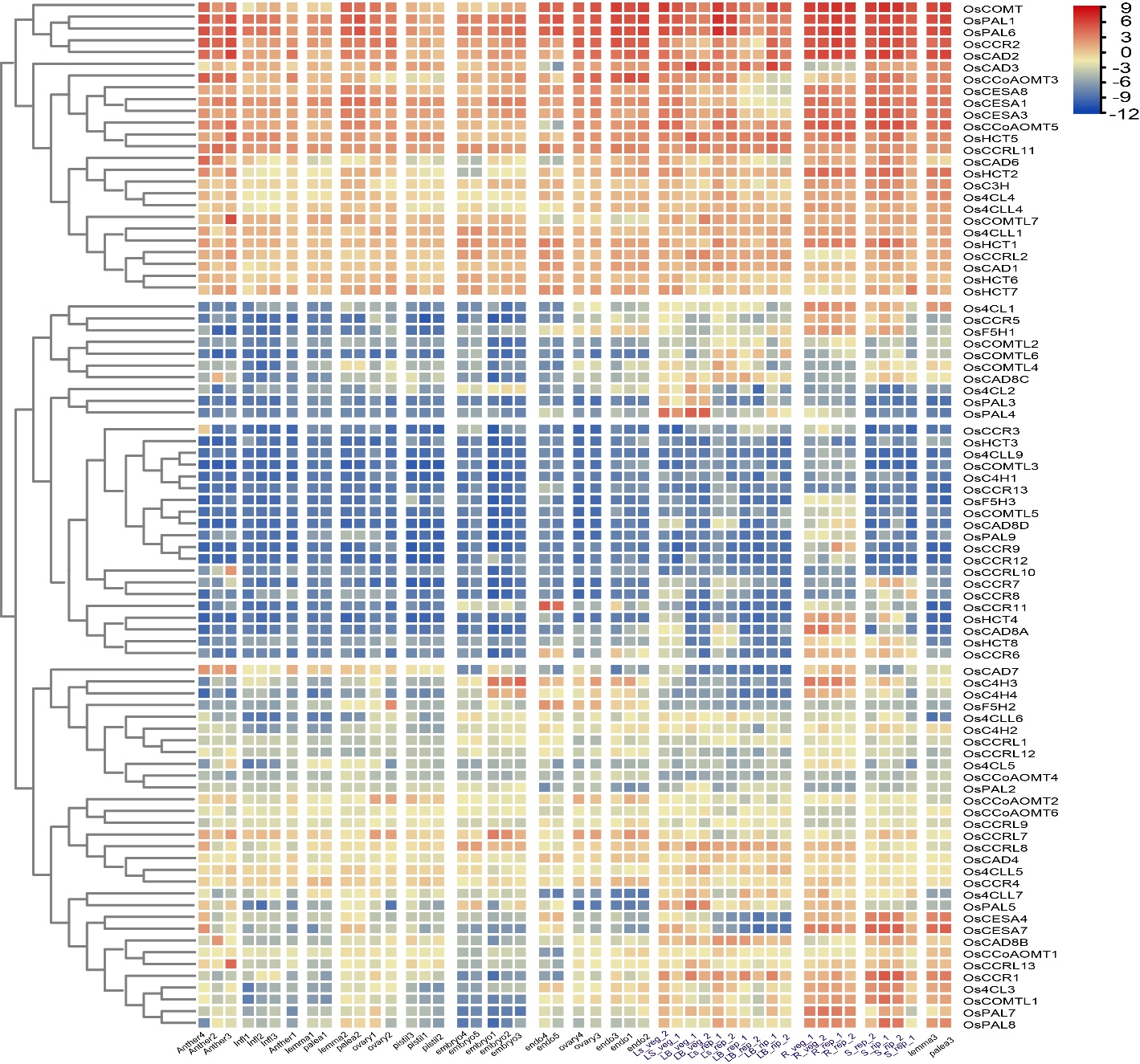
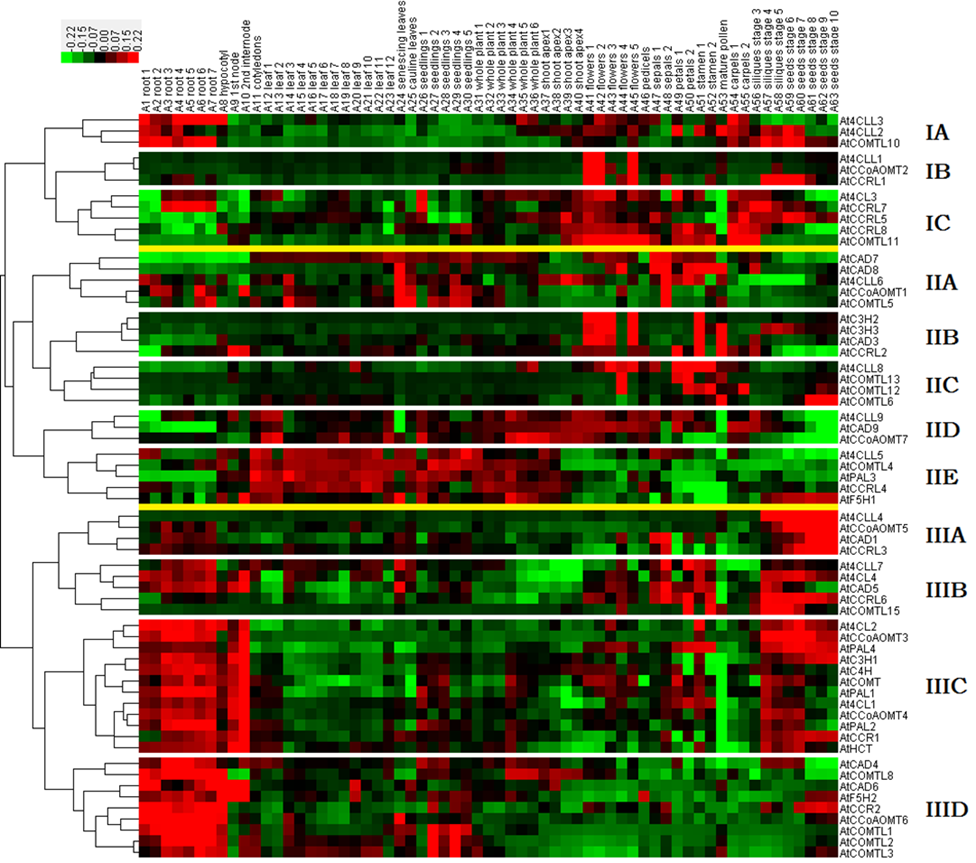
**Supplementary materials**

