1.79 | 0.00495 |  | GO:0009737 | response to abscisic acid | 5.65E-216 | Qin et al., 2021 |
| Thousand grain weight | 1 | 1 | 30228079 | 24.12 | 1.58 | Os01g0724500 | 1.58 | 0.00208 |  | GO:0071365 | cellular response to auxin stimulus | 0 | Liu et al., 2015 |
|  | 2 | 5 | 6677633 | 10.57 | 0.93 | Os05g0210600 | -1.41 | 0.00625 |  | GO:0009742 | brassinosteroid mediated signaling pathway | 8.64E-316 | Liu et al., 2017 |
|  | 3 | 8 | 17687290 | 11.62 | 1.71 | Os08g0379300 | -1.18 | 0.0272 |  | GO:0005983 | starch catabolic process | 0 | Zhang et al., 2016 |
|  | 4 | 8 | 22332745 | 21.94 | 0.89 | Os08g0457600 | 1.04 | 0.00928 |  | GO:0009737 | response to abscisic acid | 0 | Qin et al., 2021 |
|  | 5 | 11 | 17579299 | 16.75 | 3.49 | Os11g0498600 | -1.12 | 0.0378 |  | GO:0009737 | response to abscisic acid | 1.21E-80 | Qin et al., 2021 |
|  | 6 | 11 | 24346080 | 9.55 | 1.35 | Os11g0621300 | -1.01 | 0.00979 |  | GO:0010928 | regulation of auxin mediated signaling pathway | 0 | Liu et al., 2015 |
|  | 7 | 12 | 774947 | 36.20 | 9.72 | Os12g0111500 | 1.81 | 4.64E-04 |  | GO:0006511 | ubiquitin-dependent protein catabolic process | 7.49E-197 | Li et al., 2018 |

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**Table S37 Known genes within 1000 kb upstream and downstream of QTNs and 1500 kb upstream and downstream of QEIs in main crop and ratoon rice**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Trait** | **MC/RR** | **No.** | **Chr** | **Posi (bp)** | **LOD scores of QTN and QEI detection in two environments** | | | **R2 (%)** | **Comparative genomics analysis** | | **Reference** |
| **I** | **II** | **I + II** | **Known genes** | **Distance (kb)** |
| GW | RR | 1 | 2 | 7733574 |  |  | 12.92QE | 0.74 | *GW2* | 401.548 | Song et al. 2007 |
|  | RR | 2 | 2 | 25565194 |  | 22.5 |  | 1.13 | *OsVPE3* | 325.251 | Lu et al. 2016 |
|  | RR | 3 | 2 | 29241853~29413021 | 10.82 |  | 11.49 | 0.46~0.78 | *GS2* | 374.856~546.024 | Hu et al. 2015 |
|  | Both | 4 | 3 | 850101~2278621 | 4.42~12.51 |  | 5.88 | 0.26~1.95 | *OsCDPK1* | 618.593~774.997 | Ho et al. 2013 |
|  | RR | 5 | 3 | 3390977 |  |  | 9.59 | 0.2 | *BG1* | 647.364 | Liu et al. 2015 |
|  | Both | 6 | 3 | 13768754~14636351 | 14.58 |  | 11.69~34.25 | 0.44~1.57 | *VLN2* | 8.379~847.666 | Wu et al., 2015 |
|  | MC | 7 | 5 | 636512 |  |  | 14.7 | 0.4 | *GSN1* | 221.887 | Guo et al. 2018 |
