**Supplementary Table S1**. Eigen value, individual and cumulative percentage variations of five principal components based on 12 qualitative traits in two mutant populations.

|  |  |  |
| --- | --- | --- |
| **PC** | **Hassawi 2 mutant population** | **ILB4347 mutant population** |
| **Eigen value** | **Variability (%)** | **Cumulative (%)** | **Eigen value** | **Variability (%)** | **Cumulative (%)** |
| 1 | 1.94 | 50.92 | 50.92 | 2.16 | 34.22 | 34.22 |
| 2 | 0.64 | 16.93 | 67.85 | 1.54 | 24.42 | 58.63 |
| 3 | 0.45 | 11.81 | 79.66 | 0.68 | 10.69 | 69.33 |
| 4 | 0.26 | 6.75 | 86.42 | 0.61 | 9.57 | 78.90 |
| 5 | 0.19 | 5.02 | 91.44 | 0.48 | 7.64 | 86.54 |

**Supplementary Table S2**. Eigen vectors of the traits for five principle component analysis in Hassawi 2 mutant population.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Traits** | **PC 1** | **PC 2** | **PC 3** | **PC 4** | **PC 5** |
| Flag petalcolor | -0.21 | 0.31 | -0.15 | 0.43 | 0.61 |
| Anthocyanin | -0.16 | 0.25 | -0.04 | 0.29 | 0.33 |
| Wing petal color | -0.04 | 0.07 | -0.08 | -0.14 | 0.09 |
| Streaks intensity | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Streak color | -0.01 | 0.01 | -0.04 | 0.02 | 0.06 |
| Leaf shape | 0.02 | 0.72 | 0.22 | -0.63 | 0.12 |
| Leaf size | -0.03 | 0.51 | 0.23 | 0.51 | -0.62 |
| Stem pigmentation | 0.96 | 0.08 | 0.07 | 0.18 | 0.20 |
| Seed shape | -0.03 | -0.03 | 0.07 | -0.07 | 0.14 |
| Seed color | -0.11 | -0.24 | 0.92 | 0.08 | 0.22 |
| Hilum color | -0.02 | -0.01 | 0.03 | 0.00 | 0.02 |
| Growth habit | 0.01 | 0.03 | -0.06 | -0.09 | -0.05 |

**Supplementary Table S3**. Eigen vectors of the traits for five principle component analysis in ILB4347 mutant population.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Traits** | **PC 1** | **PC 2** | **PC 3** | **PC 4** | **PC 5** |
| Flag petal color  | -0.20 | -0.09 | 0.79 | 0.14 | -0.54 |
| Anthocyanin | -0.31 | 0.07 | 0.44 | 0.15 | 0.79 |
| Wing petal color | 0.45 | 0.16 | 0.09 | 0.66 | 0.14 |
| Streaks intensity | -0.49 | 0.12 | 0.00 | -0.31 | 0.11 |
| Streak color | 0.16 | 0.18 | 0.10 | 0.06 | 0.03 |
| Leaf shape | 0.03 | -0.02 | 0.08 | 0.04 | 0.02 |
| Leaf size | 0.01 | 0.00 | 0.08 | 0.04 | -0.07 |
| Stem pigmentation | 0.45 | -0.70 | 0.25 | -0.38 | 0.24 |
| Seed shape | 0.06 | -0.02 | 0.00 | 0.03 | 0.02 |
| Seed color | 0.43 | 0.65 | 0.29 | -0.51 | 0.04 |
| Hilum color | 0.05 | -0.05 | -0.01 | 0.11 | 0.04 |
| Growth habit | -0.02 | 0.00 | 0.00 | 0.02 | 0.02 |