**Table S1.** Basic information of 90 lignin-related genes identified in rice.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Genes** | **TIGR Loci** | **Probsetsa** | **Protein characteristics** | | **Number of AA** |
| **Pred Helb** | **Domains** |
| 1 | OsPAL1 | LOC\_Os02g41630 | Os.9330.4.S1\_x\_at | NONE | PAL-HAL | 701 |
| 2 | OsPAL2 | LOC\_Os04g43760 | Os.37893.1.S1\_at | NONE | PAL-HAL, Lyase\_I\_like | 340 |
| 3 | OsPAL3 | LOC\_Os11g48110 | N/A | 1 | PAL-HAL | 700 |
| 4 | OsPAL4 | LOC\_Os12g33610 | Os.27728.1.S1\_at | 1 | PAL-HAL | 680 |
| 5 | OsPAL5 | LOC\_Os04g43800 | Os.52536.1.S1\_at | NONE | PAL-HAL | 714 |
| 6 | OsPAL6 | LOC\_Os02g41650 | Os.28397.1.S3\_at | NONE | PAL-HAL | 718 |
| 7 | OsPAL7 | LOC\_Os05g35290 | N/A | NONE | PAL-HAL | 716 |
| 8 | OsPAL8 | LOC\_Os02g41680 | Os.25687.1.S1\_x\_at | NONE | PAL-HAL | 713 |
| 9 | OsPAL9 | LOC\_Os02g41670 | Os.10930.1.S1\_at | NONE | PAL-HAL | 713 |
| 10 | OsC4H1 | LOC\_Os01g60450 | OsAffx.2373.1.S1\_x\_at | 2 | p450 | 481 |
| 11 | OsC4H2 | LOC\_Os05g25640 | Os.53884.1.S1\_at | 1 | p450 | 500 |
| 12 | OsC4H3 | LOC\_Os02g26770 | N/A | 3 | p450 | 533 |
| 13 | OsC4H4 | LOC\_Os02g26810 | Os.11417.1.S1\_at | 3 | p450 | 533 |
| 14 | Os4CL1 | LOC\_Os08g14760 | Os.52921.1.S1\_at | NONE | LuxE | 564 |
| 15 | Os4CL2 | LOC\_Os02g46970 | Os.4377.1.S1\_at | 1 | LuxE | 569 |
| 16 | Os4CL3 | LOC\_Os02g08100 | Os.10669.1.S1\_at | NONE | LuxE | 554 |
| 17 | Os4CL4 | LOC\_Os06g44620 | Os.8020.2.S1\_at | NONE | LuxE | 445 |
| 18 | Os4CL5 | LOC\_Os08g34790 | Os.19375.1.S1\_at | NONE | LuxE | 539 |
| 19 | Os4CLL1 | LOC\_Os03g05780 | Os.11459.1.S1\_at | 1 | LuxE | 552 |
| 20 | Os4CLL2 | LOC\_Os10g42800 | OsAffx.30755.1.S1\_x\_at | NONE | LuxE | 564 |
| 21 | Os4CLL3 | LOC\_Os08g04770 | OsAffx.29036.1.S1\_at | NONE | LuxE | 591 |
| 22 | Os4CLL4 | LOC\_Os03g04000 | Os.18327.1.S1\_at | 2 | LuxE | 552 |
| 23 | Os4CLL5 | LOC\_Os01g67530 | Os.5174.1.S1\_at | NONE | LuxE | 442 |
| 24 | Os4CLL6 | LOC\_Os01g67540 | OsAffx.21790.1.S1\_at | 3 | LuxE | 598 |
| 25 | Os4CLL7 | LOC\_Os07g17970 | Os.15398.1.S1\_at | NONE | LuxE | 483 |
| 26 | Os4CLL8 | LOC\_Os07g44560 | OsAffx.5636.1.S1\_at | NONE | LuxE | 609 |
| 27 | Os4CLL9 | LOC\_Os04g24530 | OsAffx.13955.1.S1\_x\_at | 1 | LuxE | 522 |
| 28 | OsHCT1 | LOC\_Os04g42250 | Os.12225.1.S1\_at | NONE | Transferase | 442 |
| 29 | OsHCT2 | LOC\_Os02g39850 | Os.7870.1.S1\_at | NONE | Transferase | 442 |
| 30 | OsHCT3 | LOC\_Os06g08580 | Os.15299.1.S1\_x\_at | NONE | Transferase | 445 |
| 31 | OsHCT4 | LOC\_Os06g08640 | OsAffx.27513.1.S1\_s\_at | NONE | Transferase | 433 |
| 32 | OsHCT5 | LOC\_Os09g25460 | Os.37941.1.S1\_at | NONE | Transferase | 440 |
| 33 | OsHCT6 | LOC\_Os08g43040 | Os.15257.1.S1\_at | 1 | Transferase | 442 |
| 34 | OsHCT7 | LOC\_Os11g07960 | Os.10765.1.S1\_at | NONE | Transferase | 447 |
| 35 | OsHCT8 | LOC\_Os08g10420 | OsAffx.5777.1.S1\_at | NONE | Transferase | 458 |
| 36 | OsC3H | LOC\_Os05g41440 | Os.5391.1.S1\_at | NONE | p450 | 362 |
| 37 | OsCCoAOMT1 | LOC\_Os06g06980 | Os.4198.1.S1\_x\_at | NONE | AdoMet\_Mtases | 260 |
| 38 | OsCCoAOMT2 | LOC\_Os09g30360 | Os.4830.1.S1\_x\_at | NONE | AdoMet\_MTases | 258 |
| 39 | OsCCoAOMT3 | LOC\_Os08g38910 | Os.7348.2.S1\_x\_at | NONE | AdoMet\_MTases | 203 |
| 40 | OsCCoAOMT4 | LOC\_Os08g38920 | N/A | NONE | AdoMet\_Mtases | 234 |
| 41 | OsCCoAOMT5 | LOC\_Os08g38900 | Os.4244.1.S1\_at | NONE | AdoMet\_MTases | 190 |
| 42 | OsCCoAOMT6 | LOC\_Os08g05790 | Os.24052.1.S1\_x\_at | NONE | AdoMet\_MTases | 283 |
| 43 | OsCCR1 | LOC\_Os09g25150 | Os.9685.1.S1\_a\_at | 1 | FR\_SDR\_e | 246 |
| 44 | OsCCR2 | LOC\_Os08g34280 | Os.8544.1.S1\_at | NONE | FR\_SDR\_e | 361 |
| 45 | OsCCR3 | LOC\_Os08g17500 | Os.54671.1.S1\_at | NONE | FR\_SDR\_e | 342 |
| 46 | OsCCR4 | LOC\_Os02g08420 | Os.12948.1.S1\_at | 1 | FR\_SDR\_e | 344 |
| 47 | OsCCR5 | LOC\_Os09g04050 | Os.53814.1.S1\_at | NONE | FR\_SDR\_e | 347 |
| 48 | OsCCR6 | LOC\_Os01g18110 | Os.45894.1.S1\_x\_at | NONE | FR\_SDR\_e | 326 |
| 49 | OsCCR7 | LOC\_Os01g18120 | Os.20420.1.S1\_at | NONE | FR\_SDR\_e | 328 |
| 50 | OsCCR8 | LOC\_Os09g08720 | OsAffx.29770.1.S1\_at | NONE | FR\_SDR\_e | 324 |
| 51 | OsCCR9 | LOC\_Os02g56700 | Os.20154.1.S1\_at | NONE | FR\_SDR\_e | 339 |
| 52 | OsCCR10 | LOC\_Os02g56690 | OsAffx.24898.2.S1\_at | NONE | FR\_SDR\_e | 354 |
| 53 | OsCCR11 | LOC\_Os02g56720 | Os.55206.1.A1\_at | NONE | FR\_SDR\_e | 334 |
| 54 | OsCCR12 | LOC\_Os02g56460 | Os.6757.1.S1\_at | NONE | FR\_SDR\_e | 338 |
| 55 | OsCCR13 | LOC\_Os02g56680 | N/A | NONE | FR\_SDR\_e | 337 |
| 56 | OsCCRL1 | LOC\_Os06g41840 | Os.6207.1.S1\_s\_at | NONE | FR\_SDR\_e | 187 |
| 57 | OsCCRL2 | LOC\_Os06g41810 | Os.15971.1.S1\_at | NONE | FR\_SDR\_e | 321 |
| 58 | OsCCRL3 | LOC\_Os09g31502 | Os.51220.1.S1\_x\_at | NONE | FR\_SDR\_e | 281 |
| 59 | OsCCRL4 | LOC\_Os09g31490 | Os.15746.1.S1\_at | NONE | FR\_SDR\_e | 343 |
| 60 | OsCCRL5 | LOC\_Os09g31506 | N/A | NONE | FR\_SDR\_e | 220 |
| 61 | OsCCRL6 | LOC\_Os09g31514 | Os.17520.1.S1\_at | NONE | FR\_SDR\_e | 249 |
| 62 | OsCCRL7 | LOC\_Os03g60380 | Os.24712.1.A1\_s\_at | NONE | FR\_SDR\_e | 334 |
| 63 | OsCCRL8 | LOC\_Os01g61230 | Os.42521.1.S1\_at | NONE | FR\_SDR\_e | 326 |
| 64 | OsCCRL9 | LOC\_Os01g74660 | Os.5806.1.S1\_at | NONE | FR\_SDR\_e | 327 |
| 65 | OsCCRL10 | LOC\_Os08g40440 | OsAffx.17435.1.S1\_s\_at | NONE | FR\_SDR\_e | 295 |
| 66 | OsCCRL11 | LOC\_Os01g34480 | Os.11827.1.S1\_a\_at | NONE | FR\_SDR\_e | 284 |
| 67 | OsCCRL12 | LOC\_Os05g50250 | Os.51338.1.S1\_at | NONE | FR\_SDR\_e | 379 |
| 68 | OsCCRL13 | LOC\_Os01g45200 | Os.11247.1.S1\_at | NONE | FR\_SDR\_e | 363 |
| 69 | OsF5H1 | LOC\_Os10g36848 | Os.9727.1.S1\_at | NONE | p450 | 530 |
| 70 | OsF5H2 | LOC\_Os03g02180 | OsAffx.12708.1.S1\_x\_at | 1 | p450 | 519 |
| 71 | OsF5H3 | LOC\_Os06g24180 | OsAffx.4924.1.S1\_at | NONE | p450 | 529 |
| 72 | OsCOMT | LOC\_Os08g06100 | Os.11202.1.S1\_at | NONE | Methyltransf\_2, Dimerisation | 368 |
| 73 | OsCOMTL1 | LOC\_Os12g13810 | OsAffx.19658.1.S1\_at | NONE | Methyltransf\_2 | 262 |
| 74 | OsCOMTL2 | LOC\_Os12g10140 | OsAffx.31676.1.S1\_at | NONE | Methyltransf\_2 | 250 |
| 75 | OsCOMTL3 | LOC\_Os04g01470 | Os.23187.1.S1\_at | NONE | Methyltransf\_2, Dimerisation | 357 |
| 76 | OsCOMTL4 | LOC\_Os04g09654 | Os.10277.1.S1\_at | NONE | Methyltransf\_2, Dimerisation | 258 |
| 77 | OsCOMTL5 | LOC\_Os04g09680 | N/A | NONE | Methyltransf\_2 | 171 |
| 78 | OsCOMTL6 | LOC\_Os04g09604 | Os.26569.1.S1\_at | NONE | Methyltransf\_2 | 378 |
| 79 | OsCOMTL7 | LOC\_Os02g57760 | Os.54406.1.S1\_at | NONE | Methyltransf\_2 | 365 |
| 80 | OsCAD1 | LOC\_Os10g11810 | Os.7543.1.S1\_at | NONE | CAD1 | 297 |
| 81 | OsCAD2 | LOC\_Os02g09490 | Os.8684.1.S1\_a\_at | NONE | CAD1 | 363 |
| 82 | OsCAD3 | LOC\_Os10g29470 | Os.7496.1.S1\_a\_at | NONE | CAD1 | 366 |
| 83 | OsCAD4 | LOC\_Os11g40690 | N/A | NONE | CAD1 | 343 |
| 84 | OsCAD5 | LOC\_Os08g16910 | N/A | NONE | CAD1 | 332 |
| 85 | OsCAD6 | LOC\_Os04g15920 | Os.6089.1.S1\_at | NONE | CAD1 | 360 |
| 86 | OsCAD7 | LOC\_Os04g52280 | Os.32904.1.S1\_at | NONE | CAD1 | 379 |
| 87 | OsCAD8A | LOC\_Os09g23530 | Os.5983.1.S1\_at | NONE | CAD1 | 359 |
| 88 | OsCAD8B | LOC\_Os09g23540 | Os.37839.1.S1\_at | NONE | CAD1 | 436 |
| 89 | OsCAD8C | LOC\_Os09g23550 | Os.6862.2.A1\_at | NONE | CAD1 | 439 |
| 90 | OsCAD8D | LOC\_Os09g23560 | N/A | NONE | CAD1 | 362 |

