Supplementary Material

**Supplementary Table S1. Environmental conditions.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Location | Years | Months | Temperature (°C) | | | Relative  humidity (%) | Precipitation (mm) | Sunshine duration  (h) | Solar radiation (MJ/m2) |
| Mean | Max. | Min. |
| Suwon | 2015 | May | 18.2 | 24.9 | 12.2 | 63.0 | 32.6 | 278.8 | 561.9 |
| June | 23.1 | 29.0 | 18.2 | 66.0 | 30.2 | 245.3 | 519.1 |
| July | 25.5 | 30.0 | 22.1 | 78.0 | 225.8 | 165.8 | 412.1 |
| August | 26.2 | 31.3 | 22.5 | 78.0 | 71.0 | 205.7 | 439.4 |
| September | 22.1 | 27.9 | 16.9 | 66.0 | 6.9 | 241.6 | 420.0 |
| 2016 | May | 19.1 | 25.9 | 13.1 | 65.0 | 156.4 | 272.8 | 548.7 |
| June | 23.2 | 28.9 | 18.8 | 73.0 | 37.4 | 235.6 | 515.2 |
| July | 26.0 | 30.2 | 22.9 | 83.0 | 317.7 | 146.8 | 392.9 |
| August | 27.7 | 32.8 | 24.0 | 73.0 | 73.0 | 230.9 | 465.9 |
| September | 22.7 | 27.6 | 18.9 | 75.0 | 67.8 | 163.2 | 334.7 |
| Max., maximum temperature; Min, minimum temperature. | | | | | | | | | |

**Supplementary Table S3.** **Variation in leaf rolling index (LRI) among recombinant inbred lines (RILs) and both of their parents (T887 and M23).**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Field test 1 (FT 1)a | | Field test 2 (FT 2)a | |
| FLRI | SLRI | FLRI | SLRI |
| Number of values | 158 | 158 | 158 | 147 |
| LRI range | 0–93.3 | 0–70.4 | 0–95.8 | 0–81.8 |
| Average LRI | 27.8 | 21.3 | 25.2 | 12.5 |
| Coefficient of variation | 0.76 | 0.88 | 0.88 | 1.02 |
|  |  |  |  |  |
| Average LRI of T887 | 10.3 | 5.4 | 14.1 | 3.1 |
| Average LRI of M23 | 23.8 | 24.1 | 29.3 | 26.5 |

aFLRI, flag leaf rolling index; SLRI, secondary leaf rolling index.

**Supplementary Table S4.** **Statistics of the genetic map.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Chr. | Marker number | Genetic distance (cM) | Physical map (Mb) | No. of markers per cM | No. of markers per Mb |
| 1 | 400 | 148.8 | 43.3 | 2.7 | 9.2 |
| 2 | 1243 | 148.6 | 35.9 | 8.4 | 34.6 |
| 3 | 441 | 110.5 | 36.4 | 4.0 | 12.1 |
| 4 | 561 | 120.8 | 35.5 | 4.6 | 15.8 |
| 5 | 44 | 54.2 | 30.0 | 0.8 | 1.5 |
| 6 | 262 | 93.1 | 31.3 | 2.8 | 8.4 |
| 7 | 1387 | 120.6 | 29.7 | 11.5 | 46.7 |
| 8 | 443 | 117.2 | 28.4 | 3.8 | 15.6 |
| 9 | 104 | 82.7 | 23.0 | 1.3 | 4.5 |
| 10 | 593 | 98.6 | 23.2 | 6.0 | 25.5 |
| 11 | 560 | 123.4 | 29.0 | 4.5 | 19.3 |
| 12 | 102 | 59.6 | 27.5 | 1.7 | 3.7 |
| Total | 6140 | 1278.1 | 373.3 | 4.8 | 16.5 |