|  | Both | 8 | 5 | 5357438~5361276 | 28.87~32.99 | 21.43~44.21 | 55.83~93.69 | 3.75~17.29 | *GW5* | 3.846~7.684 | Liu et al. 2017 |
|  | Both | 9 | 7 | 24208049~25284287 | 24.84 | 18.09~29.02 | 32.31 | 0.49~1.96 | *GW7* | 102.037~614.966 | Wang et al. 2015a |
|  | MC | 10 | 8 | 27378608 |  |  | 66.21 | 0.99 | *OsSPL16* | 872.41 | Wang et al. 2012 |
|  | RR | 11 | 10 | 710130 |  |  | 7.65QE | 0.42 | *OsSCP46* | 599.992 | Li et al. 2016 |
| GL | RR | 1 | 3 | 1294521 |  | 25.37 |  | 1.58 | *OsCDPK1* | 330.577 | Ho et al. 2013 |
|  | Both | 2 | 3 | 16708508~16845802 | 32.72~40.25 | 47.94 | 22.1~36.57 | 2.02~13.09 | *GS3* | 11.033~110.693 | Mao et al. 2010 |
|  | MC | 3 | 3 | 24589241 |  |  | 10.27 | 0.12 | *qGL3* | 453.186 | Zhang et al. 2012 |
|  | MC | 4 | 3 | 35504491 |  | 5.28 |  | 0.68 | *qTGW3* | 112.509 | Ying et al. 2018 |
|  | RR | 5 | 4 | 20228091 |  |  | 15.77QE | 0.74 | *OsACOT* | 146.749 | Zhao et al. 2019 |
|  | Both | 6 | 5 | 5357676~5914985 |  | 10.46 | 33.37~45.93 | 0.73~1.41 | *GW5* | 7.446~548.284 | Liu et al. 2017 |
|  | RR | 7 | 6 | 26752211 |  |  | 22.26QE | 1.03 | *GW6a* | 158.750 | Song et al.2015b |
|  | Both | 8 | 7 | 24206745~24964429 | 10.73~26.22 | 9.07~10.3 | 12.68~67.68 | 0.15~1.52 | *GW7* | 131.277~457.583 | Wang et al. 2015a |
|  | RR | 9 | 9 | 16419362 |  | 16.74 |  | 1.25 | *SG1* | 931.578 | Nakagawa et al. 2012 |
|  | MC | 10 | 11 | 1936516 | 17.84 |  |  | 0.53 | *CycT1;3* | 793.608 | Qi et al. 2012 |
|  | Both | 11 | 12 | 27064916~27144058 | 7.86~8.66 | 8.62 | 40.38 | 0.95~1.68 | *OsPPKL3* | 749.113~828.255 | Zhang et al. 2012 |
| TGW | RR | 1 | 1 | 4921429 |  |  | 8.6 | 1.96 | *smg11* | 315.194 | Fang et al. 2016 |
|  | MC | 2 | 1 | 580218~800544 |  | 5.97 | 17.65 | 0.65~0.88 | *SPL33* | 129.34~349.666 | Wang et al. 2017 |
|  | MC | 3 | 1 | 13552450 |  | 6.85 |  | 1.88 | *OsSar1a* | 264.006 | Tian et al. 2013 |
|  | MC | 4 | 2 | 4346020 |  |  | 22.43 | 0.65 | *OsMADS29* | 508.885 | Nayar et al. 2013 |
|  | MC | 5 | 2 | 8196020 |  | 13.19 |  | 2.24 | *GW2* | 74.369 | Song et al. 2007 |
|  | Both | 6 | 2 | 25079124~26049877 | 17.19 | 17.15~18.25 |  | 1.27~2.43 | *OsVPE3* | 148.959~811.321 | Lu et al. 2016 |
|  | RR | 7 | 2 | 28749717 | 15.39 |  |  | 1.74 | *GS2* | 113.557 | Hu et al. 2015 |
|  | MC | 8 | 2 | 30953174 | 6.37 |  |  | 2.51 | *OsNF-YB1* | 760.686 | Xu et al. 2016 |
|  | Both | 9 | 2 | 31404034~31234763 | 10.92~12.69 |  |  | 3.11~3.83 | *KRP1* | 707.277~876.548 | Barrôco et al. 2006 |