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**Figure S1.** Co-expression clustering of rice lignin gene expression profiles in Nipponbare cultivar at different growth stages. Normalized count values data were downloaded from the RiceXpro database. The scale at the extreme top right represents the level of gene expression as red, yellow, and blue exhibit relatively high, medium, and low expressions, respectively. The tissue samples in the lower part of the figure in blue represent vegetative while in black show reproductive tissue samples.

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**Figure S2.** The lignin-related genes co-expression profiling (Log transformed) in *Arabidopsis*. The color scale representing the relative signal values is shown above (green refers to low expression; black refers to medium expression; red refers to high expression).

**Table S2.** Conserved amino acid motifs in the protein sequences of lignin biosynthesis genes.

|  |  |  |
| --- | --- | --- |
| **MOTIF** | **WIDTH** | **BEST POSSIBLE MATCH** |
| 1 | 65 | LPMLVYVSREKRPGYNHHKKAGAMNALVRVSAVMTNAPFMLNLDCDHYINNSQAIREAMCFMMDP |
| 2 | 75 | STVDPMKEPPLYTANTILSILAVDYPVDKVSCYVSDDGGAMLTFEAMAETAEFARKWVPFCKKHCIEPRAPEWYF |
| 3 | 81 | FFGFNGTAGVWRIKAINESGGWMDRTTVEDMDIAVRAHLKGWKFIYLNDVKCKCELPSTYKAYRHQQHRWHCGPMNLFRKC |
| 4 | 80 | VISCWYEDKTEWGKEIGWIYGSVTEDIVTGFRMHCRGWRSVYCMPKRDAFKGTAPINLTDRLHQVLRWATGSVEIFFSHH |
| 5 | 62 | DKVCYVQFPQRFDGIDPHDRYANHNTVFFDINMKGLDGIQGPMYVGTGCMFRRQALYGYDPP |
| 6 | 80 | NLKEGMECDYVKQCEYVAIFDADFQPEPDFLKRTVPHFKHNPEIGLVQARWSFVNKDECLMTRMQNMNLCYHFKVEQQVN |
| 7 | 47 | MTGMLEMKWSGITIEDWWRNEQFWMIGGTSAHLFAVFQGLLKVLTGI |
| 8 | 115 | IIINKKISFWKKIHLIYSFFLVRKIIAPFYTFTFYCIIIPMTMFVPEVEIPIWGVCYIPTTMTILNIIPNPKSFHFIIFWILFENTMSMHRMNAMISGLFQLGSANEWVVTKKSG |
| 9 | 32 | EIWFAFSWILDQFPKWCPINRETYLDRLAERY |
| 10 | 41 | LYGRRLKFLQRMAYINMTIYPFTSIFLLAYCTLPAICLLTG |
| 11 | 41 | MVLVQIPMCNEKEVYQQSIGAVCNLDWPRDRFIVQVLDDST |
| 12 | 29 | LFFNFWVIVHLYPFAKGLMGRQNRTPTIV |
| 13 | 57 | MDEARQPLSRKYPIPSSIIHPYRMLIIIRLVVLGFFFHWRITHPNRDAMWLWTMSVI |
| 14 | 44 | KIDYYKDKVQPEFVKDRRRMKREYEEFKVRINALPAKIQKRPEE |
| 15 | 45 | TKQTAADEDDEFAELYTFKWTTLLIPPTTIMMVNIIGIVAGVSKA |
| 16 | 70 | NGQVCQICGDDVGTTPDGEPFVACNECGFPVCRPCYEYERREGTQCCPQCKTRYKRHKGCPRVPGDEEED |
| 17 | 52 | KGPKATWMADGTHWPGTWIEPSENHQKGDHAGIVQVMLNHPSHKPQLGMPAS |
| 18 | 29 | GWIMQDGTPWPGNNTRDHPGMIQVFLGHS |
| 19 | 29 | VEEECEKWQQKGVNIKYEHRNNRKGYKAG |
| 20 | 41 | KKKHNRIYKKELALSFFLLTCACYDLLYHQGIHFYFLLFQG |
| 21 | 21 | VVWSILLASIFSLLWVRIDPF |
| 22 | 159 | FVCTADPHAEPPSLVISTILSVMAYNYPSEKISVYLSDDGGSILTFYALWEASIFAKKWLPFCKRYNIEPRSPAAYFSESEGHHNLCGPKEWAFIKNLYEEMRERIDSAVMSGKIPEEMKLKHKGFDEWNSDFTSKNHQPIVQILIDGKNQNAVDDDGN |
| 23 | 21 | KKFGQSSVFIASTLMEQNQER |
| 24 | 29 | WMQVRADYVAPPLQFLVWACMVMFMMQSA |
| 25 | 56 | IAFVQYPQRFDNVDPNDIYGNHNNVFFDCTMLGLDGLQGCIYIGTGCFHRREALCG |
| 26 | 32 | EIWFAFSWILDQFPKWCPINRETYLDRLAERY |
| 27 | 44 | KIDYYKDKVQPEFVKDRRRMKREYEEFKVRINALPAKIQKRPEE |
| 28 | 29 | GWIMQDGTPWPGNNTRDHPGMIQVFLGHS |
| 29 | 45 | TKQTAADEDDEFAELYTFKWTTLLIPPTTIMMVNIIGIVAGVSKA |
| 30 | 21 | VVWSILLASIFSLLWVRIDPF |