**Supplementary Table S5.** **Summary of QTLs affecting FLRI and SLRI.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Field test | Trait | Chr.a | QTL position (Mb)b | Left markerb | Right markerb | LOD | PVE (%) | Add |
| FT 1 | FLRI | 1 | **4.05 - 4.67** | **01id\_4052916** | **01id\_4673121** | 6.9 | 10.0 | -6.8 |
|  |  | 1 | 27.56 - 27.57 | sch01\_27560281 | sch01\_27566411 | 2.6 | 3.7 | -4.0 |
|  |  | 4 | 31.03 - 31.07 | sch04\_31030709 | sch04\_31070764 | 3.3 | 4.4 | 4.6 |
|  |  | 5 | **20.41 - 23.05** | **05id\_20410437** | **05id\_23047412** | 11.4 | 21.0 | 9.6 |
|  |  | 9 | **19.29 - 19.7** | **sch09\_19288183** | **sch09\_19699833** | 9.3 | 14.1 | -8.3 |
|  | SLRI | 1 | **4.05 - 4.67** | **01id\_4052916** | **01id\_4673121** | 5.1 | 7.0 | -5.0 |
|  |  | 5 | **20.41 - 23.05** | **05id\_20410437** | **05id\_23047412** | 9.4 | 16.7 | 7.7 |
|  |  | 6 | 23.36 - 23.45 | sch06\_23360101 | sch06\_23448492 | 2.9 | 3.8 | -3.8 |
|  |  | 7 | 7.78 - 7.91 | sch07\_7781158 | sch07\_7912666 | 4.7 | 6.5 | -4.8 |
|  |  | 9 | **19.29 - 19.7** | **sch09\_19288183** | **sch09\_19699833** | 14.4 | 23.9 | -9.6 |
| FT 2 | FLRI | 1 | **4.05 - 4.67** | **01id\_4052916** | **01id\_4673121** | 11.0 | 15.2 | -8.7 |
|  |  | 1 | 26.42 - 26.7 | sch01\_26424385 | sch01\_26701198 | 3.3 | 4.1 | -4.5 |
|  |  | 4 | 32.41 - 32.59 | ich04\_32414834 | sch04\_32591693 | 2.8 | 3.4 | 4.1 |
|  |  | 5 | **20.41 - 23.05** | **05id\_20410437** | **05id\_23047412** | 11.3 | 18.3 | 9.4 |
|  |  | 7 | 4.19 - 4.22 | sch07\_4194621 | sch07\_4221283 | 2.5 | 3.1 | -4.0 |
|  |  | 9 | 7.2 - 7.52 | ich09\_7197158 | sch09\_7521988 | 3.3 | 4.1 | -4.5 |
|  |  | 9 | **19.29 - 19.7** | **sch09\_19288183** | **sch09\_19699833** | 8.5 | 11.3 | -7.8 |
|  | SLRI | 1 | **4.05 - 4.67** | **01id\_4052916** | **01id\_4673121** | 2.9 | 4.5 | -3.8 |
|  |  | 2 | 21.33 - 21.38 | sch02\_21334899 | sch02\_21380162 | 3.8 | 5.6 | -4.2 |
|  |  | 5 | **20.41 - 23.05** | **05id\_20410437** | **05id\_23047412** | 10.0 | 16.5 | 7.2 |
|  |  | 7 | 14.51 - 14.61 | sch07\_14510128 | ich07\_14614284 | 6.5 | 9.9 | -5.5 |
|  |  | 9 | **19.29 - 19.7** | **sch09\_19288183** | **sch09\_19699833** | 11.1 | 18.2 | -7.8 |

aChr., chromosome; LOD, logarithm of odds; PVE, phenotypic variance explained by QTL; add, additive effect.  
Negative and positive additive effects mean that each allelic effect was derived from T887 and M23, respectively.  
bBold letters indicate significant loci affecting FLRI and SLRI in both field tests.

**Supplementary Table S6. Analysis of variance (ANOVA) of the agronomic traits of NILs and each recurrent parent.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Agronomic traitsa | | | |
| Genotype | Panicle number | Panicle dry weight (g) | Plant dry weight (g) | Total dry weight (g) |
| T887 | 8 ± 1.1 | 18.4 ± 3 | 14.1 ± 2.5 | 32.5 ± 3.7 |
| T887-*qARO9*M23 | 8.3 ± 0.6 | 16.4 ± 1.3 | 13.9 ± 2.7 | 30.3 ± 3.4 |
| T887-*qARO1*M23+*qARO9*M23 | 8.7 ± 1.5 | 18.4 ± 4.7 | 13.5 ± 1.7 | 31.8 ± 6 |
| ANOVA | ns | ns | ns | ns |
|  |  |  |  |  |
| M23 | 7.4 ± 1.5 | 27.6 ± 5.4 | 22.2 ± 4.3 | 49.7 ± 9.5 |
| M23-*qARO9*T887 | 8 ± 1 | 30.4 ± 3.2 | 21.1 ± 4.5 | 51.5 ± 4.7 |
| M23-*qARO1*T887+*qARO9*T887 | 8.2 ± 0.8 | 24 ± 2.4 | 24.8 ± 2.6 | 47.7 ± 5 |
| ANOVA | ns | ns | ns | ns |

aData represent mean ± standard deviation (SD). ns, non-significant.