|  | MC | 10 | 2 | 33674994 |  |  | 5.14 | 0.32 | *SMG1* | 231.046 | Duan et al. 2014 |
|  | MC | 11 | 2 | 35005427 |  |  | 10.91 | 0.78 | *BSG1* | 315.704 | Yan et al. 2013 |
|  | RR | 12 | 3 | 6596936 |  | 23.59 |  | 4.26 | *LPA1* | 640.226 | Sun et al. 2019 |
|  | RR | 13 | 3 | 30587749 |  | 6.78 |  | 2.17 | *OsPho1* | 744.284 | Satoh et al. 2008 |
|  | MC | 14 | 3 | 35437797 |  |  | 11.11 | 0.43 | *qTGW3* | 45.815 | Ying et al. 2018 |
|  | RR | 15 | 4 | 4570606 | 24.24 |  |  | 4.63 | *ETR2* | 167.769 | Wuriyanghan et al. 2009 |
|  | MC | 16 | 4 | 10654189 |  | 14.47 |  | 1.52 | *OscZOG1* | 721.294 | Shang et al. 2016 |
|  | RR | 17 | 4 | 22027451 |  | 6.713 |  | 3.12 | *OsACOT* | 328.841 | Zhao et al. 2019 |
|  | RR | 18 | 4 | 24390487 |  |  | 21.48 | 1.66 | *D11* | 918.895 | Zhu et al. 2015 |
|  | RR | 19 | 4 | 27688228 |  |  | 9.08 | 2.14 | *OsMKKK10* | 361.018 | Xu et al. 2018 |
|  | Both | 20 | 4 | 31490102~31939665 | 26.49~29.73 | 12.46 | 46.01 | 1.25~4.60 | *FC1* | 416.375~865.938 | Li et al. 2009 |
|  | MC | 21 | 4 | 33256631~33294138 |  | 22.65 | 24.74 | 1.21~4.08 | *flo2* | 408.346~445.853 | She et al. 2010 |
|  | MC | 22 | 5 | 630924~1479400 | 10.48 |  | 11.09 | 0.62~3.78 | *GSN1* | 227.475~616.661 | Guo et al. 2018 |
|  | Both | 23 | 5 | 5356835~5895833 | 6.32 |  | 31.77 | 2.38~3.19 | *GW5* | 8.287~529.132 | Liu et al. 2017 |
|  | RR | 24 | 5 | 14579088 |  |  | 32.4 | 3.05 | *OsAGSW1* | 461.709 | Li et al. 2015 |
|  | MC | 25 | 6 | 1540336 | 4.83 |  |  | 1.91 | *SSG6* | 89.442 | Matsushima et al. 2016 |
|  | MC | 26 | 6 | 5384404 |  |  | 11.09 | 0.96 | *OsKASI* | 483.84 | Ding et al. 2015 |
|  | MC | 27 | 6 | 8254727 |  |  | 18.22 | 0.48 | *PFPβ* | 600.42 | Duan et al. 2016 |
|  | MC | 28 | 7 | 7640833~8364433 |  | 16.51 | 50.71 | 1.19~2.47 | *SSH1* | 90.919~814.519 | Jiang et al. 2019a |
|  | RR | 29 | 8 | 6110721 | 6.11 |  |  | 2.25 | *UAP1* | 126.728 | Wang et al. 2015b |
|  | MC | 30 | 8 | 25154283 | 13.02 |  |  | 3.19 | *OsSPL14* | 120.258 | Jiao et al. 2010 |
|  | MC | 31 | 8 | 27495394 |  |  | 16.65QE | 1.52 | *OsSPL16* | 989.196 | Wang et al. 2012 |
|  | Both | 32 | 10 | 463104~1426946 | 16~21.09 |  |  | 2.15~3.4 | *OsPCR1* | 361.731~600.637 | Song et al. 2015a |
|  | RR | 33 | 11 | 10422612 | 12.59 |  |  | 1.13 | *OsMPK15* | 943.258 | Hong et al. 2019 |

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