**Table S3.** The lignin monomer composition and total lignin contents in five genotypes at six growth stages (µmol/g dry matter).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **Stage** | **H** | **G** | **S** | **H+G+S** |  | **S/G** | **H/G** | **S/H** |
| **NPB** | **I** | 37.98±1.89 | 48.00±1.89 | 26.73±2.42 | 112.72±4.73 |  | 0.56 | 0.79 | 0.70 |
| **II** | 47.77±2.05 | 71.87±2.38 | 36.08±0.67 | 155.73±3.74 |  | 0.50 | 0.66 | 0.76 |
| **III** | 67.33±1.00 | 85.16±0.89 | 56.96±1.86 | 209.46±3.64 |  | 0.67 | 0.79 | 0.85 |
| **IV** | 67.38±0.57 | 104.30±0.54 | 62.06±0.89 | 233.74±1.82 |  | 0.60 | 0.65 | 0.92 |
| **V** | 86.71±3.23 | 119.69±3.57 | 79.13±1.79 | 285.53±4.63 |  | 0.66 | 0.72 | 0.91 |
| **VI** | 129.56±2.14 | 145.30±2.55 | 79.77±1.00 | 354.62±5.61 |  | 0.55 | 0.89 | 0.62 |
|  |  |  |  |  |  |  |  |  |  |
| **C6** | **I** | 27.99\*\*±0.48 | 36.69\*\*±1.92 | 13.29\*±0.09 | 77.97\*\*±2.36 |  | 0.36 | 0.76 | 0.47 |
| **II** | 49.98\*±2.16 | 79.62\*\*±2.00 | 35.44±0.71 | 165.03\*\*±4.61 |  | 0.45 | 0.63 | 0.71 |
| **III** | 67.11±1.99 | 99.90\*\*±1.15 | 41.21\*\*±0.70 | 208.23±3.04 |  | 0.41 | 0.67 | 0.61 |
| **IV** | 66.45±0.98 | 121.20\*\*±1.34 | 53.56\*\*±1.78 | 241.20\*\*±2.15 |  | 0.44 | 0.55 | 0.81 |
| **V** | 91.20±1.12 | 146.68\*\*±2.77 | 58.27\*\*±0.83 | 296.16\*±3.87 |  | 0.40 | 0.62 | 0.64 |
| **VI** | 108.75\*\*±2.61 | 174.86\*\*±2.91 | 66.42\*\*±0.97 | 350.03±6.31 |  | 0.38 | 0.62 | 0.61 |
|  |  |  |  |  |  |  |  |  |  |
| **C15** | **I** | 33.04\*±1.14 | 44.27\*\*±1.43 | 22.10±0.43 | 99.41\*\*±2.56 |  | 0.50 | 0.75 | 0.67 |
| **II** | 52.11\*\*±2.09 | 57.82\*\*±0.98 | 30.45\*±1.56 | 140.38\*\*±4.57 |  | 0.53 | 0.90 | 0.58 |
| **III** | 64.38±1.50 | 75.59\*\*±1.92 | 40.67\*\*±0.24 | 180.64\*\*±2.09 |  | 0.54 | 0.85 | 0.63 |
| **IV** | 74.05\*±1.67 | 90.91\*\*±1.08 | 53.58\*\*±1.41 | 218.54\*±4.15 |  | 0.59 | 0.81 | 0.72 |
| **V** | 86.20±2.79 | 107.71\*±1.00 | 68.72\*±1.05 | 262.64\*\*±4.68 |  | 0.64 | 0.80 | 0.80 |
| **VI** | 138.46\*±3.55 | 112.84\*\*±1.23 | 106.64\*\*±1.72 | 357.95±3.46 |  | 0.95 | 1.23 | 0.77 |
|  |  |  |  |  |  |  |  |  |  |
| **C17** | **I** | 39.41\*±2.12 | 48.00±0.42 | 23.67±1.11 | 111.08±3.29 |  | 0.49 | 0.82 | 0.60 |
| **II** | 59.32\*±2.22 | 83.22\*\*±1.24 | 39.42±1.49 | 181.96\*\*±3.98 |  | 0.47 | 0.71 | 0.66 |
| **III** | 62.88±3.13 | 104.49\*\*±1.31 | 62.49±2.19 | 229.86\*\*±2.55 |  | 0.60 | 0.60 | 0.99 |
| **IV** | 89.11\*\*±1.72 | 101.66±1.45 | 64.37±2.59 | 255.13\*\*±3.26 |  | 0.63 | 0.88 | 0.72 |
| **V** | 108.17\*\*±2.60 | 113.05±0.52 | 75.54±1.70 | 296.75\*±4.42 |  | 0.67 | 0.96 | 0.70 |
| **VI** | 152.56\*\*±1.71 | 127.46\*\*±1.82 | 102.67\*\*±2.23 | 382.69\*\*±4.51 |  | 0.81 | 1.20 | 0.67 |
|  |  |  |  |  |  |  |  |  |  |
| **Y102** | **I** | 36.68±2.73 | 31.94\*\*±1.31 | 18.73\*±1.83 | 87.35\*\*±4.00 |  | 0.59 | 1.15 | 0.51 |
| **II** | 56.84\*\*±2.75 | 51.97\*±2.67 | 34.48±2.06 | 143.30\*±1.54 |  | 0.66 | 1.09 | 0.61 |
| **III** | 59.60\*±3.72 | 63.10\*\*±0.47 | 41.37\*\*±0.72 | 164.07\*\*±3.86 |  | 0.66 | 0.94 | 0.69 |
| **IV** | 70.78±1.99 | 73.43\*\*±1.52 | 38.20\*\*±1.24 | 182.42\*\*±3.77 |  | 0.52 | 0.96 | 0.54 |
| **V** | 101.31\*±0.66 | 95.38\*\*±0.92 | 72.21\*\*±1.88 | 268.90\*\*±2.25 |  | 0.76 | 1.06 | 0.71 |
| **VI** | 132.48\*±1.30 | 126.54\*\*±1.36 | 86.90\*±2.57 | 345.91±2.15 |  | 0.69 | 1.05 | 0.66 |

Note; NPB was used as the control group, while the four mutants were used as comparison groups. \* and \*\* A significant difference by t-test at *p* < 0.05 and 0.01 (n = 3); and Stage of samples (I refers to the 2nd internode length is 0-2 cm; II refers to the length is 3-5 cm; III refers to the length is 6-8 cm; IV refers to the length is 10-12 cm; V refers to the length is greater than 13 cm; VI refers to mature internode). The deviation around the mean values is indicated by the (±) sign.

**Table S4.** The monomer composition of total lignin increased between two consecutive stages (µmol/g dry matter).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Genotype** | **Stages** | **H** | **G** | **S** | **H+G+S** |
| **NPB** | **I-II**& | 9.79\*\*±0.27 | 23.87\*\*±0.62 | 9.35±1.88 | 43.01\*\*±1.65 |
| **II-III** | 19.56\*\*±1.06 | 13.29\*±1.67 | 20.88\*±1.34 | 53.73\*\*±1.47 |
| **III-IV** | 0.04±0.50 | 19.14\*\*±0.35 | 5.11±0.99 | 24.29\*±2.03 |
| **IV-V** | 19.33\*±2.69 | 15.38±3.10 | 17.07\*\*±0.91 | 51.78\*±3.10 |
| **V-VI** | 42.85\*\*±1.48 | 25.61\*\*±1.02 | 0.63±1.21 | 69.09\*\*±3.59 |
|  |  |  |  |  |  |
| **C6** | **I-II** | 21.98\*±1.71 | 42.93\*\*\*±0.34 | 22.15\*\*±0.64 | 87.07\*\*±2.54 |
| **II-III** | 17.14\*±0.94 | 20.28\*±1.21 | 5.78\*\*\*±0.07 | 43.19\*\*±2.02 |
| **III-IV** | -0.67±1.08 | 21.3\*\*\*±0.18 | 12.34\*±1.09 | 32.98\*\*±1.78 |
| **IV-V** | 24.76\*\*\*±0.15 | 25.48\*±2.06 | 4.71±1.41 | 54.95\*\*±2.29 |
| **V-VI** | 17.55\*±1.63 | 28.17\*\*±1.35 | 8.15\*±1.31 | 53.87\*\*±2.85 |
|  |  |  |  |  |  |
| **C15** | **I-II** | 19.06\*±1.13 | 13.56\*\*±0.57 | 8.35\*±1.16 | 40.97\*±2.32 |
| **II-III** | 12.27\*\*±0.60 | 17.77\*±1.41 | 10.22\*±1.32 | 40.26\*±2.50 |
| **III-IV** | 9.67\*±0.86 | 15.32\*±0.85 | 12.91\*±1.23 | 37.90\*±2.59 |
| **IV-V** | 12.15\*±1.63 | 16.8\*\*±0.84 | 15.14\*±1.13 | 44.09\*±3.15 |
| **V-VI** | 52.26\*\*±1.17 | 5.13\*±0.52 | 37.92\*\*±0.72 | 95.31\*\*\*±1.32 |
|  |  |  |  |  |  |
| **C17** | **I-II** | 19.9\*\*±0.40 | 35.22\*\*±0.87 | 15.76\*±0.94 | 70.88\*\*±2.20 |
| **II-III** | 3.57±1.18 | 21.27\*\*\*±0.15 | 23.07\*\*±0.72 | 47.90\*\*±2.23 |
| **III-IV** | 26.23\*±2.28 | -2.83±0.72 | 1.87±0.77 | 25.27\*±1.68 |
| **IV-V** | 19.06\*±1.77 | 11.39\*±1.19 | 11.17\*±0.89 | 41.62\*\*±1.23 |
| **V-VI** | 44.39\*\*±1.19 | 14.41\*±1.73 | 27.14\*±1.57 | 85.94\*\*\*±0.21 |
|  |  |  |  |  |  |
| **Y102** | **I-II** | 20.16\*±1.73 | 20.03\*±1.77 | 15.76\*\*±0.70 | 55.94\*\*±2.69 |
| **II-III** | 2.75±2.13 | 11.13±2.32 | 6.88±1.36 | 20.77\*±2.90 |
| **III-IV** | 11.19±2.21 | 10.33\*±1.21 | -3.16±0.57 | 18.35\*\*±0.43 |
| **IV-V** | 30.53\*\*±1.36 | 21.94\*\*±0.71 | 34.01\*\*±0.96 | 86.48\*\*±1.64 |
| **V-VI** | 31.16\*\*±0.65 | 31.16\*\*\*±0.48 | 14.68\*±0.95 | 77.01\*\*\*±0.58 |

**Note:** \*, \*\* and \*\*\* A significant difference by *t*-test at *p* < 0.01, 0.001 and 0.0001 (n = 3); Stage of samples (I-II refers to the 2nd internode length is 0-2 to 3-5 cm; II-III refers to the length is 3-5 to 6-8 cm; III-IV refers to the size is 6-8 to 10-12 cm; IV-V refers to the length is 10-12 to greater than 13 cm; V-VI refers to the length is greater than 13 cm to mature). The deviation around the mean values is indicated by the (±) sign.

**Table S5.** Twenty-seven genes with high expression levels from the CREP database in the stem were selected for qPCR.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Genes** | **TIGR Loci** |  | **No.** | **Genes** | **TIGR Loci** |
| 1 | Os4CL1 | LOC\_Os08g14760 |  | 16 | OsCOMT | LOC\_Os08g06100 |
| 2 | Os4CL3 | LOC\_Os02g08100 |  | 17 | OsCOMTL4 | LOC\_Os04g09654 |
| 3 | Os4CL5 | LOC\_Os08g34790 |  | 18 | OsCOMTL6 | LOC\_Os04g09604 |
| 4 | OsC3H | LOC\_Os05g41440 |  | 19 | OsF5H1 | LOC\_Os10g36848 |
| 5 | OsC4H2 | LOC\_Os05g25640 |  | 20 | OsF5H2 | LOC\_Os03g02180 |
| 6 | OsCAD1 | LOC\_Os10g11810 |  | 21 | OsF5H3 | LOC\_Os06g24180 |
| 7 | OsCAD2 | LOC\_Os02g09490 |  | 22 | OsHCT1 | LOC\_Os04g42250 |
| 8 | OsCAD8A | LOC\_Os09g23530 |  | 23 | OsHCT2 | LOC\_Os02g39850 |
| 9 | OsCAD8C | LOC\_Os09g23550 |  | 24 | OsHCT3 | LOC\_Os06g08580 |
| 10 | OsCCoAOMT1 | LOC\_Os06g06980 |  | 25 | OsPAL2 | LOC\_Os04g43760 |
| 11 | OsCCoAOMT5 | LOC\_Os08g38900 |  | 26 | OsPAL8 | LOC\_Os02g41680 |
| 12 | OsCCR1 | LOC\_Os09g25150 |  | 27 | OsPAL9 | LOC\_Os02g41670 |
| 13 | OsCCR2 | LOC\_Os08g34280 |  |  |  |  |
| 14 | OsCCR3 | LOC\_Os08g17500 |  |  |  |  |
| 15 | OsCCR8 | LOC\_Os09g08720 |  |  |  |  |

**Table S6.** The primers of 27 genes for qRT-PCR.

|  |  |
| --- | --- |
| **Gene name** | **PCR primer** |
| **4CL1-F** | 5'  GCCCTTCTCATCACCCATCCAA  3' |
| **4CL1-R** | 5'  GCGACTGGTATTTCTCCGATTT  3' |
| **4CL3-F** | 5'  CCTGAGGCGACCAAGAACAC  3' |
| **4CL3-R** | 5'  CGGTGATTTCTGAGCCTTCTG  3' |
| **4CL5-F** | 5'  GGCCGGTGCTATCAATGTG  3' |
| **4CL5-R** | 5'  GGGTTGTTCAGGTATCCTTTCAT  3' |
| **C3H-F** | 5'  CAGTTATTGGGCTTCTATGGGAC  3' |
| **C3H-R** | 5'  GACGGCGTTCAGGTAAGGG  3' |
| **C4H2-F** | 5'  TGAACCACCCGAGCATCC  3' |
| **C4H2-R** | 5'  CCGCAGCGTCTCCTTCAC  3' |
| **CAD1-F** | 5'  TGAAAGTTGGTGGTGTAATGGC  3' |
| **CAD1-R** | 5'  AAGCGAAATCTGACATCCCG  3' |
| **CAD2-F** | 5'  GACTCGCTGGACTACATCATCG  3' |
| **CAD2-R** | 5'  AGTTGAGCACCTCCTCCGTCT  3' |
| **CAD8A-F** | 5'  AAGGGTTCAGGAGGAAGACGA  3' |
| **CAD8A-R** | 5'  CGTTCTTGATGGTGTGCAGGT  3' |
| **CAD8C-F** | 5'  GGAGGGCTCAGAAGGACGAT  3' |
| **CAD8C-R** | 5'  GCACGACGCGACGAAGTAG  3' |
| **CCoAOMT1-F** | 5'  GCTGGTGGAGGAGGAGGG  3' |
| **CCoAOMT1-R** | 5'  TCATCAGCCGCTCGTGGT  3' |
| **CCoAOMT5-F** | 5'  CTGGGGATGCTGCTGAAGAT  3' |
| **CCoAOMT5-R** | 5'  CCACCACCTTCCCGTCCT  3' |
| **CCR1-F** | 5' CCAAGAAGTACGCCAATGCC 3' |
| **CCR1-R** | 5' GCTGCTTCCGTGGGTTCA 3' |
| **CCR2-F** | 5'  CTGCTGGAGCGACCTTGACT  3' |
| **CCR2-R** | 5'  TTGAGGATGTGGGCGACG  3' |
| **CCR3-F** | 5'  GGACACCGGAAACTGGTACTG  3' |
| **CCR3-R** | 5'  AGCCGTCCAGGTACTTGAGC  3' |
| **CCR8-F** | 5'  GGAATGCTGTCGCTGGGTAT  3' |
| **CCR8-R** | 5'  TCTGCTTGCTGTCTTCACACTTG  3' |
| **COMT-F** | 5' AGGGAGCAGGGGGTGTTC 3' |
| **COMT-R** | 5' CAGGCGTTGGCGTAGATGTA 3' |
| **COMTL4-F** | 5'  ATTGTTGTTGATATTGTTCTCCCTG  3' |
| **COMTL4-R** | 5'  TCCTGCTCTGTCCTTATCTTTCC  3' |
| **COMTL6-F** | 5'  CAGCACGATACCCGTTCCA  3' |
| **COMTL6-R** | 5'  GTTCGCAAGGCACCACTGA  3' |
| **F5H1-F** | 5'  GCGATGGCGGAGATGATG  3' |
| **F5H1-R** | 5'  GATGACGCAGCGGAGGAA  3' |
| **F5H2-F** | 5'  ATGGACCCGTGGCTTGTTC  3' |
| **F5H2-R** | 5'  GCTCGACACCACCACCATG  3' |
| **F5H3-F** | 5' GTGGAGTTCAAGGGTGGGG 3' |
| **F5H3-R** | 5' AGAGCAACGGGCAGGACA 3' |
| **HCT1-F** | 5'  CATCTCCTCCTTCTCGCTCCT  3' |
| **HCT1-R** | 5'  TCGTAGGAGAGTGCGGTCAAT  3' |
| **HCT2-F** | 5'  TGGTTCCGTTCTACCCGATG  3' |
| **HCT2-R** | 5'  GGATGGGGAAGGAGGAGATG  3' |
| **HCT3-F** | 5'  CTCGGCAACGCCATCTTC  3' |
| **HCT3-R** | 5'  TCCAGGTGGTCCAGCAGC  3' |
| **PAL2-F** | 5'  TCTACAACAACGGGCTCACG  3' |
| **PAL2-R** | 5'  GCAACCAGGTAGGTGGAGGA  3' |
| **PAL8-F** | 5' GCCTGCCATCCAACCTGTC 3' |
| **PAL8-R** | 5' TTGCCTCGTCGGTCTTCCT 3' |
| **PAL9-F** | 5' CTGGTCCCGCTCTCCTACAT 3' |
| **PAL9-R** | 5' CTCGGCAAGGACAGCAAGA 3' |

**Table S7.** The qRT-PCR gene expressions of 27 genes in Nipponbare (NPB).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Genes** | **I** | | **II** | | **III** | | **IV** | | **V** | |
| Os4CL1 | 0.15 | ±0.01 | 0.88 | ±0.06 | 0.14 | ±0.00 | 0.05 | ±0.01 | 0.05 | ±0.00 |
| Os4CL3 | 2.67 | ±0.44 | 116.10 | ±7.72 | 113.84 | ±3.20 | 49.79 | ±1.73 | 54.49 | ±2.08 |
| Os4CL5 | 0.05 | ±0.00 | 0.33 | ±0.02 | 0.25 | ±0.02 | 0.10 | ±0.01 | 0.01 | ±0.00 |
| OsC3H | 5.53 | ±0.04 | 40.06 | ±1.00 | 21.09 | ±1.16 | 8.46 | ±0.15 | 9.90 | ±0.39 |
| OsC4H2 | 0.01 | ±0.00 | 0.02 | ±0.00 | 0.04 | ±0.00 | 0.01 | ±0.00 | 0.01 | ±0.00 |
| OsCAD1 | 1.32 | ±0.08 | 14.03 | ±1.70 | 7.24 | ±0.44 | 2.84 | ±0.01 | 6.19 | ±0.39 |
| OsCAD2 | 2.94 | ±0.09 | 5.86 | ±0.64 | 4.41 | ±0.04 | 0.76 | ±0.05 | 1.25 | ±0.07 |
| OsCAD8A | 0.02 | ±0.00 | 0.00 | ±0.00 | 0.16 | ±0.00 | 0.01 | ±0.00 | 0.01 | ±0.00 |
| OsCAD8C | 0.34 | ±0.02 | 0.86 | ±0.15 | 0.51 | ±0.00 | 0.11 | ±0.01 | 0.67 | ±0.06 |
| OsCCoAOMT1 | 3.20 | ±0.15 | 8.72 | ±0.26 | 5.43 | ±0.61 | 1.73 | ±0.05 | 3.74 | ±0.13 |
| OsCCoAOMT5 | 18.70 | ±0.85 | 23.31 | ±3.08 | 21.87 | ±0.53 | 13.12 | ±0.09 | 2.25 | ±0.13 |
| OsCCR1 | 0.00 | ±0.00 | 0.04 | ±0.00 | 0.04 | ±0.00 | 7.05 | ±0.29 | 0.10 | ±0.00 |
| OsCCR2 | 0.02 | ±0.00 | 0.15 | ±0.01 | 0.16 | ±0.02 | 0.02 | ±0.00 | 0.02 | ±0.00 |
| OsCCR3 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsCCR8 | 3.32 | ±0.16 | 3.96 | ±0.07 | 4.30 | ±0.28 | 0.73 | ±0.05 | 0.02 | ±0.00 |
| OsCOMT | 52.25 | ±1.04 | 140.51 | ±5.39 | 54.55 | ±3.83 | 7.13 | ±0.26 | 17.09 | ±0.95 |
| OsCOMTL4 | 1.47 | ±0.05 | 3.65 | ±0.41 | 1.17 | ±0.10 | 0.39 | ±0.01 | 1.87 | ±0.07 |
| OsCOMTL6 | 0.03 | ±0.00 | 0.02 | ±0.00 | 0.02 | ±0.00 | 0.01 | ±0.00 | 0.09 | ±0.00 |
| OsF5H1 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsF5H2 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsF5H3 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsHCT1 | 11.17 | ±0.59 | 24.91 | ±1.36 | 7.96 | ±1.14 | 4.13 | ±0.23 | 8.72 | ±0.71 |
| OsHCT2 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsHCT3 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsPAL2 | 0.15 | ±0.00 | 0.99 | ±0.06 | 0.48 | ±0.04 | 0.21 | ±0.00 | 0.47 | ±0.05 |
| OsPAL8 | 0.45 | ±0.03 | 5.83 | ±0.61 | 11.07 | ±1.47 | 8.27 | ±0.07 | 0.90 | ±0.05 |
| OsPAL9 | 0.01 | ±0.00 | 0.25 | ±0.03 | 0.33 | ±0.01 | 0.11 | ±0.00 | 0.00 | ±0.00 |

**Table S8.** The qRT-PCR gene expressions of 27 genes in the mutant C6.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Genes** | **I** | | **II** | | **III** | | **IV** | | **V** | |
| Os4CL1 | 0.13 | ±0.01 | 0.37 | ±0.03 | 0.54 | ±0.03 | 0.13 | ±0.01 | 0.06 | ±0.00 |
| Os4CL3 | 62.02 | ±2.66 | 78.74 | ±8.18 | 139.64 | ±18.51 | 102.12 | ±9.00 | 13.73 | ±1.93 |
| Os4CL5 | 0.51 | ±0.04 | 0.70 | ±0.03 | 0.35 | ±0.01 | 0.57 | ±0.05 | 0.01 | ±0.00 |
| OsC3H | 28.73 | ±0.91 | 24.56 | ±3.78 | 30.70 | ±2.44 | 19.63 | ±2.40 | 3.73 | ±0.42 |
| OsC4H2 | 0.01 | ±0.00 | 0.01 | ±0.00 | 0.02 | ±0.00 | 0.02 | ±0.00 | 0.00 | ±0.00 |
| OsCAD1 | 6.92 | ±0.78 | 2.80 | ±0.18 | 5.01 | ±0.28 | 5.42 | ±0.66 | 2.82 | ±0.36 |
| OsCAD2 | 2.47 | ±0.17 | 3.30 | ±0.22 | 5.38 | ±0.21 | 3.10 | ±0.27 | 0.41 | ±0.02 |
| OsCAD8A | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.02 | ±0.00 | 0.02 | ±0.00 | 0.05 | ±0.01 |
| OsCAD8C | 1.21 | ±0.13 | 0.54 | ±0.05 | 0.86 | ±0.03 | 0.37 | ±0.01 | 0.41 | ±0.03 |
| OsCCoAOMT1 | 6.01 | ±0.32 | 3.74 | ±0.51 | 11.18 | ±0.78 | 4.84 | ±0.61 | 2.06 | ±0.32 |
| OsCCoAOMT5 | 16.58 | ±0.81 | 11.11 | ±0.85 | 22.18 | ±0.93 | 14.68 | ±0.92 | 1.12 | ±0.09 |
| OsCCR1 | 0.01 | ±0.00 | 0.02 | ±0.00 | 0.08 | ±0.01 | 0.06 | ±0.01 | 0.03 | ±0.00 |
| OsCCR2 | 0.01 | ±0.00 | 0.11 | ±0.00 | 0.19 | ±0.01 | 0.13 | ±0.01 | 0.02 | ±0.00 |
| OsCCR3 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.01 | ±0.00 | 0.00 | ±0.00 |
| OsCCR8 | 3.63 | ±0.21 | 1.55 | ±0.22 | 0.52 | ±0.00 | 2.38 | ±0.06 | 0.02 | ±0.00 |
| OsCOMT | 53.85 | ±4.62 | 51.73 | ±6.86 | 97.39 | ±10.07 | 32.61 | ±3.73 | 7.47 | ±0.30 |
| OsCOMTL4 | 6.17 | ±0.60 | 1.46 | ±0.01 | 2.90 | ±0.19 | 1.39 | ±0.03 | 1.59 | ±0.12 |
| OsCOMTL6 | 0.64 | ±0.03 | 0.17 | ±0.02 | 0.62 | ±0.05 | 0.73 | ±0.08 | 1.11 | ±0.02 |
| OsF5H1 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsF5H2 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsF5H3 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsHCT1 | 10.50 | ±1.09 | 12.49 | ±1.75 | 19.24 | ±1.34 | 8.86 | ±1.07 | 5.77 | ±0.69 |
| OsHCT2 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsHCT3 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsPAL2 | 0.62 | ±0.03 | 0.63 | ±0.01 | 1.41 | ±0.06 | 0.47 | ±0.06 | 0.11 | ±0.01 |
| OsPAL8 | 15.44 | ±0.80 | 22.92 | ±3.04 | 23.56 | ±0.97 | 22.10 | ±2.87 | 0.82 | ±0.01 |
| OsPAL9 | 3.22 | ±0.42 | 1.73 | ±0.13 | 0.68 | ±0.04 | 0.60 | ±0.07 | 0.00 | ±0.00 |

**Table S9.** The qRT-PCR gene expressions of 27 genes in the mutant C15.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Genes** | **I** | | **II** | | **III** | | **IV** | | **V** | |
| Os4CL1 | 0.10 | ±0.01 | 0.34 | ±0.02 | 2.64 | ±0.19 | 0.47 | ±0.04 | 0.03 | ±0.00 |
| Os4CL3 | 9.18 | ±0.81 | 61.65 | ±4.05 | 386.38 | ±2.68 | 124.30 | ±4.04 | 1.33 | ±0.07 |
| Os4CL5 | 0.01 | ±0.00 | 0.05 | ±0.01 | 1.21 | ±0.10 | 0.29 | ±0.02 | 0.01 | ±0.00 |
| OsC3H | 3.50 | ±0.23 | 10.44 | ±1.49 | 63.07 | ±3.74 | 20.29 | ±1.27 | 1.38 | ±0.07 |
| OsC4H2 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.03 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsCAD1 | 0.48 | ±0.02 | 1.19 | ±0.06 | 8.81 | ±0.57 | 3.96 | ±0.22 | 2.41 | ±0.11 |
| OsCAD2 | 1.30 | ±0.14 | 2.25 | ±0.08 | 15.66 | ±0.97 | 5.87 | ±0.18 | 0.12 | ±0.01 |
| OsCAD8A | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.01 | ±0.00 | 0.00 | ±0.00 | 0.05 | ±0.00 |
| OsCAD8C | 0.13 | ±0.01 | 0.69 | ±0.03 | 0.39 | ±0.04 | 0.26 | ±0.01 | 0.16 | ±0.01 |
| OsCCoAOMT1 | 0.37 | ±0.03 | 1.42 | ±0.05 | 11.29 | ±0.83 | 3.41 | ±0.40 | 0.87 | ±0.06 |
| OsCCoAOMT5 | 2.38 | ±0.16 | 5.09 | ±0.05 | 38.50 | ±2.94 | 9.38 | ±1.35 | 0.39 | ±0.01 |
| OsCCR1 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.58 | ±0.04 | 0.23 | ±0.04 | 0.00 | ±0.00 |
| OsCCR2 | 0.01 | ±0.00 | 0.03 | ±0.00 | 0.64 | ±0.04 | 0.08 | ±0.01 | 0.00 | ±0.00 |
| OsCCR3 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsCCR8 | 2.24 | ±0.15 | 0.02 | ±0.00 | 0.08 | ±0.00 | 0.03 | ±0.00 | 0.00 | ±0.00 |
| OsCOMT | 13.96 | ±0.99 | 38.79 | ±1.13 | 220.34 | ±17.52 | 69.98 | ±4.13 | 1.35 | ±0.06 |
| OsCOMTL4 | 0.47 | ±0.06 | 2.16 | ±0.11 | 1.99 | ±0.16 | 2.10 | ±0.09 | 0.87 | ±0.08 |
| OsCOMTL6 | 0.03 | ±0.00 | 0.03 | ±0.00 | 0.05 | ±0.00 | 0.10 | ±0.00 | 0.31 | ±0.01 |
| OsF5H1 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.02 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsF5H2 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsF5H3 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsHCT1 | 4.06 | ±0.14 | 5.98 | ±0.05 | 47.68 | ±2.51 | 19.62 | ±0.47 | 1.18 | ±0.05 |
| OsHCT2 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.01 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsHCT3 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsPAL2 | 0.12 | ±0.01 | 0.22 | ±0.03 | 5.16 | ±0.17 | 0.64 | ±0.03 | 0.00 | ±0.00 |
| OsPAL8 | 0.45 | ±0.03 | 3.78 | ±0.16 | 47.54 | ±1.36 | 10.94 | ±0.57 | 0.10 | ±0.01 |
| OsPAL9 | 0.01 | ±0.00 | 0.37 | ±0.02 | 0.88 | ±0.10 | 0.20 | ±0.03 | 0.00 | ±0.00 |

**Table S10**. The qRT-PCR gene expressions of 27 genes in the mutant C17.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Genes** | **I** | | **II** | | **III** | | **IV** | | **V** | |
| Os4CL1 | 0.14 | ±0.01 | 0.51 | ±0.04 | 1.69 | ±0.11 | 0.19 | ±0.01 | 0.03 | ±0.00 |
| Os4CL3 | 18.00 | ±1.38 | 58.06 | ±3.89 | 107.35 | ±11.48 | 37.47 | ±3.31 | 77.74 | ±0.82 |
| Os4CL5 | 0.27 | ±0.02 | 1.92 | ±0.03 | 0.70 | ±0.04 | 0.03 | ±0.00 | 0.01 | ±0.00 |
| OsC3H | 7.64 | ±0.05 | 15.76 | ±0.66 | 21.94 | ±2.20 | 7.08 | ±0.77 | 4.49 | ±0.41 |
| OsC4H2 | 0.00 | ±0.00 | 0.02 | ±0.00 | 0.02 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsCAD1 | 2.06 | ±0.10 | 3.63 | ±0.34 | 6.89 | ±0.25 | 1.77 | ±0.04 | 2.55 | ±0.33 |
| OsCAD2 | 1.33 | ±0.13 | 3.54 | ±0.29 | 6.86 | ±0.64 | 1.76 | ±0.17 | 1.80 | ±0.22 |
| OsCAD8A | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.01 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsCAD8C | 0.47 | ±0.01 | 0.77 | ±0.06 | 1.37 | ±0.07 | 0.22 | ±0.02 | 0.06 | ±0.00 |
| OsCCoAOMT1 | 1.57 | ±0.02 | 3.85 | ±0.32 | 6.77 | ±0.33 | 1.32 | ±0.07 | 1.47 | ±0.06 |
| OsCCoAOMT5 | 5.90 | ±0.46 | 19.16 | ±1.48 | 16.88 | ±0.44 | 1.12 | ±0.12 | 5.08 | ±0.44 |
| OsCCR1 | 0.01 | ±0.00 | 0.07 | ±0.00 | 0.09 | ±0.00 | 0.02 | ±0.00 | 0.16 | ±0.01 |
| OsCCR2 | 0.07 | ±0.00 | 0.29 | ±0.03 | 0.20 | ±0.00 | 0.00 | ±0.00 | 0.02 | ±0.00 |
| OsCCR3 | 0.00 | ±0.00 | 0.01 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsCCR8 | 5.83 | ±0.23 | 5.29 | ±0.21 | 1.25 | ±0.10 | 0.26 | ±0.01 | 0.30 | ±0.03 |
| OsCOMT | 13.66 | ±0.82 | 40.44 | ±1.40 | 105.03 | ±4.37 | 20.24 | ±2.12 | 27.78 | ±3.85 |
| OsCOMTL4 | 1.10 | ±0.01 | 1.58 | ±0.10 | 3.67 | ±0.09 | 1.69 | ±0.17 | 0.56 | ±0.07 |
| OsCOMTL6 | 0.02 | ±0.00 | 0.04 | ±0.00 | 0.06 | ±0.00 | 0.20 | ±0.01 | 0.27 | ±0.04 |
| OsF5H1 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.02 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsF5H2 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsF5H3 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsHCT1 | 4.26 | ±0.05 | 8.35 | ±0.84 | 13.94 | ±0.37 | 5.78 | ±0.56 | 14.88 | ±0.71 |
| OsHCT2 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsHCT3 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsPAL2 | 0.17 | ±0.01 | 0.66 | ±0.06 | 0.94 | ±0.03 | 0.10 | ±0.01 | 0.18 | ±0.01 |
| OsPAL8 | 5.68 | ±0.40 | 15.94 | ±0.44 | 7.27 | ±0.38 | 1.03 | ±0.07 | 1.46 | ±0.12 |
| OsPAL9 | 0.92 | ±0.07 | 1.89 | ±0.15 | 0.59 | ±0.02 | 0.05 | ±0.00 | 0.00 | ±0.00 |

**Table S11.** The qRT-PCR gene expressions of 27 genes in the mutant Y102.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Genes** | **I** | | **II** | | **III** | | **IV** | | **V** | |
| Os4CL1 | 0.10 | ±0.00 | 0.10 | ±0.01 | 0.06 | ±0.00 | 0.05 | ±0.00 | 0.01 | ±0.00 |
| Os4CL3 | 8.31 | ±0.74 | 15.32 | ±0.37 | 9.65 | ±0.37 | 17.82 | ±1.06 | 0.74 | ±0.05 |
| Os4CL5 | 0.12 | ±0.00 | 0.12 | ±0.01 | 0.17 | ±0.01 | 0.49 | ±0.04 | 0.00 | ±0.00 |
| OsC3H | 16.76 | ±1.45 | 13.34 | ±0.42 | 48.41 | ±4.17 | 44.16 | ±4.18 | 8.29 | ±0.37 |
| OsC4H2 | 0.03 | ±0.00 | 0.01 | ±0.00 | 0.05 | ±0.00 | 0.02 | ±0.00 | 0.01 | ±0.00 |
| OsCAD1 | 5.87 | ±0.12 | 4.14 | ±0.14 | 5.99 | ±0.36 | 8.69 | ±0.48 | 3.00 | ±0.40 |
| OsCAD2 | 2.70 | ±0.13 | 2.58 | ±0.09 | 18.12 | ±1.91 | 10.46 | ±0.23 | 1.84 | ±0.27 |
| OsCAD8A | 0.06 | ±0.00 | 0.00 | ±0.00 | 0.04 | ±0.00 | 0.00 | ±0.00 | 0.01 | ±0.00 |
| OsCAD8C | 1.08 | ±0.15 | 1.40 | ±0.06 | 0.56 | ±0.04 | 0.57 | ±0.04 | 0.09 | ±0.01 |
| OsCCoAOMT1 | 5.50 | ±0.31 | 5.16 | ±0.13 | 14.69 | ±1.03 | 15.92 | ±1.13 | 3.03 | ±0.47 |
| OsCCoAOMT5 | 10.68 | ±0.04 | 11.44 | ±0.82 | 43.65 | ±1.52 | 23.30 | ±1.39 | 6.08 | ±0.72 |
| OsCCR1 | 0.01 | ±0.00 | 0.03 | ±0.00 | 0.72 | ±0.02 | 1.10 | ±0.08 | 0.29 | ±0.03 |
| OsCCR2 | 0.12 | ±0.00 | 0.13 | ±0.01 | 0.36 | ±0.01 | 0.56 | ±0.05 | 0.06 | ±0.00 |
| OsCCR3 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsCCR8 | 2.14 | ±0.11 | 1.61 | ±0.05 | 1.25 | ±0.07 | 0.54 | ±0.04 | 0.04 | ±0.01 |
| OsCOMT | 77.09 | ±4.05 | 53.57 | ±4.00 | 220.95 | ±6.24 | 274.24 | ±18.23 | 36.37 | ±3.50 |
| OsCOMTL4 | 3.98 | ±0.40 | 3.40 | ±0.33 | 1.14 | ±0.02 | 3.16 | ±0.16 | 0.41 | ±0.03 |
| OsCOMTL6 | 0.26 | ±0.01 | 0.11 | ±0.00 | 0.11 | ±0.01 | 1.09 | ±0.15 | 0.28 | ±0.02 |
| OsF5H1 | 0.01 | ±0.00 | 0.01 | ±0.00 | 0.00 | ±0.00 | 0.01 | ±0.00 | 0.00 | ±0.00 |
| OsF5H2 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsF5H3 | 0.01 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsHCT1 | 6.73 | ±0.31 | 8.62 | ±0.28 | 41.41 | ±2.30 | 37.75 | ±1.97 | 21.33 | ±2.64 |
| OsHCT2 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsHCT3 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 | 0.00 | ±0.00 |
| OsPAL2 | 0.62 | ±0.02 | 1.07 | ±0.06 | 5.57 | ±0.23 | 3.92 | ±0.38 | 0.80 | ±0.06 |
| OsPAL8 | 4.31 | ±0.39 | 5.31 | ±0.14 | 45.90 | ±0.37 | 53.08 | ±4.08 | 7.99 | ±0.97 |
| OsPAL9 | 0.32 | ±0.03 | 0.40 | ±0.05 | 0.45 | ±0.03 | 0.47 | ±0.02 | 0.00 | ±0.00 |